1 Adult Critical Care

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1 Summary

Introduction

Adult critical care is an important, high-profile and high-cost area of modern healthcare provision. This chapter aims to provide an objective synthesis of evidence available from published and other sources that can inform debate on the planning of critical care services.

Definition of critical care

The term ***critical care*** has been defined as:

> *care for patients who have potentially recoverable conditions who can benefit from more detailed observation (with or without invasive treatment) than can be provided safely in an ordinary ward.*[1]

Background to the development of critical care services

Critical care services are atypical in the wide heterogeneity of their patients. This is in part a reflection of the way in which these services have evolved.

The progress of intensive care in the UK has been described as 'haphazard', consisting of 'largely unplanned and unevaluated' developments that occurred in reaction to changes in surgical and medical practice.

There has been debate about the configuration of critical care services, fuelled by a perception that there are not enough beds in some parts of the country and that existing beds are not in the right places.

During the late 1990s, the NHS Executive established a National Expert Group to review adult critical care services in the UK and to produce a national Framework for future organisation and care delivery. As a result, in May 2000 a critical care modernisation plan was announced.

Scope of this chapter

Throughout this chapter, we present and discuss both UK and international research findings on adult critical care services. Data on the profile of service provision, utilisation and associated costs relate to England and Wales unless otherwise stated.

Critical care services have previously been differentiated into intensive care and high-dependency care. The critical care modernisation plan announced in May 2000 introduced the notion that adult acute care should be seen as a spectrum, classified across four levels, much as paediatric critical care is organised. The four levels are:

- Level 0 – normal acute ward care
- Level 1 – acute ward care, with additional advice and support from the critical care team
- Level 2 – more detailed observation or intervention
- Level 3 – advanced respiratory support alone, or basic respiratory support together with support of at least two organ systems.

Sub-categories

In contrast with needs assessments for disease groups, where disease classification is central to the discussion and is relatively straightforward, in critical care practice it is difficult to classify and group clinical data into defined categories or hierarchies. Healthcare Resource Groups (HRGs) or Diagnosis Related Groups (DRGs) are used to categorise patients on the basis of diagnosis; but this approach is not applicable in critical care, where there is wide heterogeneity within diagnostic groups.[?]

Patients can be categorised by severity of illness; on the basis of demographic characteristics; on more precise measures of severity of illness; or according to the organ systems needing monitoring or support.

Epidemiology of critical care

Age and gender

There is evidence that critical care patients are mostly males and that a high proportion are elderly.

Intensive Care National Audit and Research Centre (ICNARC) data show that 4.8% of admissions are in the age range 0–17, and that 46.5% of admissions are of people aged 65 years or over. The mean age of patients is 57.3 years.

Types of admission

Intensive care

There is evidence that the greatest proportion of admissions to ICUs are for medical emergencies (41%), followed by planned admissions from elective surgery (25%) and emergency surgical admissions (18%). There are more recent data suggesting that the proportion of non-surgical admissions to ICUs is increasing.

The most common source of admission to intensive care is theatre or recovery in the same hospital (44.1%), followed by a ward in the same hospital (22.3%) and A&E in the same hospital (17.1%).

High-dependency care

There is little information available on the types of admission and diagnostic categories of patients in HDUs in the UK, but the Augmented Care Period (ACP) dataset, introduced in 1997, will go some way towards addressing this.

Several studies have examined the potential for using HDU beds to alleviate some of the demand on ICU beds, by differentiating between those patients requiring high-dependency care and those requiring intensive care.

The reclassification of critical care into three levels, announced in the critical care modernisation plan in May 2000, will lead to a better reflection of severity in activity data.

Indications for admission

One study reported that over 70% of admissions to ICUs were in the cardiovascular or respiratory categories. Other data show that the ten most frequent reasons for admission are:

- Aortic or iliac dissection or aneurysm – surgical
- Acute myocardial infarction – non-surgical
- Pneumonia, with no organism isolated – non-surgical
- Bacterial pneumonia – non-surgical
- Septic shock – non-surgical
- Primary brain injury – non-surgical
- Large bowel tumour – surgical
- Left ventricular failure – non-surgical
- Asthma attack in a new or known asthmatic – non-surgical
- Non-traumatic large bowel perforation or rupture – surgical.

The most common condition admitted made up only 6.5% of admissions, and the top ten conditions made up only 26.8% of admissions.

The ten conditions that use the greatest number of bed-days are as follows:

- Bacterial pneumonia – non-surgical
- Pneumonia, with no organism isolated – non-surgical
- Aortic or iliac dissection or aneurysm – surgical
- Septic shock – non-surgical
- Primary brain injury – non-surgical
- Non-traumatic large bowel perforation or rupture – surgical
- Acute myocardial infarction – non-surgical
- Exacerbation of chronic obstructive airways disease – non-surgical
- Inhalation pneumonitis (gastrointestinal contents) – non-surgical
- Non-cardiogenic pulmonary oedema (ARDS) – non-surgical.

These conditions made up 32.8% of bed-days.

Severity of illness

Patients are usually admitted to intensive care because of the severity of their illness, rather than solely on the underlying diagnosis. Studies of ICUs have shown a considerable range in the mean APACHE II score for patients admitted.

The critical care modernisation plan introduced an approach to the classification of critical care that reflects the variable severity of illness.

Length of stay

It is essential that the length of stay in critical care be defined in terms of fractions of days rather than whole days, because many patients are admitted for periods of only a few hours. One study reported the median length of stay in ICUs as 1.6 days, while another dataset indicates an overall median length of stay of 2 days, and an average of 5.02. Mean length of stay is consistently higher than median length of stay, indicating that outlying lengthy periods have skewed the average.

Population demand for critical care

The need for intensive care is related to the severity of the patient's clinical condition and the need for invasive monitoring and treatment. Establishing the need for critical care beds is therefore problematic, and one is restricted to establishing some measure of demand for beds.

A mismatch between the continuum of health needs and the management of illness in hospitals may inflate the demand for critical care services. General advances in medicine and surgery and changes in surgical practice may also increase the demand on facilities.

Numbers of admissions to ICUs and HDUs

One estimate of admission rates to ICUs is 92.8 per 100 000 population. Another estimate, using data for the North West region, identified 154 admissions per 100 000, but noted several possible sources of bias.

Although information is available about the demand for critical care, until recently there was none relating to population need. A prospective assessment of the need for both intensive care and high-dependency care beds has recently been published. It concluded that to meet the needs of a population of 500 000 on 95% of occasions would require 30 intensive care beds and 55 high-dependency care beds if these were provided in a single unit; and if they were provided in three separate units, the number of beds would increase by 10%.

Occupancy levels

Occupancy is often used as a measure of health service activity, indicating the activity of an inpatient unit in terms of its maximum capacity. There are several different methods of calculating bed occupancy, and the choice of method can have a significant impact.

One study reported the median average occupancy to be 83% in ICUs, 81% in combined ICU/HDUs and 74% in HDUs. Another study of London ICUs found 86% occupancy, with some as high as 95%.

These levels of occupancy seem inappropriately high for a service expected to respond to unpredictable emergencies.

Unmet demand

One study found a wide variation across trusts in the proportion of patients refused intensive care admission owing to lack of beds. There is evidence that refusal rates are influenced by type of unit, type of hospital and staffing, and that patients who are refused admission to intensive care have worse outcomes.

Substantial numbers of transfers occur because of bed shortages. Such transfers indicate bed shortage in the originating unit and may not reflect shortages across an entire system.

There is evidence from transfers data that shows markedly increased demand during the winter.

There is research to suggest that the most common indications for transfers are referrals for neurosurgical care, lack of beds in ICU and lack of renal support services.

For a patient needing intensive care following major elective surgery, the lack of a bed will often cause the operation to be cancelled at the last minute, since only then will the bed situation be known with certainty. One study suggested that a lack of intensive care beds had caused 124 out of 256 units (48%) to cancel operations in an eight-week period.

In some instances, a bed may be created by prematurely discharging a patient not previously deemed ready to leave the ICU. Data suggest that over 7% of intensive care survivors are discharged early because of a shortage of unit beds.

Limitations of the data

It should be noted that the data discussed above probably underestimate the shortfall of supply.

Estimating need from data on bed occupancy, refusals and transfers is complicated by the variations in admissions and discharge criteria.

The Augmented Care Period (ACP) dataset was introduced in 1997 to collect data on intensive and high-dependency care activity for patients other than neonates, enabling the level of care that patients receive to be identified.

Early analyses of limited ACP datasets suggest that a significant number of days of intensive or high-dependency care may be provided in inappropriate locations.

International comparisons

There is some evidence that smaller bed numbers in the United Kingdom mean that only the most severely ill patients are admitted.

In the USA, up to about 20% of patients receive care in an ICU or CCU at some time during their stay in hospital, but the use of intensive care is much less common in Europe. However, without case-mix data it is questionable whether such international comparisons are helpful.

Future demand

Indications are that the demand for critical care in the future will grow. Increasingly aggressive surgery is likely to escalate the demand for high-dependency and intensive care. If the current shortage in donor organs is corrected, more frequent transplant activity will also increase the pressure on critical care.

Services available and their costs

Service provision in England and Wales

The haphazard development of critical care has led to a marked variability in the provision of these services across the country. Until the announcement of the critical care modernisation programme in May 2000 there had been no national or even regional strategy for critical care. As a consequence, the number of intensive care beds and the spending on intensive care per head of population, in relation to population figures, have varied considerably.

There is currently a substantial debate about the configuration of intensive care services, fuelled by a perception that there are not enough beds in some parts of the country and that existing beds may not be in the right places. Surveys have confirmed substantial variation in the provision of critical care beds.

Little routine statistical information has previously been available for critical care. The ACP dataset should go some way to meeting this need, and additional information is now available through the Audit Commission and through initiatives such as ICNARC.

The critical care modernisation plan calls for a data-collecting culture, promoting an evidence base, and requires NHS trusts to comply with the ACP dataset.

A recent study found 521 critical care units in operation in England and Wales. There is evidence for great variability in configuration of critical care facilities within trusts, and there are many combinations of generalist and specialist ICUs, HDUs and combined ICU/HDUs.

One study reported data on bed numbers in individual units. The median numbers of available beds were as follows:

- 5.3 in ICUs
- 6 in combined ICU/HDUs
- 4 in HDUs.

Pattern of care provided in critical care

Data from ICNARC indicate that 54% of admissions are mechanically ventilated and 42.3% are not. Another dataset shows that the average proportion of admissions who receive ventilation is 57.8%. Evidence suggests wide variation between ICUs in the levels of dependency of their patients.

Admission guidelines

Identifying those patients most likely to benefit from critical care is one of the key challenges in providing the service.

The admission guidelines developed by a Department of Health working party in 1996 described the characteristics of intensive care and high-dependency care. These guidelines were superseded in 2000 by a new approach to categorising critical care based on three levels.

Discharge guidelines

The decision to discharge a patient from intensive care or high-dependency care will depend partly on the level of care available in the unit or ward to which the patient is to be discharged. Assessment of the continuing appropriateness of intensive care should be made at regular intervals.

The availability of step-down care within the hospital has an important influence on the decision to discharge from critical care.

Staffing

Intensive care should be a consultant-led service with considerable direct consultant input into decisions on admission, care and discharge.

Intensive care and high-dependency units are critically dependent on adequate numbers of appropriately trained nurses. One recent study found wide variations in the numbers of nurses employed.

Difficulties with recruitment and retention of nurses is one of the reasons for discrepancies between the numbers of funded and available beds. Support workers may be employed to help trained nursing staff, potentially reducing the need for nurses to perform non-nursing tasks.

A central focus of the modernisation programme for critical care was workforce development. This includes the recruitment, training and retention of medical and nursing staff, and requires a balanced skill-mix so that professional staff are able to delegate less skilled and non-clinical tasks. The programme also injected additional resources into NHS trusts for the recruitment and retention of critical care nurses.

Clinical management

Critical care units generally follow one of two different patterns of clinical management: 'closed' (in which a critical care consultant has complete responsibility for a patient) or 'open' units (in which responsibility remains with the patient's admitting consultant}.

The modernisation programme for critical care required that admission to Levels 2 and 3 of critical care should be by agreement between consultants only.

Costs

Intensive care provides care at a high cost to a small number of patients. Annual spending on intensive care in the UK has been estimated at £675 million, representing about 2% of the hospital budget. It appears that at least 50% of ICU patient costs are incurred by staffing.

Cost accounting in critical care is underdeveloped, even though critical care is an increasingly expensive speciality in the UK.

One study found a median cost per patient day of £1064 in 1994/5 and £1087 in 1995/6, and wide variation between trusts on annual costs.

Another study found the average daily patient-related cost of care to be £592 and overhead costs to be £560, resulting in a total average cost of £1152. This study found a strong, highly significant statistical correlation between (1) the Therapeutic Intervention Scoring System (TISS) and the cost of care for each calendar day, and (2) the APACHE II score and cost of the first 24-hour period.

There is evidence of high variability in the daily cost of individual critical care patients, and so top-down costing approaches that average out daily costs may be misleading. Bottom-up methodologies are more useful.

Effectiveness of services and interventions

Perceptions of constraints in supply cause questions to be raised about the appropriate use of intensive care, and, more fundamentally, about the need to determine which types of patient actually benefit from critical care.

Evidence of the effectiveness of specific interventions

For a few conditions, the benefits of intensive care are indisputable. For the majority of conditions, however, its effectiveness remains unproven. Indeed, the role of intensive care in preventing death has yet to be properly investigated.

Given the enormous heterogeneity of the case-mix, any trials in intensive care will require huge numbers of patients if these questions are to be answered.

Where such evidence exists, it clearly needs to be widely publicised. Even then, whether such strategies are adopted in practice depends on factors such as the magnitude and precision of estimates of benefit and harm, as well as access, availability and costs.

Cost effectiveness

Recent data suggest that 22% of ICU patients die before leaving the unit, a further 8% die before leaving hospital and 7% die in the first six months at home. The relatively high mortality rates in critical care patients mean that large sums of money are spent on patients who, ultimately, do not survive. Evidence from one study suggests that the 15% of ICU patients who died consumed 37% of the ICU budget.

Other research has estimated the total hospital cost per quality adjusted life year (QALY) at £7500. When the cost-per-QALY comparisons are made with other healthcare interventions, intensive care is found to lie between heart transplantation and home dialysis.

Models of care

Possible models of care

The modernisation programme for critical care called for a strategic change to modernise services, and injected additional resources into NHS trusts for the recruitment and retention of critical care nurses.

Four main elements of the programme required action by NHS trusts. These were:

- a hospital-wide approach to critical care, with services that extend beyond the physical boundaries of intensive care and high-dependency units, making optimum use of available resources, including beds
- a networked service across those NHS trusts that together serve one or more local health economies, meeting the critical care needs of those within the network, and minimising the need for transfer outside
- workforce development, including the recruitment, training and retention of medical and nursing staff, and the creation of a balanced skill-mix so that professional staff are able to delegate less skilled and non-clinical tasks
- better information, with all critical care services collecting reliable management information, and participating in outcome-focused clinical audit.

A new approach to classifying critical care was also introduced, as described earlier.

There have been suggestions that critical care services should be more centralised. This would lead to units becoming larger, a concept familiar in other countries. An inevitable consequence of centralisation or stratification is an increased need to transfer patients between hospitals.

Specialist weaning units have been proposed to address 'bed blocking' by patients dependent on ventilation and to concentrate expertise in weaning such patients.

Several recent studies have suggested that earlier recognition and intervention of seriously ill patients on general wards is likely to reduce their need for critical care, and have proposed the development of 'outreach' services from critical care specialists to support ward staff in managing patients at risk.

The role of intermediate care

Some commentators see the existence of intermediate care as a way of managing illness that matches the continuum of health needs. It has been argued that grouping patients by level of need can enable the best use to be made of available technical resources and staffing.

The critical care modernisation programme introduced a new approach to classifying critical care services across four levels, thereby matching more closely the continuum of health needs.

The focus on high-dependency care as an alternative to intensive care was made somewhat redundant by the announcement of the modernisation programme. The following discussion of high-dependency care makes some general points about having a stratified system, reflecting severity of illness.

Several studies have examined the impact of opening a high-dependency unit, finding that:

- the occupancy of intensive care beds by patients needing only high-dependency care was reduced
- the occupancy by patients needing intensive care was increased

- a significant decrease was seen in re-admissions
- ICU patients' initial severity of illness was lower and their length of stay reduced, but there was no reduction in demand for intensive care
- admissions to the ICU decreased initially as would be expected, but this was followed by an increase over the pre-HDU level of ICU admissions
- there was a significant reduction in the cancellation of elective surgery and in the number of patients transferred out of the ICU because of demand for beds.

The impact of opening an HDU in a given hospital will depend on the case-load and case-mix that it sees, plus the extent to which existing facilities meet that demand.

How many beds are needed?

There is no fixed formula for the number of critical care beds needed by a trust, and it is important that the number is tailored to the workload and case-mix that the hospital treats.

The following have been put forward as factors to be considered when estimating the size of an ICU:

- number of acute beds in hospital or catchment area
- type of acute bed
- previously calculated occupancies of wards, HDUs and ICUs
- history of refusals
- location of other high-care areas
- number of operating theatres
- surgical specialities services and case-mix
- medical specialities
- A&E department
- sub-regional or regional services
- ability to transfer patients to an off-site ICU
- paediatric care
- location.

There is no firm guidance as to the optimum size for an ICU.

The number of beds needed will in part depend on how they are configured. One researcher has calculated that, to meet needs on 95% of occasions for a population of 500 000 would require 30 intensive care beds and 55 high-dependency beds if these were all in a single unit. For three separate units to meet an identical need on 95% of occasions, 10% more beds would be needed.

Detailed mathematical models have an established place in providing quantitative information about healthcare resource needs; but, to be helpful, they must be able to deal with complexity, uncertainty, variability and, sometimes, inadequate data.

Appropriate use of critical care beds

It is important that the use of critical care facilities is reserved for appropriate patients, as far as possible. This will depend in part on the facilities available, but also on the presence of experienced, suitably trained, senior clinicians able to make timely decisions on admission, on discharge and on withholding or withdrawing treatment.

Configuration and provision of critical care services

Recurring crises because of shortages of intensive care beds suggest that the present configuration of critical care services is failing, and have led to the belief that more such beds are required. However, there are data to suggest that some intensive care beds are used for patients needing only high-dependency care. Reliable information is urgently required to illuminate this area.

In the absence of adequate information, it is impossible to make explicit recommendations regarding the centralisation or stratification of critical care services. Nonetheless, given the shortcomings in the current service configuration, greater collaboration between trusts would seem desirable.

These issues were recognised in the report of the National Expert Group set up in 1999 by the NHS Executive to review adult critical care services in the UK. This resulted in a critical care modernisation plan that injected extra resources for additional staff, beds and services, and introduced a new approach to the classification of critical care services.

The notion of outreach medical emergency teams was also acknowledged in the report and resulted in a call for the establishment of such teams.

Recommendations

Provision and configuration at trust level

The provision of critical care beds must be sufficient to meet the needs of emergency referrals on at least 95% of occasions, while at the same time allowing major elective surgery to be undertaken without frequent cancellations. The numbers and types of critical care beds should be tailored to the workload and case-mix of each individual trust.

When assessing the need for critical care services in a trust, the numbers of refused admissions, premature discharges, transfers, cancelled operations and the numbers of patients being managed on general wards who would benefit from critical care should all be considered.

The configuration of the service in terms of the geographical, operational and management relationship between different levels of critical care beds needs also to be considered.

Outreach services should be developed so that seriously ill patients elsewhere in the trust can benefit from the expertise and skills of the intensive care staff, both medical and nursing.

Operational policies at inter-trust level

With a scarce, expensive resource such as critical care, trusts and their patients would benefit from a more collaborative approach than currently exists. A possible model would be one based on centralisation, along the lines of that adopted for paediatric intensive care.

Coping with pressure

Trusts should plan for an escalating response to escalating pressure, defining how and under what circumstances other resources will be called upon. Similar strategies should be agreed between trusts.

Appropriate use of resources

Critical care beds should be used for appropriate patients, and decisions on withholding and withdrawing treatment should be made in a timely manner. This requires input from appropriately trained and experienced consultants. Units should have clear guidelines covering issues such as admission, discharge, clinical care and patient transfers.

There should be sufficient numbers of general ward beds to ensure the prompt discharge of patients no longer needing critical care.

The allocation of nurses to patients should be tailored to individual patient need rather than according to rigid ratios.

Data requirements

Information on the need for, the use of, and the outcome from critical care is urgently needed to inform strategic planning.

Universal and accurate completion of the ACP dataset should be encouraged and will provide valuable data on the use of critical care facilities. All intensive care units should participate in ICNARC's Case Mix Programme.

Hospital survival after intensive care has been over-emphasised as a measure of performance. While many patients survive to leave hospital, not enough is currently known about their longer-term outcome and quality of life.

In the absence of current measures of process for critical care services, performance indicators should be defined and introduced.

Staffing needs

Trusts should review the number of consultant sessions they allocate to intensive care, to ensure that decisions on admission, discharge, transfers and withholding or withdrawing treatment are made by appropriate clinicians.

Trusts should also ensure that critical care nursing staff are being used optimally, with nurse:patient ratios tailored as far as possible to individual patient need. Consideration should be given to employing other staff to take over any non-nursing roles.

Outreach services are likely to need additional staff.

Commissioning for critical care services

At present, very few critical care units deal directly with commissioners and, for the majority, costs are theoretically built into block contracts for the major clinical specialities. The development of HRGs for critical care will help to make critical care activity and costs more explicit.

The call, in May 2000, for NHS trusts to establish Critical Care Delivery Groups, with the involvement of both medical and nursing critical care clinicians, may provide an avenue for clinicians to become more involved in contracting.

Critical care services should be specifically identified in discussions with commissioners, and intensive care clinicians should be involved in that exercise.

It may be appropriate for critical care to be considered outside the remit of PCGs except where it occurs as a planned episode following major elective surgery.

A suitable currency for critical care services remains to be defined.

Information requirements, outcome measures, targets and research priorities

Information requirements

Information is required on the need for, the use of and the outcome from critical care in order to inform strategic planning at trust, regional and national level. The paucity of such data has plagued previous attempts to review adult critical care services.

The introduction of the mandatory Augmented Care Period (ACP) dataset has given responsibility for critical care data collection to acute trusts. This requirement was reinforced by the critical care modernisation programme, announced in May 2000.

A twice-yearly national census of adult intensive care and high-dependency beds was also introduced because of a lack of basic information in this area.

In 1994, the Intensive Care National Audit and Research Centre (ICNARC) was established, offering a national Case Mix Programme for intensive care units. While at present only about 60% of units in England and Wales participate, the critical care modernisation programme called for all trusts to join ICNARC.

Outcome measures

Traditionally, the most commonly used outcome measure from critical care has been patient survival. The APACHE II method allows a case-mix-adjusted probability of hospital death to be calculated for each adult patient, enabling a standardised mortality ratio (SMR) to be derived.

Even with case-mix-adjustment, the importance of hospital survival has been somewhat over-emphasised and would not be considered adequate for other life-threatening pathologies.

Similarly, not enough is known about restoration of function and quality of life in survivors of critical illness. Patients should be evaluated in terms of their ongoing health and the extent to which they are restored to their previous lifestyle. One measure of the quality of life that may be appropriate for use with survivors is the Short Form 36.

Targets

There is an urgent need for performance indicators to be agreed and introduced for critical care services.

Research priorities

A major criticism of intensive care practice is that, despite its rapid development, it is not sufficiently underpinned by a firm basis of research. This is partly because of the ethical questions surrounding doing research in this area and the large size of samples needed.

In 1997, a joint Medical Research Council/Department of Health working party on intensive and high-dependency care highlighted the need for research and specifically identified five priority areas.

A study exploring clinicians' views of research priorities in critical care found that the priority was felt to be in the organisation and delivery of critical care.

2 Introduction and statement of the problem

Adult critical care is an important, high-profile and high-cost area of modern hospital healthcare provision. This chapter provides a comprehensive review of up-to-date research findings, and is set out under eight key headings:

- introduction to the services reviewed
- sub-categories
- epidemiology of critical care
- services available and their cost
- effectiveness of services and interventions
- models of care
- recommendations
- information requirements, outcome measures, targets and research priorities.

Our aim is to provide an objective synthesis of evidence available from published and other sources that can inform debate on the planning of critical care services.

Definition of critical care

The term ***intensive care*** has been defined by the Intensive Care Society (ICS)[1] as:

> *a service for patients who have potentially recoverable conditions, who can benefit from more detailed observation and invasive treatment than can be provided safely in an ordinary ward or high-dependency area. It is usually reserved for patients with threatened or established organ failure, often arising as a result or complication of an acute illness or trauma, or as a predictable phase in a planned treatment programme.*

In 1996, the Department of Health defined ***high-dependency care*** as providing a level of care between that of a general ward and intensive care.

The term ***critical care*** has emerged in light of the development of high-dependency care, and has been defined as:

> *care for patients who have potentially recoverable conditions who can benefit from more detailed observation (with or without invasive treatment) than can be provided safely in an ordinary ward.*[2]

Critical care, therefore, encapsulates intensive care, high-dependency care and any other care with higher observational requirements than those available on a general ward. Throughout this chapter, the term 'critical care' will be used to refer collectively to both intensive care and high-dependency care.

There are some aspects of critical care that are outside the scope of this chapter. These are highlighted later in this section.

Background to the development of critical care services

Intensive care and high-dependency services are characterised by wide heterogeneity among the patients. This is in part a reflection of the way in which these services have evolved.

Critical care evolved from the need to care for post-operative patients away from the general ward. This was recognised by Florence Nightingale in her observation of recovery areas near the operating theatre in many country hospitals.[3] In 1923, what could be claimed as the first intensive care unit (ICU) – a small facility for post-operative neurosurgical patients – was opened at the Johns Hopkins Hospital in Baltimore, USA. However, many of the procedures and treatments that are routine in ICUs today were developed during the Second World War, and subsequently in the rapid evacuation and care of those wounded in the Korean and Vietnam wars.[4]

The modern concept of the intensive care unit has largely evolved from the work of Larsen[5] in the polio epidemic in Copenhagen in 1952. He showed that deaths from respiratory failure decreased from 87% to 40% with the change from cuirasse ventilation (the 'iron lung') to manual positive pressure ventilation through a cuffed tracheostomy tube.

As new procedures and equipment were developed for the treatment of critically ill patients, there was a growth in intensive care provision during the 1960s.[6] The progress of intensive care in the UK has been described as 'haphazard',[7] consisting of 'largely unplanned and unevaluated' developments that occurred in reaction to changes in surgical and medical practice. Such developments often resulted more from local enthusiasm than from any evidence of benefit.

A paucity of information about critical care services was largely responsible for the abandonment of an attempted review by the King's Fund in 1989;[8] to a great extent, this position still applies over ten years later.

There is currently debate about the configuration of critical care services, fuelled by a perception that there are not enough beds in some parts of the country and that existing beds are not in the right places. There is certainly evidence suggesting that, at least in some places, levels of bed provision are failing to meet demand, and that many intensive care units run at occupancy levels too high for a service expected to respond to unpredictable emergencies. A widely reported case in March 1995 involved a patient being transferred from Kent to Yorkshire because of a lack of specialist neurosurgical facilities.[9] A small proportion of such cases draw the attention of the media and, by their very nature, attract considerable publicity.

In a recent initiative, the NHS Executive established a National Expert Group to review adult critical care services in the UK and to produce a national Framework for future organisation and care delivery. As a result of the report of the Group,[10] in May 2000 a critical care modernisation plan was announced,[11] which injected extra resources for additional staff, beds and services, and introduced a new approach to the classification of critical care services.

Scope of this chapter

Throughout this chapter, we present and discuss both UK and international research findings on adult critical care services. Data on the profile of service provision, utilisation and associated costs relate to England and Wales unless otherwise stated.

In this chapter, we have excluded consideration of:

- specialised units that restrict their intake to certain specialities (e.g. neurosurgical units)
- units that restrict their intake to certain patient groups (e.g. coronary care)
- services for children (i.e. paediatric intensive care).

However, our review of provision in England and Wales does include units where combined general and coronary care work is undertaken.

General intensive care units

Most ICUs are general and take both medical and surgical patients with a range of underlying diseases. Many units have a number of designated high-dependency beds, while others (usually in the absence of other high-dependency facilities) will admit high-dependency patients into intensive care beds. In much the same way, coronary care beds are sometimes provided in the same unit.[12,13] Audit Commission data[14] show that 32% of trusts have general adult ICUs and 28% have combined ICU/HDUs.

An ICU should be able to manage all the common organ system failures and hence provide respiratory support (including mechanical ventilation), circulatory support and renal support and provide the full range of invasive monitoring required for such activity[1] (*see* Figure 1).

The Department of Health[15] categorised organ system monitoring and support as follows:

1. **Advanced respiratory support**
   - mechanical ventilatory support (excluding mask continuous positive airways pressure (CPAP) or non-invasive, e.g. mask ventilation);
   - the possibility of a sudden, precipitous deterioration in respiratory function requiring immediate endotracheal intubation and mechanical ventilation.

2. **Basic respiratory monitoring and support**
   - the need for more than 40% oxygen via a fixed performance mask;
   - the possibility of progressive deterioration to the point of needing advanced respiratory support;
   - the need for physiotherapy to clear secretions at least two-hourly, whether via a tracheostomy or mini-tracheostomy or in the absence of an artificial airway;
   - patients recently extubated after a prolonged period of intubation and mechanical ventilation;
   - the need for mask CPAP or non-invasive ventilation;
   - patients who are intubated to protect the airway but need no ventilatory support and are otherwise stable.

3. **Circulatory support**
   - the need for vasoactive drugs to support arterial pressure or cardiac output;
   - support for circulatory instability owing to hypovolaemia from any cause and which is unresponsive to modest volume replacement. This will include, but not be limited to, post-surgical or gastrointestinal haemorrhage or haemorrhage related to a coagulopathy;
   - patients resuscitated following cardiac arrest where intensive or high-dependency care is considered clinically appropriate.

4. **Neurological monitoring and support**
   - central nervous system depression from whatever cause, sufficient to prejudice the airway and protective reflexes;
   - invasive neurological monitoring.

5. **Renal support**
   - the need for acute renal replacement therapy (haemodialysis, haemofiltration or haemodiafiltration).

Figure 1: ICU organ monitoring and support.

High-dependency units

The role of the HDU is to provide an intermediate 'step-up' or 'step-down' facility between the ICU and the general ward. High-dependency units deserve particular attention, as their role has been the subject of debate in recent years. In some hospitals there are separate high-dependency units. Such units can be separate entities or form part of a general ward or ICU.[16] Recent Audit Commission data indicate that 39% of acute trusts have separate HDUs,[17] while 28% have high-dependency beds in combined ICU/HDU units.

Table 1 sets out typical attributes of both care settings.[12]

Table 1: Attributes of intensive and high-dependency care.

Intensive care should provide:	High-dependency care should provide:
a designated area where such care is provided	
a clear operational policy based on a background of multidisciplinary care and effective communication	
a designated consultant as director, supported by consultants with allocated intensive care sessions sufficient to provide continuous (non-resident) availability	a designated consultant as director, with continuous cover from either the admitting speciality or intensive care
a minimum nurse:patient ratio of 1:1 throughout the 24 hours of the day, together with a nurse-in-charge plus additional nurses according to patient needs, the total number of beds and geographical arrangements within the unit. The skill-mix of nurses should reflect the physiological instability of the patient	an average nurse:patient ratio of 1:2 throughout the 24 hours of the day, together with a nurse-in-charge plus additional nurses according to patient needs, the total number of beds and geographical arrangements within the unit. The skill-mix of nurses should reflect the possibility that patients may be physiologically unstable
24-hour dedicated cover by resident trainee medical staff	continuous availability of trainee medical staff either from the admitting speciality or from intensive care
the ability to support common organ system failures – in particular, ventilatory, circulatory and renal failure	appropriate monitoring and other equipment
a sufficient case-load to maintain skills and expertise	
administrative, technical and secretarial support	
continuing education, training and audit	

Specialised units

Specialised units also exist. These include cardiothoracic surgical units, neurological and neurosurgical units as well as burns units, liver units and spinal injury units. These may operate at an intensive care level, at a high-dependency level or as combined units. Because they deal with specific disease categories, it is more appropriate to consider these units in chapters that deal with specific diseases.

Coronary care units

Coronary care unit (CCU) patients often require close patient monitoring and observation rather than intensive care.[16] Coronary care units are excluded from this chapter, as they are not considered to be a sub-category of ICUs. This also reflects the approach taken by the Department of Health in its *Guidelines on admission to and discharge from intensive care and high-dependency units*.[15]

The critical care modernisation plan, announced in May 2000,[11] introduced the notion that adult acute care should be seen as a spectrum across four levels, much as paediatric care is organised. The four levels are:

- Level 0 – normal acute ward care
- Level 1 – acute ward care, with additional advice and support from the critical care team, e.g. patients who are at risk of deterioration, or who are recovering after requiring higher levels of care
- Level 2 – more detailed observation or intervention; e.g. patients with a single failing organ system, or post-operative patients, or patients stepping down from higher levels of care
- Level 3 – advanced respiratory support alone, or basic respiratory support together with support of at least two organ systems.

Paediatric units

Paediatric units are facilities designed, staffed and equipped for the management of critically ill children. Our focus will exclude intensive care and high-dependency services for children, although any consideration of adult intensive care services should take account of the fact that children are sometimes treated in adult general or specialised ICUs, often before transfer to a specialised paediatric ICU.

3 Sub-categories

In contrast to needs assessments for disease groups, where disease classification is central to the discussion and relatively straightforward, it is difficult in critical care practice to classify and group clinical data into defined categories or hierarchies. Healthcare Resource Groups (HRGs) or Diagnosis Related Groups (DRGs) are used to categorise patients on the basis of diagnosis, but this approach is not applicable in critical care, where there is wide heterogeneity within diagnostic groups.[18]

Patients can be categorised by severity of illness, as discussed earlier. Alternatively, categories can be based on demographic characteristics, on more precise measures of severity of illness or according to the organ systems needing monitoring or support. In this section a variety of approaches to sub-categorisation have been used, according to available datasets. Data are frequently broken down into surgical and non-surgical, often with further classification below this level such as emergency and elective. Other methods of sub-categorisation are based on clinical condition, but usually encompass only the most common conditions and are therefore not exhaustive.

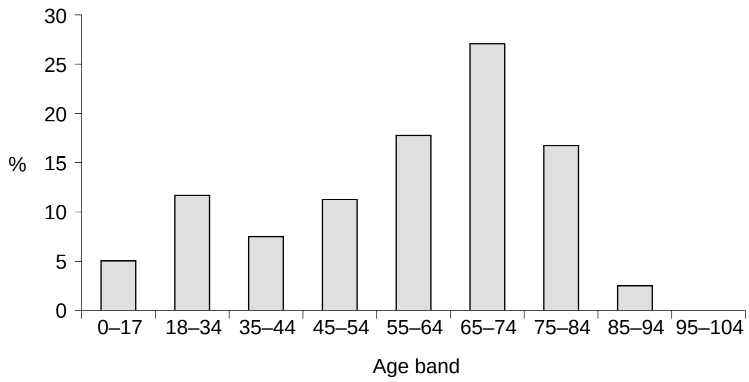
4 Prevalence and incidence

This section is in two parts: the first focuses on the characteristics of patients admitted to critical care services, and the second discusses the demand for critical care. It has been split in this way because data on the need for critical care are not available. We can only report the types of cases and the numbers presenting.

Characteristics of patients admitted to critical care

Age and gender

Dragsted and Qvist[13] concluded that there is little systematic information about the characteristics of ICU patients; but the available data showed a consistent predominance of males and a high proportion of elderly patients.



Source: ICNARC

Figure 2: Admissions to intensive care units by age, 12/95–4/98.

Figure 2 shows the age distribution across the Case Mix Programme Database (n=22 058) of the Intensive Care National Audit and Research Centre (ICNARC) for the period December 1995 to April 1998. The 62 units covered by the database are all adult units and have contributed data for varying periods.

These ICNARC data show that 4.8% of admissions were in the age range 0–17, and that 46.5% of admissions were of people aged 65 or over. The mean age of patients in this dataset is 57.3 years.

In comparison, the percentage of overall hospital admissions by age band over the period 1995 to 1998, as extracted from Hospital Episode Statistics (HES) datasets, is:

- under 18 years – 11.0%
- over 55 years – 43.2%
- over 65 years – 31.7%.

Elderly patients are likely to need more intensive care than their proportion in the hospital or general population indicates. Bull[19] suggested that the high proportion of patients aged 65 or over reflects a substantial change in clinical policy towards actively treating and resuscitating critically ill patients irrespective of age. It may also reflect more aggressive policies of medical and surgical treatment in the elderly.

Data from individual ICUs in the UK indicate that at least 50% of patients admitted in the early 1990s were aged 55 years or over.[20,21,22] The ICNARC data reflected in Figure 2 show that over 64% of admissions are now of people aged 55 or over. This may indicate that greater numbers of elderly people are being admitted to intensive care.

These data indicate a mean age of 57.3 years. As this dataset and that used by Rowan[23] included large samples, it appears that critical care patients are getting increasingly elderly. However, changes in paediatric intensive care policy following the report of the National Co-ordinating Group in 1997[24] may have resulted in fewer children being admitted to adult units, thereby causing an increase in mean age.

Data from a survey by a working party of the British Paediatric Association (BPA) indicated that in 1991 at least 20% of children receiving intensive care were admitted to adult ICUs.[25] Even very young children were being cared for in adult units: about 23% of children admitted to adult ICUs were aged under 1 year, and almost 5% were under 1 month old.[26] In the Study of Intensive Care in England[12] it was reported that 79% of general adult ICUs treated at least one child during 1992. Paediatric intensive care services have since been reorganised, but data from the Audit Commission indicate that small numbers of children are still being treated in adult units.

Our analysis of Audit Commission data[17] indicates that adult units continue to treat small numbers of children even though there has been rationalisation and improvement of paediatric critical care services.[23] Data from the Audit Commission give the median percentage of admissions under 16 years old to adult units as 1.22 for all units, 1.97 for ICUs, 1.18 for combined units and none for HDUs. It is likely that these admissions are for short periods pending transfer; however, information on length of stay is not available.

In the ICS study,[27] 60% of the patients were male, a proportion similar to that on the intensive care census day in England in 1992 (58%).[12]

Types of admission

Intensive care

Metcalfe and McPherson[12] looked at the proportions of types of admission to general ICUs in England in 1992. These are shown in Table 2. Overall, the greatest proportion of admissions were for medical emergencies (41%), followed by planned admissions from elective surgery (25%), and emergency surgical admissions (18%). However, in each category there were wide ranges in the numbers of admissions per ICU.

Table 2: Types of admission to general ICUs in England in 1992.

Type of admission	No. of ICUs	Range	Admissions	%
Elective, after elective surgery	117	1–998	11,128	25
Unplanned, after elective surgery	102	0–120	2,906	7
Emergency surgical	114	2–224	8,123	18
Emergency medical	129	0–937	18,102	41
Other	123	0–443	4,086	9
Total			44,345	100

Proportions are approximate (incomplete because the breakdowns are from different numbers of hospitals; data cover 73% of all 60,761 admissions recorded for 1992). Data from Metcalfe and McPherson.[12]

Table 3 shows types of admission reported to ICNARC's Case Mix Programme Database (n=22 058) for the period December 1995 to April 1998 compared with data from the Intensive Care Society's APACHE II study in Britain and Ireland.[27] The 62 units covered by the ICNARC's Case Mix Programme Database are all adult units and have contributed data for varying periods. Patients under 16 years old have been excluded.

Table 3 shows a marked increase in non-surgical admissions to intensive care units. Although this may reflect a true change in case-mix, several factors complicate the comparison. For example, the earlier dataset was from fewer hospitals, of which a far higher proportion were university hospitals (62% compared to 31%).

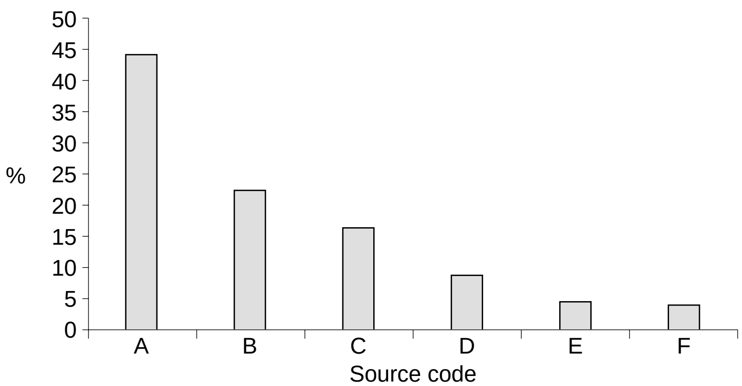
Table 3: Types of admission reported via APACHE II and ICNARC, 12/95–4/98.

APACHE II Study (1993)		**ICNARC (1995–98)**	
Type	*%*	*Type*	*%*
Surgical	52.3	Surgical	44.5
Emergency & Urgent	23.9	Emergency*	9.9
		Urgent**	9.0
Elective & Scheduled	28.3	Scheduled	10.0
		Elective	15.3
Non-surgical	47.7	Non-surgical	55.4
Total	100.0	Total	100.0

*Refers to immediate surgery where resuscitation is simultaneous with surgical treatment.
**Refers to surgery as soon as possible after resuscitation.

The Audit Commission[14] has calculated that surgical admissions to ICUs amount to 48%, while admissions to ICUs and HDUs overall amount to 47%, indicating a less pronounced decrease in surgical admissions than is shown in Table 3.

Figure 3 shows admissions to intensive care by source of admission. Data are taken from ICNARC's Case Mix Programme Database for the period December 1995 to April 1998 (n=22 058). The 62 units covered by the database have contributed data for varying periods.



Source code	*Source*
A	Theatre/recovery, same hospital
B	Ward, same hospital
C	A&E, same hospital
D	Other hospital
E	Other sources
F	Other critical care units

Source: ICNARC

Figure 3: Admissions to intensive care by source, 12/95–4/98.

The most common source of admission is theatre or recovery in the same hospital (44.1%), followed by a ward in the same hospital (22.3%) and A&E in the same hospital (17.1%).

High-dependency care

Little information is available on the types of admission and diagnostic categories of patients in HDUs in the UK, but the Augmented Care Period (ACP) dataset, introduced in 1997, will go some way towards addressing this. In the survey by Thompson and Singer of 28 HDUs in 26 hospitals in the UK and Northern Ireland,[28] information on patient admissions was available for 22 of the units, as shown in Figure 4.

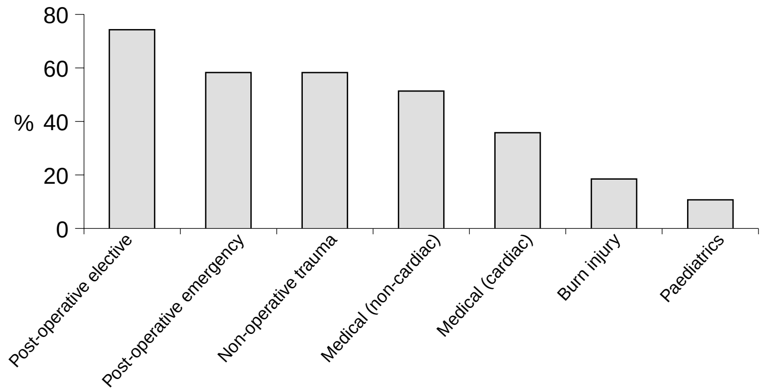


Figure 4: Patient admissions in 28 HDUs.

Unfortunately, data from the Audit Commission[14] do not describe case-mix or severity separately for high-dependency care. However, several studies[29,30,31,32,33,34] have examined the potential for HDU beds to alleviate some of the demand on ICU beds by differentiating between patients requiring high-dependency and patients requiring intensive care.

The reclassification of critical care into three levels, announced in the critical care modernisation plan in May 2000,[11] will result in a better reflection of severity within the activity data.

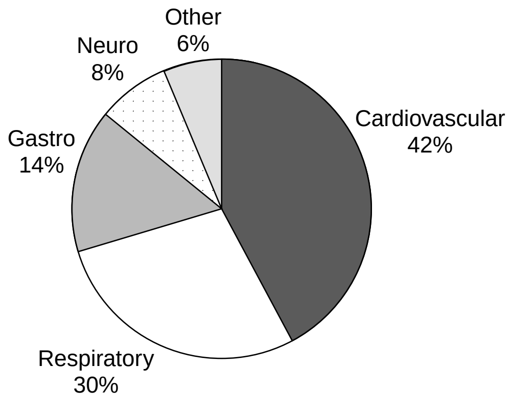
Indications for admission

In the three-month prospective audit of six general ICUs in the Study of Intensive Care in England,[12] seven diagnostic categories were used to indicate the primary system failure or insufficiency that made it necessary to admit the patient to the ICU. Over 70% of the 483 admissions were in the cardiovascular and respiratory categories (Figure 5).

The ICU is characterised by the presence of a wide variety of underlying diseases, and there is no generally accepted classification system that describes the clinical characteristics of ICU patients.[11]

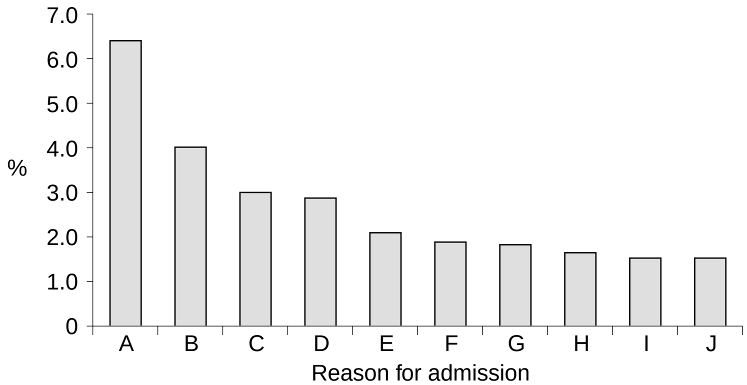
ICNARC's Case Mix Programme Database provides data on the primary reason for admission. The ten most frequent conditions admitted to ICUs during the period December 1995 to April 1998 are shown in Figure 6. The 62 units covered by the database have contributed data for varying periods.

It can be seen that the most common condition admitted made up only 6.5% of admissions, and that the top ten conditions made up only 26.8% of admissions. This indicates the high variability of reasons for admission to intensive care units.



Data are for 483 admissions; 'other' includes renal, haematological and metabolic categories.

Figure 5: Primary system failure or insufficiency leading to ICU admission.

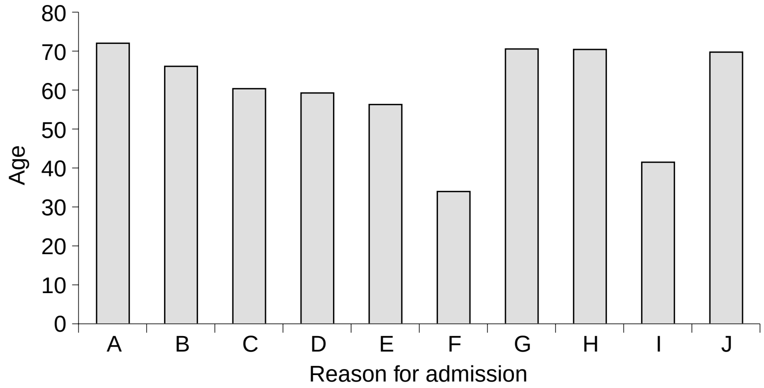


Reason code	***Primary reason***
A	Aortic or iliac dissection or aneurysm – surgical
B	Acute myocardial infarction – non-surgical
C	Pneumonia, no organism isolated – non-surgical
D	Bacterial pneumonia – non-surgical
E	Septic shock – non-surgical
F	Primary brain injury – non-surgical
G	Large bowel tumour – surgical
H	Left ventricular failure – non-surgical
I	Asthma attack in new or known asthmatic – non-surgical
J	Non-traumatic large bowel perforation or rupture – surgical

Source: ICNARC

Figure 6: Most frequent reasons for admission.

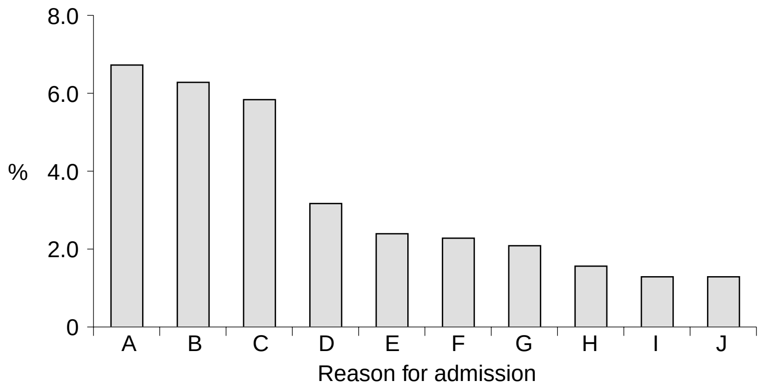
Figure 7 shows reason for admission (using the coding above) by average age of patient. Not surprisingly, primary brain injury and asthma are seen in a significantly younger population.



N.B. For codes giving the primary reason for admission, *see* Figure 6.

Figure 7: Reason for admission by average age.

The ten conditions that used the greatest number of bed-days for the period December 1995 to April 1998 are shown in Figure 8. These conditions made up 32.8% of bed-days. The 62 units covered by the database have contributed data for varying periods.



Reason code	***Primary reason***
A	Bacterial pneumonia – non-surgical
B	Pneumonia, no organism isolated – non-surgical
C	Aortic or iliac dissection or aneurysm – surgical
D	Septic shock – non-surgical
E	Primary brain injury – non-surgical
F	Non-traumatic large bowel perforation or rupture – surgical
G	Acute myocardial infarction – non-surgical
H	Exacerbation of chronic obstructive airways disease – non-surgical
I	Inhalation pneumonitis (gastrointestinal contents) – non-surgical
J	Non-cardiogenic pulmonary oedema (ARDS) – non-surgical

Source: ICNARC

Figure 8: The ten conditions using the greatest number of bed-days.

The primary reason for admission is very variable, with the greatest user of bed-days, bacterial pneumonia, making up only 6.7% of the total, and the ten conditions which consume the greatest number of bed-days making up only 32.8% of all bed-days.

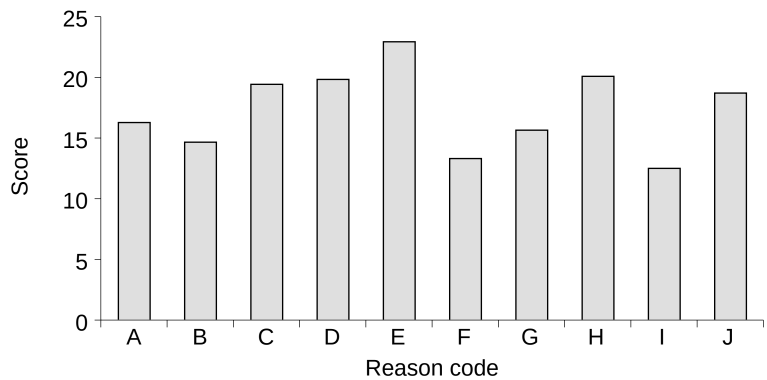
Severity of illness

Patients are usually admitted to intensive care because of the severity of their illness, rather than solely on the underlying diagnosis. Severity can be assessed by the APACHE II scoring system, a physiologically-based scoring system that incorporates weightings for age, severity of acute illness, chronic illness and operative status (*see* later in the chapter). The APACHE II score increases with increasing severity of illness: the maximum is 71, but a score rarely exceeds 55. The severity score is closely correlated with risk of death in hospital, and, when combined with a defined diagnostic category, can be used to derive a probability of death in hospital.

Studies of ICUs have shown a considerable range in the mean APACHE II score for patients admitted. In a three-month audit of six ICUs,[12] the median APACHE II score was 19.0, with a range of 1.0–54.0 (a score of 20 indicates a severely ill patient). Rowan *et al.*[23] reported an overall mean APACHE II score of 17.9 for the 26 ICUs studied; the range of means was 14.8–22.6, but the highest and lowest scores over all units ranged between 0 and 51.

There is evidence that case-mix severity in this country may be higher than in the United States. One study[35] compiled the APACHE II risk-of-death score of a group of 12 762 admissions to 15 ICUs in the North Thames region between January 1992 and May 1996. The authors found an average risk of death of 0.286, which agrees approximately with the 0.272 found by Rowan *et al*.[36] in another British study in 1993. Research from the United States[?] reported an average risk of death of 0.188 for teaching and 0.151 for non-teaching hospitals. Goldhill and Summer[35] also report that, while only two of the 15 ICUs in their study had an average risk of death of less than 0.25, only four of the 37 units in the American study[37] reported an average risk of death greater than this.

ICNARC's Case Mix Programme Database includes an APACHE II score for eligible patients (aged 16 years or over with a length of stay of eight or more hours in the unit). During the period December 1995 to April 1998 there were 19 421 eligible admissions. The mean APACHE II score was 16.29. Figure 9 shows the mean APACHE II score by the top ten conditions admitted.



N.B. For codes giving the primary reason for admission, *see* Figure 6.

Figure 9: Mean APACHE II score by the top ten conditions.

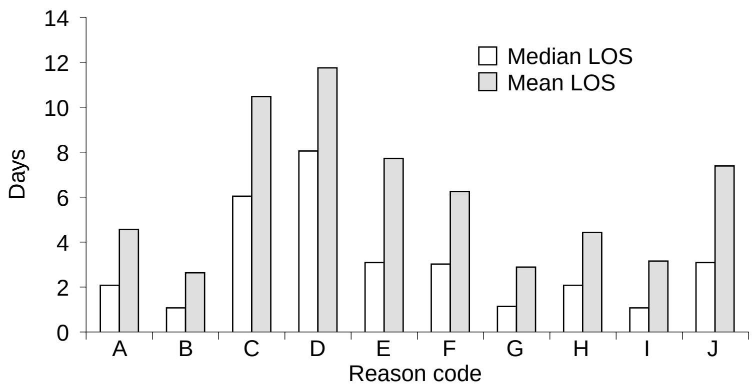
The critical care modernisation plan[11] introduced an approach to the classification of critical care that reflects variable severity of illness.

Length of stay

In the three-month audit,[12] the median length of stay over the six ICUs was 1.6 days. However, the range was very large, from less than one hour to 64.3 days.

It is essential that the length of stay in critical care be defined in terms of fractions of days rather than whole days, because many patients are admitted for periods of only a few hours. A system whose minimum unit is 1 day will fail to consider a significant proportion of patients. The use of whole days also makes occupancy figures difficult to interpret. Ridley and Rowan[38] advocate measuring length of stay in hourly units, because the duration of admission to intensive care is generally short but highly variable, and throughput is high.

ICNARC's Case Mix Programme Database provides length-of-stay data by primary reason for admission. Figure 10 shows the median and mean length of stay for the ten most frequent conditions admitted to intensive care units during the period December 1995 to April 1998.



N.B. For codes giving the primary reason for admission, *see* Figure 6.

Figure 10: Length of stay (LOS) for the top ten conditions.

ICNARC's dataset provides an overall median length of stay of 2 days, and an average of 5.02. Figure 10 also shows that the mean length of stay is consistently higher than the median length of stay, indicating that outlying lengthy periods have skewed the average.

Data for 148 non-specialist ICUs from the Royal College of Anaesthetists' national audit of intensive care in 1992/93[39] are shown in Table 4 and clearly illustrate the skewed pattern for length of stay.

Table 4: Statistics on length of stay in 148 non-specialist ICUs.

Time in ICU	Percentage of patients*	
	Mean ± SD	Range
< 24 hrs	29.93 ± 15.87	3–73
24–48 hrs	26.77 ± 11.41	10–72
2–7 days	29.77 ± 14.09	5–80
> 7 days	13.13 ± 7.40	2–55

*Proportions of all patients in all 148 ICUs, and ranges of means of patients per ICU over 148 ICUs.

Needs assessment for critical care

Population demand for critical care

The need for intensive care relates less to specific diagnoses than to the severity of the patient's clinical condition and the need for invasive monitoring and treatment. Disease conditions in the community can be monitored to a large extent by the disease group for which patients are admitted to hospital. HRGs can indicate how many people in a particular catchment area are admitted to hospital with a particular condition. This type of measure is based on the number who enter hospital, and is therefore dependent somewhat on supply; but the situation is further compounded for critical care for two reasons. Firstly, depending on the severity of the illness, a particular condition will require intensive care in only some instances. Secondly, whether or not a specific condition receives intensive care is also likely to vary from hospital to hospital.

Establishing the need for critical care beds is therefore problematic, and one is restricted to establishing some measure of demand for beds. This may underestimate the need in some instances and overestimate it in others. In some areas, competition for beds may be stronger than in others, depending on bed availability and differing criteria for admission and discharge.[12]

Various factors that increase demand on intensive care beds have been identified. Ridley[40] perceives a mismatch between the continuum of health needs and the management of illness in hospitals – the latter traditionally has been divided into specialist areas. In many hospitals, a gulf between care available in ICUs and that available in general wards has developed, and may have contributed to problems with ICU bed availability. There may be a reluctance to return to general wards those patients who, while no longer needing intensive care, might not receive there the level of care they do require. This perceived gulf supports the notion of graduated care.[41]

General advances in medicine and surgery, such as improvements in outcome following perioperative intensive care of high-risk surgical patients[42,43,44] and changes in surgical practice, may also increase the demand on intensive care facilities. There may further be a growing tendency, following the implementation of the internal market, for NHS trusts to introduce additional major surgery without investing concurrently in ICU, HDU and anaesthetic services to support such activity.[45]

In the past, any spare capacity in an ICU has been used for patients who may have been considered 'borderline'. This 'open door' policy[39] may establish a pattern whereby, in time, all such cases are admitted even though their severity of illness might not strictly justify it. Any lack of high-dependency facilities reinforces this pattern.

Numbers of admissions to ICUs and HDUs

The Audit Commission's 1998 study[14] received data on admissions from 113 of 128 ICUs in England and Wales. The total number of admissions for 1997/98 was 42 640. If this figure is extrapolated to estimate the number of admissions for all 128 units, assuming that missing data follow a similar pattern, the total number of admissions was 48 300. This gives a rate of admission to an ICU per 100 000 population (based on mid-1996 population data) of 92.8.

A separate exercise to identify the demand for intensive care beds has also been attempted, using the North West NHS region to illustrate a population rate. Table 5 shows the rate of admission to intensive care per 100 000 admissions to hospital. Hospital Episodes Statistics (HES) for 1996/97 have been used to establish general rates of hospital admission, and ICNARC data for the North West, to establish rates of intensive care use. ICBIS (the Intensive Care Bed Information Service) for the North West provided data for 1996/97 relating to transfers out of the North West.

The advantages of using the North West region were that all units there are registered with ICNARC and that it has a comprehensive intensive care bed register allowing identification of transfers out of the system.

Unfortunately ICNARC does not collect data on HDUs, so population rates of demand for high-dependency beds were not available.

Data were available from 33 intensive care units in the North West. Data covered different periods of time and were therefore scaled up to a standard period (three years). Data relating to patients under 15 years of age were removed. There were only 28 transfers out of the North West during the period.

Table 5: Rate of admission to intensive care per 100,000 admissions to hospital.

Health authority	ICU patients per 100,000 admissions: 15 years and over	Hospitalisation rate per 100,000 population per year: 15 years and over	ICU admits – age standardised rate per 100,000 pop. per year: 15 years and over	Conversion rate: hospitalisations to ICU admissions
Morecambe Bay	940	25,326	242	1.0%
South Lancashire	550	28,618	161	0.6%
St Helen & Knowsley	570	29,296	173	0.6%
NW Lancashire	810	24,014	188	0.8%
West Pennine	560	26,842	148	0.6%
Manchester	510	26,972	139	0.5%
East Lancashire	640	24,400	151	0.6%
Wirral	500	26,997	135	0.5%
Salford & Trafford	590	27,978	167	0.6%
Liverpool	460	27,975	129	0.5%
Stockport	680	26,603	180	0.7%
Sefton	570	21,979	124	0.6%
South Cheshire	630	28,092	176	0.6%
North Cheshire	630	26,431	163	0.6%
Bury & Rochdale	440	26,449	118	0.4%
Wigan & Bolton	510	25,890	130	0.5%
Average	**590**	**26,373**	**154**	**0.6%**

The hospitalisation rate given in Table 5 may appear high. This is because a large segment of the population with a proportionally lower number of episodes (i.e. those under 15 years of age) has been removed.

Two main assumptions have been made in this analysis. The first concerns missing postcode information from the ICNARC data: the pattern of postcode distribution in the data was used, assuming that there was no systematic reason for the data to be missing. Secondly, one unit gave no information on length of stay, so the overall rate was used.

The overall North West ICU admission rate is higher than that calculated from the Audit Commission data: 154 admissions per 100 000, compared with 92.8. There are several possible sources of bias: (a) Audit Commission data have been extrapolated because only 88% of units responded to this question; (b) scaling up the ICNARC data may have overestimated admissions if, for instance, there had been bed-closures during the three-year period. More information is needed from other parts of the country, and overall, about population rates of admission to intensive care.

Although information is available regarding demand for critical care, until recently there was none relating to population need. Lyons *et al.*[46] have recently published the results of a prospective assessment of need for both intensive care and high-dependency beds for a population of 500 000. They concluded that to meet the need on 95% of occasions would require 30 intensive care beds and 55 high-dependency beds if these were provided in a single unit. They suggested that if there were three separate units for the same population with equal demand, the total number of beds required to meet the need on 95% of occasions would increase by 10%.

Occupancy levels

Occupancy is often used as a measure of health service activity, indicating the activity of an inpatient unit in terms of its maximum capacity. There are several different methods of calculating bed occupancy, and the choice of method can have a significant impact. Ridley and Rowan[38] report that the impact of methodological differences in calculating the occupancy will tend to be greatest in specialised areas such as critical care, where the duration of admission is generally short but highly variable, and throughput is high.

An interpretation of occupancy calculations rests fundamentally on how accurately the length of stay is measured. If it is measured in whole numbers of days, critical care units can show an occupancy of greater than 100%, as more than one patient may use a particular bed on a given day.

The Audit Commission[15] in its 1998 survey reported the median average occupancy to be 83% in ICUs, 81% in combined ICU/HDUs and 74% in HDUs. However, occupancy was not defined in the survey.

St George's Hospital in South London conducted two one-day telephone surveys of 34 London-area intensive care units and 56 from a nationwide sample during January 1995.[29] The researchers concluded that most ICUs were running at about 86% occupancy, with some as high as 95%. The first survey, of 34 ICUs within the London M25 area, suggested that only eight intensive care beds were available in London on the day of the survey.

These levels of occupancy are high for a service expected to respond to unpredictable emergencies.

The Audit Commission[15] in its 1998 survey asked units to report on how many days there had been no spare bed with available staffing; how many patients had been refused admission because the unit was full; and how many cancelled operations there had been. These data were analysed to provide both the proportion of the year when the unit has a spare bed, and a 'refused-access rate' – the proportion of admissions refused and operations cancelled. The results are shown in Table 6.

One conclusion drawn from the telephone surveys undertaken by St George's Hospital in 1995[29] was that the number of patients in London requiring intensive care was greater than the number of beds available, with occupancy levels in ICUs ranging from 86% to 95%.

Table 6: How often an ICU has a spare bed, and the refused-access rate.

		Proportion of year with a spare bed	Refused-access rate
ICUs	– median	0.63	0.13
	– average	0.60	0.14
Combined ICU/HDUs	– median	0.67	0.10
	– average	0.59	0.12
HDUs	– median	0.43	0.07
	– average	0.44	0.25

Unmet demand

Evidence of shortfall: refusals

One of the aims of the study of the provision of intensive care in England[12] was to assess demand relative to supply by examining requests for admission, particularly those that had to be refused. It emerged that the provision of intensive care, based on the number of staffed beds, was unequal between regional health authorities, and that reported refusal rates also varied.

Part of the study prospectively examined a three-month period in six ICUs, chosen to provide a span of high, average and low bed-provision in relation to population; the overall mean refusal rate for appropriately referred patients was 18%. Although the most powerful determinant of the refusal rate was the provision of staffed beds per 100 000 population, the refusal rate was also determined by a number of other factors.

The results of multiple regression analysis demonstrated that the following factors influenced refusal rates:

- type of unit – 'unmixed' ICUs (i.e. those without high-dependency or coronary care beds) were associated with high refusal rates
- type of hospital – high refusal rates were associated with referral centres, hospitals with large numbers of other critical care beds, and district general hospitals with undergraduate teaching responsibilities
- staffing – ICUs with an exclusive director and those with high nurse staffing levels were associated with high refusal rates, and so were units in which ICU-allocated consultant sessions were shared with other duties (e.g. anaesthetics).

Metcalfe *et al.*[47] note that the number of refusals they found in their study is probably an underestimate, as some patients, not referred because hospital or ambulance staff knew that a unit was already full, may have been omitted from data collection.

In its 1998 survey, the Audit Commission[2] found a wide variation in the proportion of patients who were refused admission to intensive care because there was no bed. It ranged from none to almost 50% of requests, with a median value of 8%. Some of these patients will have been transferred to units with spare capacity.

Evidence of shortfall: transfers

Substantial numbers of transfers occur because of bed shortages. Such transfers indicate a bed shortage in the originating unit and may not reflect shortages across an entire system. Nevertheless, such transfers suggest at least deficiencies in the distribution of beds or units.

When no bed is available and none can be created, there are significant implications for the patient and relatives. One option is to transfer the patient to an alternative ICU where there is a vacant bed. This may be many miles away and entails moving a critically ill patient, with the associated risks. It also means transferring care for the patient, who may often have many and complex problems, to a team previously unfamiliar with the case. Such transfers also involve significant upheaval for the relatives, who thereafter may have to travel long distances in order to visit the patient. In some instances a bed may not be available anywhere, and it is likely that deaths have occurred in such situations.

The Emergency Bed Service (EBS), which covers London, Anglia and Oxford, South and West, South East, West Midlands and Trent Regions, records transfers and transfer enquiries. It should be noted that some transfers result from independent negotiation between consultants, and these may be missed by EBS. Therefore the data presented in Figure 11 may underestimate activity; however, the markedly increased demand during winter is clear.

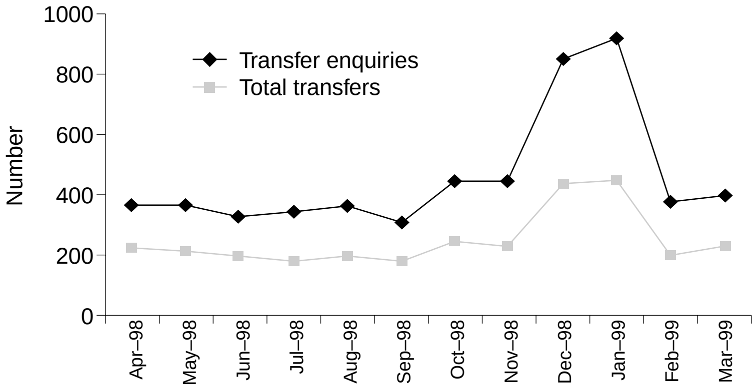


Figure 11: Emergency Bed Service – transfers and enquiries.

ICBIS monitors bed availability by telephoning each unit in the region four times a day. Figure 12 provides information on bed availability and number of transfers. The bed availability figure is an average of the four daily figures, averaged over the month. It should be noted that bed availability information reflects only the ability and willingness of units to accept patients from other hospitals, but nonetheless it represents availability from an operational perspective.

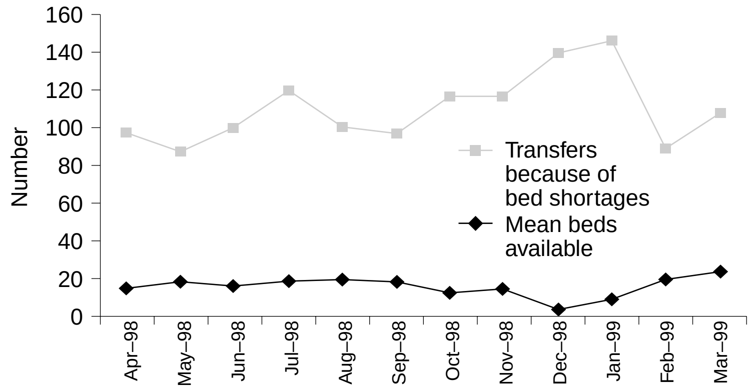


Figure 12: Beds available and transfers in the North West Region, 1998/99.

The shortage of beds experienced in December and the simultaneous increase in transfers are clear from the diagram.

Data from 198 general and mixed intensive care units in the UK, collected in 1994,[48] provided a mean annual number of admissions of 353 (range 40–1540) and a mean of 19 patients transported from each unit per year. The most common indications for these transfers were referrals for neurosurgical care (109; 55%), lack of beds in ICU (87; 44%) and lack of renal support services (54; 27%). These indications were not mutually exclusive. Only 12 ICUs transferred more than 40 patients a year to another hospital.

The authors estimate that the number of critically ill patients requiring secondary transport to adult intensive care units in Britain that year exceeded 11 000. In a large proportion of these patients, transfer was necessary for non-clinical reasons, primarily relating to a lack of intensive care beds in the originating hospital.

A national postal survey conducted by the Royal College of Anaesthetists in 1992/93[39] asked about patient transfers in the eight weeks preceding the questionnaire. Figure 13 provides information on units and numbers of patients transferred. Figure 14 shows the principal reasons for transfer.

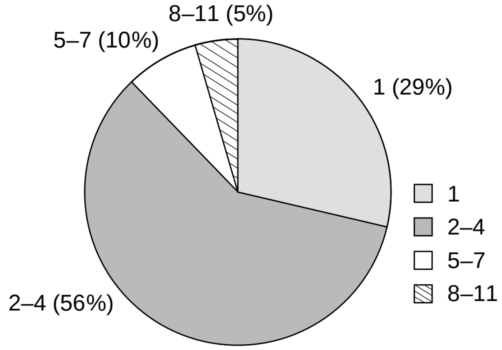


Figure 13: Transfers out in the preceding 8 weeks.

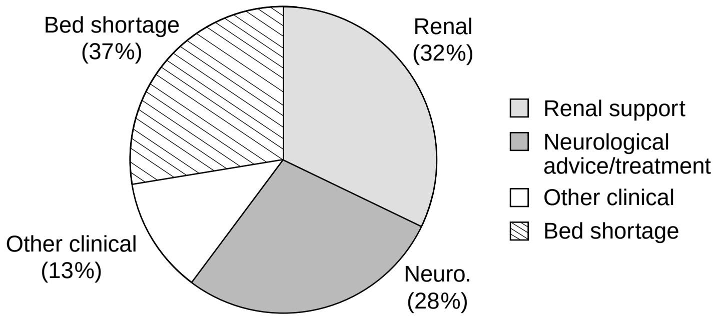


Figure 14: Reasons for transfer.

Evidence of shortfall: cancelled operations

For a patient needing intensive care following major elective surgery, the lack of a bed will entail cancellation of the operation – often at the last minute, since only then will the bed situation be known with certainty. Apart from the distress for the patient, such episodes waste the theatre resources allocated to the case.

The national postal survey conducted by the Royal College of Anaesthetists in 1992/93[39] revealed that lack of intensive care beds had caused 124 out of 256 units (48%) to cancel operations in the eight weeks preceding the questionnaire.

Evidence of shortfall: early discharge

In some instances, a bed may be created by prematurely discharging a patient not previously deemed ready to leave the ICU. In the absence of a designated HDU, such patients are likely to be returned to a general ward where, inevitably, they receive a lower level of observation and care. Data from ICNARC's Case Mix Programme, covering a total of 22 059 intensive care admissions, suggest that over 7% of intensive care survivors are discharged early because of a shortage of unit beds. Furthermore, recent data also from ICNARC[49] suggest that case-mix-adjusted outcome is significantly worse in patients discharged from ICUs at night, most often because of a lack of beds. Discharge at night was associated with a 33% increased risk of ultimate hospital mortality (OR: 1.33; 95% CL: 1.06–1.65) and seems to be increasing, from 2.7% in 1988–90 to 6% in 1995–98.

Limitations of the data

Unidentified demand

It should be noted that, although data on refusals, transfers and cancelled operations provide an indication of unmet demand, they probably underestimate it, because:

- referrals stop when units are full
- refusal information is difficult to collect
- units may not be told about cancelled operations
- intensive care may be provided in places outside the unit: for example, in recovery, in resuscitation and on the ward.[30,50]

Evidence of patients managed in inappropriate areas

Estimating need from data on bed occupancy, refusals and transfers is complicated by the variations in admission and discharge criteria. There is evidence that intensive care beds are sometimes used for high-dependency cases and vice versa, but also that patients meriting both high-dependency and intensive care are sometimes managed on general wards.

The Augmented Care Period (ACP) dataset[51] was introduced in 1997. Data on intensive and high-dependency care activity for patients other than neonates are collected in the form of an ACP dataset. These periods should be recorded wherever they occur, with the exception of general wards, A&E, radiology departments, labour wards and special care baby units. The dataset will enable the level of care that patients receive to be identified in the areas covered.

A very preliminary analysis has been performed on the first six months' data from the national ACP dataset (October 1997–March 1998).[51] This included information from an estimated 102 acute trusts, which, when cleaned to remove obviously illogical or incomplete data, left details relating to a total of

75 trusts and 22 140 patients. Analysis was performed at the level of individual ACPs, and ratios were averaged. The data suggest that approximately 25% of bed-days on general ICUs are accounted for by patients requiring only high-dependency care. Similarly, it appears that around 11% of bed-days on general HDUs are taken up by patients actually needing intensive care. These figures should be interpreted with caution, given that they represent the first six months of input to a new dataset.

An audit[30] conducted over seven months at the Royal Cornwall Hospital applied ACP definitions to patients in all hospital inpatient areas, including general wards. The ACP dataset identifies successive periods of augmented care (intensive or high-dependency care), should a patient require more than one within a single hospital episode. Tables 7a, 7b and 7c summarise the findings for patients receiving up to three ACPs.

Table 7a: Data relating to first ACPs.

Location	ICU days	HDU days	Total ACP days
General ICU/HDU	1,035	366	1,401
CCU	165	120	285
Recovery	13	4	17
General wards	74	100	174

Table 7b: Data relating to second ACPs.

Location	ICU days	HDU days	Total ACP days
General ICU/HDU	57	36	93
CCU	3	1	4
General wards	6	17	23

Table 7c: Data relating to third ACPs.

Location	ICU days	HDU days	Total ACP days
General ICU/HDU	44	0	44

It is evident from the data that a significant number of days of intensive or high-dependency care were provided in inappropriate locations – most notably, for patients receiving a first ACP, 74 days and 100 days respectively on general wards.

Another study[31] used three different methods to identify potential HDU admissions: an APACHE III score of 10 or less; low risk monitor rating in the Wagner risk stratification method; or not requiring advanced respiratory support. The study found that between 20.8% and 51.2% of ICU patients might be more appropriately managed in an HDU. The authors suggest that the perceived national shortage in intensive care beds might be improved by the development of more HDUs.

In a survey of ICUs in six hospitals, Crosby and Rees[32] reported that more than 50% of patients who required high-dependency care were placed in ICUs.

The study by Metcalfe *et al.*[47] examining data from six intensive care units over a three-month period suggested that 65% of patients admitted inappropriately could have been treated in HDUs, and 13% could have been treated in coronary care units.

Ryan *et al.*[33] examined admissions to Freeman Hospital's ICU over a two-month period, classifying each admission through criteria for either intensive or high-dependency care. They found that 23% of bed-days were occupied by patients thus classified as high-dependency, and that 12% of discharges were delayed because of the absence of a high-dependency unit. The authors estimated that, over the study period, 22 additional patients could have been cared for if a high-dependency unit had existed.

A similar study was conducted in Leicester,[34] using the more recent 1996 guidelines for admission to intensive care and high-dependency units[15] to classify patients being admitted to an ICU over a two-month period. High-dependency patients accounted for 1914 bed hours (21.6%) out of the potential available 8880 hours.

However, in a survey[52] of admissions to intensive care in three acute hospitals where high-dependency care was provided, only 2.4% of patients were found to have been placed inappropriately, as assessed by clinical guidelines drawn up by an multidisciplinary group.

Crosby and Rees carried out a 'snapshot' two-day survey to assess the clinical dependency of patients on acute surgical wards in eight hospitals in England and Wales.[32] Using slightly different criteria, they found an average requirement for high-dependency care of 6.8% in terms of bed-days for patients on these wards. (High-dependency care was defined as continuous monitoring with appropriately trained nurses constantly present, and a nurse-to-patient ratio of about 1:2.5.)

The Audit Commission's 1998 survey examined admissions receiving high-dependency care, and reported[14] the median number of admissions receiving high-dependency care as a percentage of admissions to various units, as shown in Table 8.

Table 8: Median percentage of admissions receiving high-dependency care, of total admissions to unit.

ICUs	Combined ICU/HDU units	HDUs
26%	47%	84%

The Commission also looked at the use made of available beds across ICUs, combined units and HDUs, reporting the results shown in Table 9.

Table 9: Use made of available beds.

The percentage of available beds used for:	ICUs	Combined ICU/HDU units	HDUs
Only intensive care patients	54%	19%	6%
Either intensive or high-dependency care patients	46%	61%	23%
Only high-dependency care patients	0%	20%	71%

International comparisons

There is some evidence that the smaller bed numbers in the United Kingdom mean that only the most severely ill patients are admitted. Comparisons between the UK[35] and US[37] have already been reported. The EURICUS[53] study found severity of illness (measured by the Simplified Acute Physiology Score II) to be higher in the UK than in any of the other 11 countries or areas. The overall score for the UK was 38.5, while other scores ranged from 28.5 in Germany to 37.5 in Portugal.

Table 10: Numbers of critical care beds in European countries.

Country	Critical care beds per 100,000 population
England and Wales (1)	4.8
Finland (2)	6.0
Denmark (3)	6.5
Italy (4)	9.0
Belgium (5)	21.3
Luxembourg (6)	21.8

1 *Source*:[14] Based on available beds, and mid-1996 population census information. Bed numbers include specialist critical care beds but exclude coronary care.
2 *Source*:[54]
3 *Source*:[55]
4 *Source*:[56]
5 *Source*:[57]
6 *Source*:[58] Author states these beds are available.

These comparisons should be treated with some caution. In the case of Italy, Denmark, Finland, Luxembourg and Belgium, it is not clear whether high-dependency, coronary care or specialist units have been included (though it is unlikely). Neither is it clear for any of these countries except Luxembourg whether bed numbers refer to beds that are actually available, or to those that would be, given staff and/or equipment. The figure for England and Wales, which is relatively low, does include high-dependency beds and specialist beds. This suggests that the number of beds per 100 000 population in England and Wales is actually significantly lower than that of the comparison group.

There is little information available on admission rates to ICUs as a proportion of the hospital or general population. In the USA, up to about 20% of patients receive care in an ICU or CCU at some time during their stay in hospital, but the use of intensive care is much less common in Europe.[13] In a Danish university hospital, 1.6% of patients were admitted to the ICU, while a Norwegian study reported that 1.7% of a hospital's patients were admitted to an ICU;[13] but another European author cites 5% as the percentage of hospital patients requiring intensive care.[59]

A comparison of ICUs in 13 hospitals in the USA and two hospitals in New Zealand revealed that the US hospitals designated 5.6% (range: 2.6%–10.3%) of their total beds as adult intensive care, compared with 1.7% (0.8%–2.6%) in the two New Zealand hospitals.[60]

However, without case-mix data it is questionable whether such international comparisons are helpful.

Future demand

The NHS reforms in 1990 led to greater emphasis on assessing the benefit of costly technological advances and to more focus on effective clinical practice.[61]

Even in this changing climate, indications are that demand for critical care in the future will increase.

Two recent studies on optimising treatment for high-risk surgical patients[42,43] illustrate a trend towards greater critical care intervention preoperatively. They showed improved outcomes for high-risk patients and may herald further demand on intensive care facilities.

5 Services available and their costs

Service provision in England and Wales

Introduction

The haphazard development of critical care has resulted in markedly variable provision of these services across the country. Until the announcement of the critical care modernisation programme in May 2000[11] there had been no national or even regional strategy for critical care. As a consequence, the number of intensive care beds and spending on intensive care, in relation to population figures, has varied considerably.[62]

There is currently substantial debate about the configuration of intensive care services, fuelled by a perception that there are not enough beds in some parts of the country and that existing beds may not be in the right places. Ryan, basing his findings on eight units, argued that there is an uneven distribution of ICU beds in the UK, and placed provision at a level between 1.8 and 3 beds per 100 000 population.[63] Our analysis of more recent Audit Commission data, however, suggests that this figure is at the lower end of the range, with 1.8 adult ICU beds per 100 000 and 3.6 beds if combined ICU/HDU units are included. If beds in HDUs are included, however, the data indicate 4.8 beds per 100 000. These figures are still significantly lower than those for other European countries, but do not include coronary care beds.

A survey conducted for the Department of Health in 1993[12] showed similar variations in intensive care bed provision. The numbers across the then 14 regional health authorities varied between 1.8 and 3.0 intensive care beds per 100 000 population (mean value 2.2), with evidence of clustering around London.

Critical care differs from other acute services in that it crosses speciality boundaries and therefore spans all hospital services. This has implications for contracting and budgeting, as resources for critical care are usually top-sliced, reducing direct accountability and control in the funding.

A fundamental challenge for critical care is that episodes of care have not until recently been easily identifiable from centrally held datasets such as HES. This has resulted in little routine statistical information being available for critical care. The recently introduced mandatory ACP dataset should go some way to meeting this need, and additional information is available through the Audit Commission and through initiatives such as ICNARC.

The critical care modernisation plan[11] calls for a data-collecting culture that promotes an evidence base, and requires NHS trusts to comply with the ACP dataset.

Critical care units

The Audit Commission undertook a study of critical care services across England and Wales during 1998, basing it on two questionnaires.[14] One covered the number of critical care units and beds for all specialities in a trust; the other asked more detailed questions about general adult critical care units. Every acute trust gave information about the critical care facilities in their hospital(s). Detailed information on general adult ICUs and HDUs was provided for 94% of units.

As Table 11 shows, there were 521 critical care units in operation in England and Wales. 32% were described as ICUs, 39% as HDUs and 28% as combined ICU/HDUs.

Table 11: Critical care facilities in England and Wales.

	Number of Trusts reporting presence of unit:			
	ICU	**Combined ICU/HDU**	**HDU**	**Total (% of all units)**
General or mixed speciality	128	83	25	236 (45%)
Surgical	2	3	26	31 (6%)
Medical	0	1	8	9 (2%)
Cardiac or coronary care	16	16	101	133 (26%)
Cardiothoracic	9	14	8	31 (6%)
Combined general and coronary care	8	10	1	19 (4%)
Neurological/surgical	5	8	11	24 (5%)
Short-term critical care	0	2	3	5 (1%)
Burns	1	4	6	11 (2%)
Trauma	0	1	1	2 (0%)
Liver	0	3	1	4 (1%)
Renal	0	1	10	11 (2%)
Spinal	0	1	4	5 (1%)
Total units	**169 (32%)**	**147 (28%)**	**205 (39%)**	**521**

A survey of HDUs in UK hospitals published in 1995[28] found that most (80%) of the units were geographically separate from the ICU within the hospital; about 40% were part of an acute ward. Some hospitals provide high-dependency and intensive care beds in the same unit,[12,28] an arrangement that may be more flexible and have advantages for staff deployment and morale.[?] However, the HDU is sometimes adjacent to the ICU, and nurse staffing may be common to both units.[12] Formal rotations for staff in a separate HDU can avoid problems of staff isolation, and maintain expertise.[15]

Thompson and Singer[28] found that 71% of the HDUs acted as a 'step-down' facility for patients discharged from an ICU and 75% used the HDU as a 'step-up' for patients from general ward areas.

In some hospitals, ICUs and/or HDUs may specialise in the care of certain groups of patients – for example, post-operative thoracic or neurosurgical patients.[52]

The Audit Commission[17] data were also examined to identify the configuration of critical care services at the individual hospital level. Adult general/mixed speciality units and combined general/coronary care were included. There was great variability in configuration, and many combinations of generalist and specialist ICUs, HDUs and combined ICU/HDUs. The most prevalent configurations are shown in Table 12. The large number of trusts with 'some other combination' in each of the categories reflects the high variability between units, which makes summary difficult.

Table 12: Critical care configurations in NHS trusts.

Trusts with:	Critical care configuration
1 hospital (135 trusts)	26 (19%) had a combined ICU/HDU only 22 (16%) had an ICU only 33 (24%) had an ICU and an HDU 2 (2%) had a combined ICU/HDU that admitted coronary care patients 52 (39%) had some other combination
2 hospitals (44 trusts)	5 had a combined ICU/HDU only 2 had an ICU only 10 had an ICU and an HDU on the same site 27 had some other combination
3 hospitals (28 trusts)	5 had a combined ICU/HDU only 5 had an ICU and an HDU 18 had some other combination
4 hospitals (10 trusts)	4 had a combined ICU/HDU 5 had an ICU only 1 had some other combination
5 hospitals (5 trusts)	3 had an ICU only 2 had some other configuration
Total trusts: 222 (*excludes those that did not provide acute care for adults)*	

Critical care beds

Data on bed numbers across England and Wales in Table 13 have been taken from the Audit Commission's survey,[17] which used the following definitions[2] for bed status:

- *equipped*: the beds exist now and have the necessary equipment to allow them to be used;
- *funded*: the budget exists for the nursing and other staff to allow the bed to be used;
- *available*: the staff are in post and the bed is generally available to admit patients into.

The Audit Commission[17] also reported data on bed numbers in individual units. Table 14 shows the median number of available beds by type of unit.

Numbers of beds were also reported on a trust basis. The median numbers of available critical beds per 500 acute beds are shown in Table 15.

Variability in units

As already noted, there is marked variability in the organisation and operation of critical care units in the UK. Ridley *et al.*[64] reviewed activity and organisation of eight intensive care units in the former Anglia NHS region and found considerable heterogeneity. Table 16 provides some comparisons on staffing and activity indicators for 1994. Some of these variations may be explained by hospital size and type, but the authors did not provide this information.

Significant variations between units were also noted for the mean age of patients (range approximately 55–60), APACHE scores (range approximately 11–16), length of stay (range approximately 1–1.7)

Table 13: Numbers of critical care beds across England and Wales.

Critical care beds	Equipped	Funded	Available
General or mixed speciality	1,564	1,412	1,421
Surgical	137	127	136
Medical	39	34	35
Cardiac or coronary care	799	795	817
Cardiothoracic	289	245	241
Combined general & coronary care	153	142	147
Neurological/surgical	154	142	130
Short-term critical care	33	23	22
Burns/plastics	54	52	51
Trauma	4	4	4
Liver	25	25	12
Renal	103	103	106
Spinal injury	26	26	25
Other types – not specified	172	140	135
Total	**3,552**	**3,270**	**3,311**

Table 14: Median number of available beds by type of unit.

	ICUs	Combined ICU/HDUs	HDUs
Median number of available beds	5.3	6.0	4.0

Table 15: Median number of available beds per trust.

Size of trust	Median number of critical care beds per 500 acute beds
Small trusts (less than 500 beds)	12.4
Medium trusts (between 500 and 750 beds)	7.9
Large trusts (over 750 beds)	9.8

Table 16: Staffing and activity indicators (1994).

ICU	Total consultant sessions	Nursing WTEs	Staffed beds (WTE/bed)	Number of admissions (1994)	Admits per bed	Refused admits
Cambridge	10	52.8	8 (6.6)	483	60.4	no record
Ipswich	9	32	6 (5.3)	393	65.5	no record
King's Lynn	9	24	4 (6.0)	261	65.3	22
Norwich	10	43	6 (7.1)	675	112.5	61
Peterborough	10	31	5 (6.2)	339	67.8	34
Bury St Edmunds	5.5	25	4.25 (5.9)	266	62.6	14
Yarmouth	10	27	4 (6.75)	274	68.5	no record
Hinchinbrooke	10	25	3 (8.3)	295	98.3	no record

and occupancy (range 56%–76%). Occupancy was calculated by summing all lengths of stay and dividing by the maximum number of available bed days.

Pattern of care provided in critical care

ICNARC's Case Mix Programme Database provides information on whether patients in intensive care units were mechanically ventilated or not. Of 17 712 admissions during the period December 1995 to April 1998, 54% were mechanically ventilated and 42.3% were not. Data regarding mechanical ventilation were missing for the remainder.

Audit Commission figures[17] indicate that the average percentage of admissions receiving ventilation is 57.8%. This agrees with the Study of Intensive Care Provision in England,[12] which reported that mechanical ventilation was required in 57% of patients admitted on the day of a census. The initial support required at admission on the census day is shown in Figure 15.

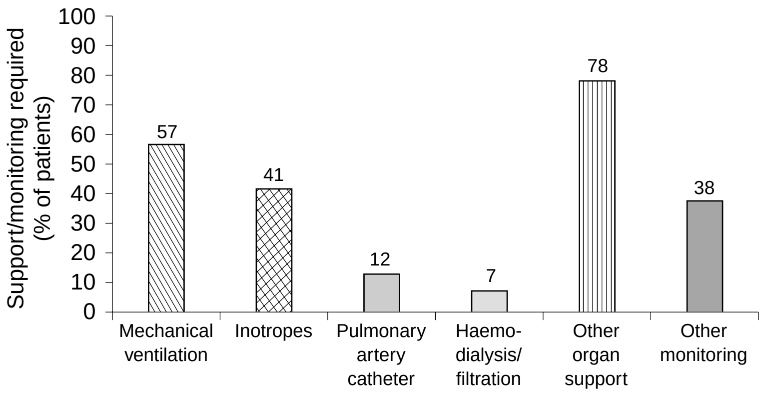


Figure 15: Initial support required at admission (SICP census day).

At midnight on the census day 646 beds were occupied in 162 ICUs in England. The types of support/ monitoring provided to these patients during the census day are shown in Table 17.

Table 17: Types of support/monitoring provided (SICP census day).

Support/monitoring	No. (%) of patients*	No. (%) of ICUs
Mechanical ventilation	417 (65)	136 (85)
Invasive haemodynamic monitoring (excluding PAC)	470 (73)	134 (84)
Enteral feeding	235 (36)	115 (72)
Parenteral feeding	140 (22)	81 (51)
Pulmonary artery catheter (PAC)	118 (18)	68 (43)
Renal replacement therapy	57 (9)	39 (24)
TOTAL	646 (100)	162 (100)

*Some patients were receiving more than one type of support/monitoring.

In 15% of units, no patient was receiving mechanical ventilation.

There is recent evidence to suggest that the type of support required may be changing. Parker *et al.*,[65] in their study of admissions to one critical care unit over a four-year period, found that the proportion of patients requiring respiratory support decreased consistently, from 65% of patients in 1993 to 32% in 1996. They also observed that the median duration of respiratory support decreased from 20 hours in 1993 to 16 hours in 1996.

The authors also noted a decrease in the proportion of patients undergoing pulmonary artery catheterisation, from 20% in 1995 to 13% in 1996. The percentage of patients having inotropic support showed a consistent fall over the period, with 52% receiving vasoactive drugs in 1993, 44% in 1994, 35% in 1995 and a projected 22% in 1996.

The pattern that emerges is one of wide variation between ICUs in the levels of dependency of their patients. It is likely that significant numbers of intensive care beds are occupied by patients requiring only high-dependency care.

Admission guidelines

Identifying those patients most likely to benefit from critical care is one of the key challenges in providing the service.

The Admission Guidelines developed by a Department of Health working party[15] described the characteristics of intensive care and high-dependency care, as shown in Table 18.

Table 18: Characteristics of intensive and high-dependency care.

Intensive care is appropriate for:	High-dependency care is appropriate for:
patients requiring or likely to require advanced respiratory support alone	patients requiring support for a single failing organ system, but excluding those needing advanced respiratory support
patients requiring support of two or more organ systems	patients who can benefit from more detailed observation or monitoring than can safely be provided on a general ward
patients with chronic impairment of one or more organ systems sufficient to restrict daily activities (co-morbidity) and who require support for an acute reversible failure of another organ system	patients no longer needing intensive care, but who are not yet well enough to be returned to a general ward
	post-operative patients who need close monitoring for longer than a few hours

Thompson and Spiers[34] report that measurement of Therapeutic Intervention Scoring System (TISS) points and APACHE II scores confirmed that categorising patients according to these guidelines produced significantly different populations of patients. Mean TISS points for intensive-care-status patients were 38.7 (standard deviation 10.4) compared to 21.66 points (standard deviation 5.98) for high-dependency-status patients. The median APACHE II score for intensive-care-status patients was 16 (range 1–45) compared to 11 (range 1–27) for high-dependency-status patients. The authors commented that the criteria appear to differentiate well between ICU and HDU patients.

Classification of critical care is to be based on three levels following the announcement of the critical care modernisation programme.[11] These levels are:

- Level 1: acute ward care, with additional advice and support from the critical care team; e.g. patients who are at risk of deterioration, or who are recovering after requiring higher levels of care
- Level 2: more detailed observation or intervention; e.g. patients with a single failing organ system, or post-operative patients, or patients stepping down from higher levels of care
- Level 3: advanced respiratory support alone, or basic respiratory support together with support of at least two organ systems.

Discharge guidelines

The Department of Health guidelines[15] state that a patient should be discharged from intensive care when the condition that led to admission has been adequately treated and reversed, or when the patient can no longer benefit from the treatment available. The guidelines go on to say that stringent discharge criteria need to be developed and applied locally to ensure that other patients are not denied admission.

The decision to discharge a patient from intensive care or high-dependency care will depend partly on the level of care available in the unit or ward to which the patient is to be discharged.

The availability of an HDU within the hospital has an important influence on the decision to discharge. In the absence of step-down care, many patients stay on an ICU longer than necessary.[12]

It has been suggested that the continuing appropriateness of intensive care should be assessed at regular intervals. A decision to limit further treatment should be made only after discussion amongst the intensive care team and the referring team, and should have the full acceptance and understanding of the patient and his/her family/partner.[12]

A recent UK study[66] looked at the frequency with which treatment was withdrawn from intensive care patients and the primary reason for the decision. The authors examined 1745 admissions to an intensive care unit in Bristol, of whom 338 (19.4%) died in ICU. Of these, 220 deaths followed the withdrawal of treatment (12.6% of all ICU admissions). The primary reason for withdrawal of treatment was imminent death in 45% of cases, qualitative considerations in 50% and lethal conditions in 5%. The authors report that the reason varied significantly depending on the patient's age.

A King's Fund Panel[8] recognised that, when death is inevitable, discharge from the ICU can generate a sense of rejection in patients and family and that death in the ICU can be more humanitarian. Conversely, in some circumstances, the atmosphere of another ward may be more appropriate for terminal care. Inevitably, competing pressures for beds will affect these decisions.

Where a patient needs to be transferred to a specialist unit, close collaboration between the senior medical staff of both units is required to ensure appropriate timing of the transfer.[12]

As with discharge from intensive care, it is important that policies are in place to expedite timely discharge from high-dependency care to general wards.[12]

Staffing

Medical staff

It has been recommended that every critical care unit have a designated consultant with administrative responsibility.[1,12] Of 220 trusts responding to the Audit Commission's recent survey,[17] 41% reported that they had one consultant with overall responsibility for critical care services, and 53% reported that they did not. The remainder did not respond.

The Intensive Care Society[1] recommends a minimum allocation of 15 consultant sessions for an ICU of four or more beds and recognises that large, busy units may need as many as 30 allocated sessions.

Evidence suggests that a high level of consultant input produces better patient outcomes. A retrospective study suggested that the appointment of a full-time intensive care specialist had a significant impact on both unit and hospital mortality in a Canadian teaching hospital[67] and followed similar findings in both teaching[68] and community hospitals[69] in the United States.

The study by Metcalfe and McPherson[12] commented on the level of consultant input to intensive care in England in 1993. Their one-day census of all ICUs revealed that in almost 40% of units no consultant was present at all during the 24-hour period surveyed. This fits with the findings of the Royal College of Anaesthetists' national audit of intensive care,[39] which also examined the allocation of consultant sessions. This found that 57% of ICUs had six or fewer sessions per week and that 15 units had no sessions allocated at all.

A central focus of the modernisation programme for critical care[11] was workforce development, including the recruitment, training and retention of medical and nursing staff, with a balanced skill-mix so that professional staff are able to delegate less skilled and non-clinical tasks.

The Intensive Care Society recommends that trainee medical staff should have no responsibilities other than intensive care and related activities, such as cardiac arrest or major trauma teams.[1]

Nursing staff

Intensive care is synonymous with a 1:1 nurse:patient ratio. Busy units may also have additional, supervising or supernumerary nurses. Such staffing requires at least 6.3 whole-time equivalents (WTEs) per bed,[1] a figure that allows for annual and professional leave but does not take into account sickness or maternity leave.

High-dependency patients are generally considered to require an average of one nurse to two patients.[13] On occasions, however, a confused, restless patient on the HDU may require more nursing input than does one who is stable, sedated and ventilated on the ICU. A seven-month study of nursing workload on an adult general HDU concluded that a nurse:patient ratio of 1:2 may be insufficient, and recommended a ratio of 2:3.[70]

The Audit Commission found wide variations in the number of nurses employed in terms of the usual number on duty or in relation to patient workload. Although the average number of nursing WTEs employed per intensive care bed had increased from 5.2 in 1993[12] to 7.6 in 1998,[17] many units still fail to meet the Intensive Care Society standards.

Difficulties with recruitment and retention of nurses is one of the reasons for discrepancies between the numbers of funded and available beds. Figures reported by the Audit Commission[17] indicated that 53% of ICUs, 49% of combined ICU/HDUs and 48% of HDUs blamed recruitment difficulties for differences between the funded establishment and staff in post. Turnover rates for qualified nurses during 1997/98 were 12.2% in ICUs, 11% in combined units and 8.3% in HDUs. Sickness absence rates for qualified nurses during 1997/98 were 4.6%, 4.3% and 5% respectively.

Support workers such as auxiliary nurses and healthcare assistants may be employed to assist the trained nursing staff. Such personnel may reduce the need for nurses to perform non-nursing tasks and allow them to concentrate on direct patient care.

The modernisation programme for critical care[11] injected additional resources into NHS trusts for the recruitment and retention of critical care nurses, and called for a balanced skill-mix so that professional staff are able to delegate less skilled and non-clinical tasks. The programme requirements were based on a report by a Department of Health Expert Group,[10] which included an in-depth review of adult critical care nursing.

Other staff

Technicians, physiotherapists, pharmacists, radiographers and dieticians all have important roles in the critical care unit, and appropriate clerical support is also essential.[1]

Clinical management

Intensive care units generally follow one of two different patterns of clinical management: ‘closed’ or ‘open’ units.[1] In a ‘closed’ unit, the intensive care consultant(s) have complete responsibility for the care of patients admitted to the unit, and the referring team are involved only when their specialist input is needed.

Patients are admitted to ‘open’ units under the care of their admitting consultants and remain so throughout their stay.

Current evidence favours the ‘closed’ system[71,72,73] that seems to operate in the majority of ICUs in the United Kingdom. In HDUs, on the other hand, the ‘open’ model predominates.

The modernisation programme for critical care[11] required that admission to Levels 2 and 3 of critical care should be by consultant-to-consultant agreement only.

Costs

Intensive care provides care at high cost to a small number of patients. Annual spending on intensive care in the UK has been estimated at £675 million, representing about 2% of the hospital budget.[74] Costs of intensive care elsewhere in Europe have been estimated to represent up to 20% of a hospital’s budget.[75]

It has been estimated that about 1% of the USA’s GNP is spent on ICU services. While few of the constraints on critical care experienced in the UK would apply or be acceptable in the US, the available clinical data suggest that ICU clinical performance is similar in the two countries.[61]

Because of the high cost of intensive care, there is considerable interest in information regarding costs and effectiveness, but cost accounting in intensive care is underdeveloped.[76] A study of a non-random sample of intensive care units in twelve European countries[77] found that only 14 out of 88 (in five countries) had cost-accounting within the unit, and only 38 out of 88 ICU directors indicated that there was an awareness of cost per bed per day in their units.

Costs in the UK

Singer *et al.*[78] noted that intensive care is an increasingly expensive speciality in the UK, the costs for which are rising over and above general inflation.

A national working group led by the Medical Economics and Research Centre based in Sheffield has been looking at ICU costs, using both top-down and bottom-up approaches.

Top-down approach

The top-down approach defines a total cost for the service and derives from that an average cost per bed-day. Work by the Sheffield group has identified six 'cost blocks' as follows:[79]

1 Current cost of using equipment
2 Estates
3 Non-clinical support services
4 Clinical support services
5 Consumables
6 Staff

This cost classification was applied to 11 units in 1994/5 and 1995/6 (5 district general hospitals and 6 university hospitals). The first three cost blocks were related to overheads, and consistently constituted 15% of total ICU costs. Cost block 4 accounted for 9% of total costs in 1994/5 and 6% in 1995/6, whereas cost blocks 5 and 6 accounted for 22% and 53% of the total costs in 1994/5 and 24% and 55% in 1995/6. This study found a median cost per patient day of £1064 in 1994/5 and £1087 in 1995/6. Table 19 shows staff costs as a proportion of median cost per bed.

Table 19: Staff costs as a proportion of median cost per bed.

% of median cost per bed:	1994/95	1995/96
Consultants	5%	5%
Other medical	4%	5%
Total medical	10%	9%
Senior nurses	14%	14%
Junior nurses	24%	29%
Total nurses	38%	43%
Total medical/nursing staff	48%	52%

One of the authors' major findings was of a wide variation in annual costs between trusts but similar proportional contributions for each cost block.

Singer *et al.*,[78] also using a top-down method, examined changes in the costs of critical care in one trust between two periods: April 1988–February 1989 and January–July 1991. For the more recent of these periods, they found similar intensive care costs at £1149 per patient day. The corresponding cost for high-dependency care was £438 per patient day.

The authors noted that 'hidden' costs such as infrastructure maintenance, capital assets and diagnostic services accounted for nearly a quarter of total expenditure, and that staff costs accounted for over 50%.

Bottom-up approach

The bottom-up approach ascribes a cost to individual patients on the basis of the resources they use. Although more accurate than the top-down method, it is complex and costly to implement.

Edbrooke *et al.*[74] used a bottom-up method to identify ICU patient costs. This activity-based costings methodology, operational in the ICU of the Royal Hallamshire Hospital since 1995, uses a computerised data management system to record actual costs of nursing, medical ward rounds, drug treatments, disposables, equipment use and clinical support services such as physiotherapy, radiology and laboratory services. The authors report the average daily patient-related cost of care to be £592 and overhead costs to be £560, resulting in a total average cost of £1152 (standard deviation £243). They found a strong, highly significant statistical correlation between (1) the Therapeutic Intervention Scoring System (TISS) and the cost of care for each calendar day, and (2) the APACHE II score and cost of the first 24-hour period. They note that patient-related costs of care are high initially and then fall rapidly to a constant level.

Another survey using a bottom-up approach showed that caring for ventilated patients costs twice as much as caring for those breathing spontaneously.[80] Patients with severe sepsis or early septic shock are also significantly more expensive to treat than are non-septic patients.[81]

These average daily costs may appear to be comparable with those reported by Singer *et al.* (£1148 per patient day).[78] However, Edbrooke *et al.*[74] caution that the distribution of costs is non-gaussian and therefore that the mean is an insufficient descriptor of average costs of care. They also point out that the effects of case-mix on these figures is unknown.

There is evidence of high variability in the daily cost of individual ICU patients. It has been suggested that the cost of individual patients per day ranges from £100 to £8000.[82] For this reason, top-down costing approaches that average out daily costs may be misleading. Bottom-up methodologies are clearly more useful in intensive care but may not be practicable for the majority of units.

The Audit Commission has also collected information relating to service contracts, staff budgets and expenditure that is useful in showing the variability between units.

Cost drivers

A consistent finding has been that at least 50% of ICU patient costs are incurred by staffing. Havill *et al.*[83] tested the hypothesis that nursing hours may predict cost, and found a very strong correlation between direct nursing hours and cost.

This is important where health authorities or trusts may be considering providing more critical care beds. While the average or median cost per day may be approximately £1150, each new bed will not cost this amount, as some 25% of costs relate to fixed overheads.

An economic analysis that examined the daily costs of 90 critically ill patients[84] found a wide variation in costs between patients and diagnoses; a strong relationship between the cost of the first day of management and the APACHE II score; and higher daily costs of treatment in patients who died in intensive care. Table 20 provides descriptive statistics for daily costs of treatment.

Table 20: Daily costs of patients.

	Died in ICU	**Died after ICU**	**Survivors**
Number of patients	21	13	56
Patient days	122	57	262
Overall mean cost per patient (£)	816	508	550
Standard errors of mean	80	33	25
95% CL of mean	649–982	435–580	498–601
Range of mean costs (£) between patients	349–1238	377–750	262–1017

Table 21 shows the distribution of mean daily costs for each diagnostic category.

Table 21: Mean daily cost per patient for each diagnostic category.

Diagnosis	n	ICU mortality (n)	Mean daily cost (£)	95% CI
Respiratory				
Chronic obstructive airways disease	5	1	597	461–773
Pneumonia	4	3	760	370–1149
Post-op. respiratory failure	2	1	385	246–524
Pulmonary neoplasm	3	1	484	318–649
Post-respiratory arrest	1	0	609	
Respiratory observation	24	0	479	380–577
Cardiovascular				
Aortic aneurysm repair	6	0	525	437–612
Septic shock	7	4	911	768–1053
Cardiac disease	10	5	573	410–735
Shock	6	2	569	226–912
Gastro-intestinal bleeding	1	0	438	
Perforation/obstruction	6	0	619	585–654
Other	3	2	816	416–1217
Trauma	3	0	500	258-743
Neurological	2	0	509	148–870
Renal failure	2	0	691	517–864
Metabolic	4	3	944	710–1177
Total	89			

While APACHE II score and cost of first-day care are related, severity of illness is only an indirect measure of overall costs because the healthcare costs depend more upon the intensity of observation, nature of interventions required and care actually delivered.

6 Effectiveness of services and interventions

Perceptions of constraints in supply raise questions about the appropriate use of intensive care and, more fundamentally, the need to determine which types of patient actually benefit from critical care. This is especially important given the high costs involved.

It is beyond the scope of this chapter to provide a systematic review of the effectiveness of all the interventions used in critical care. We have, however, identified some important recent studies to illustrate general points.

Evidence for the effectiveness of specific interventions

For a few conditions, the benefits of intensive care are indisputable. In patients with an acute reversible polyneuropathy such as Guillain-Barré syndrome, mechanical ventilation is undeniably life-saving at the point where respiratory failure becomes life-threatening. For the majority of conditions, however, the effectiveness of intensive care remains unproven. Indeed, the role of intensive care in preventing death has yet to be properly investigated.[47] The main problem with establishing the effectiveness of intensive care is the common view that, because its use for various conditions is considered standard for good medical practice, prospective randomised controlled trials of the benefits are deemed ethically unacceptable.[59] However, given the wide variation in practice and genuine doubt as to which practices are best, others are not convinced that such trials would be unethical.[85]

Given the enormous heterogeneity of case-mix, any trials in intensive care would require huge numbers of patients if questions are to be answered. These difficulties have meant that very few satisfactory trials have been carried out in intensive care settings. As a result, there remain large areas of practice that lack evidence about risks and benefits – for example, optimum fluid balance strategies and the use of pulmonary artery catheters (PACs).[86] Given the paucity of evidence in critical care, decisions tend to be based on the clinician's experience and judgement and on individual patient circumstances, which may result in treatments being used despite evidence that they are ineffective – for example, low-dose dopamine infusions in preventing renal failure, or albumin infusion in hypoalbuminaemia. It may also result in withholding interventions such as PAC to guide haemodynamic management in the high-risk surgical patient, despite evidence of effectiveness.

Examples of areas where evidence exists to guide critical care practice are as follows:

- ventilator circuit and secretion management strategies in the prevention of ventilator-associated pneumonia[87]
- strategies to prevent upper gastrointestinal bleeding in ventilated patients[88]
- the use of formal protocol-driven strategies for weaning patients from mechanical ventilation[89,90]
- the use of selective decontamination of the digestive tract in critically ill adults[91]
- the optimisation of high-risk patients before major surgery[42,43]
- the increased mortality associated with growth hormone treatment in critically ill adults[92]
- mechanical ventilation with lower total volumes, which decreases mortality in patients with acute lung injury and acute respiratory distress syndrome.[93]

Where such evidence exists, it clearly needs to be widely publicised. Even then, whether such strategies are adopted in practice depends on factors such as the magnitude and precision of estimates of benefit and harm, as well as access, availability and costs.[91]

Cost effectiveness

Recent data suggest that, on average, 22% of ICU patients die before leaving the unit, a further 8% die before leaving hospital and 7% die in the first six months at home. Nine percent are left with severe limitations to daily living, 38% have some limitation but are able to live independently, and only 16% are left in good health with no limitations. For combined ICU/HDUs, 16% of patients die before leaving the unit and a further 20% before leaving hospital. For HDUs, the corresponding figures are 6% and 9% respectively.[17]

The relatively high mortality rates for intensive care patients mean that large sums of money are spent on patients who, ultimately, do not survive. Although current methods of predicting outcome can fairly accurately predict mortality rates for groups of patients, they cannot as yet do so for individuals with sufficient accuracy for non-survivors to be confidently identified at the time of intensive care admission.

A group at Guy's Hospital surveyed 3600 adult ICU admissions. The 15% who died consumed 37% of the ICU budget.[94] Ridley *et al.* [84] reported that in 1989 the mean daily cost per patient for non-survivors was £816 (95% CL £649–£982), while for survivors it was £550 (95% CL £498–£601).

An effective cost per survivor can be derived by dividing the total ICU budget by the number of patients surviving. A series of 523 intensive care patients studied at Guy's Hospital gave an effective cost per survivor of £4916. However, when considered separately, the figure for patients staying in the ICU for more than 72 hours was £24 925.[95] Gilbertson *et al.*[96] studied a series of 156 patients, of whom 29% had severe respiratory conditions as well as renal failure. The effective cost per survivor was almost £12 000.

Ridley *et al.*[97] performed a cost-utility analysis by looking at both costs and quality of life in 56 survivors one year after their admission to the ICU in 1989. They estimated the total hospital cost per quality adjusted life year (QALY) at £7500. When the cost-per-QALY comparisons are made with other healthcare interventions (all adjusted to 1989 costs), intensive care was found to lie between heart transplantation (£6070) and home dialysis (£13 070). If the costs of non-survivors were built into the calculation, however, the cost per QALY for intensive care would increase considerably.

Stockwell[98] estimates the cost of every extra survivor produced by intensive care to be approximately £45 000. Comparing this with corresponding costs for statins used to treat men with hypercholesterolaemia (£226 560) and enalapril to control hypertension (£36 300), he contests that intensive care does not compare unfavourably on a cost basis with other treatments.

Developments in costing

For the reasons outlined earlier, DRGs are inappropriate in the ICU, and work is currently in hand to develop and validate HRGs for intensive care. The ACP dataset, introduced throughout the NHS in October 1997, may provide a basis for HRGs. While there are no published studies at present, preliminary work suggests a reasonably good correlation between some ACP parameters and intensive care costs.[62]

7 Models of care and recommendations

Possible models of care

The modernisation programme for critical care[11] called for strategic change to modernise services, and injected additional resources into NHS trusts for the recruitment and retention of critical care nurses.

Four main elements of the programme required action by NHS trusts. These were:

- a hospital-wide approach to critical care, with services that extend beyond the physical boundaries of intensive care and high-dependency units, making optimum use of available resources, including beds
- a networked service across those NHS trusts that together serve one or more local health economies, meeting the critical care needs of those within the network and minimising the need for transfer outside
- workforce development, including the recruitment, training and retention of medical and nursing staff, and a balanced skill-mix so that professional staff are able to delegate less skilled and non-clinical tasks
- better information, with all critical care services collecting reliable management information and participating in outcome-focused clinical audit.

A new approach to classifying critical care was also introduced, with a spectrum of three levels of critical care (where Level 0 denotes normal acute ward care) as follows:

- Level 1 – acute ward care, with additional advice and support from the critical care team; e.g. patients who are at risk of deterioration, or who are recovering after requiring higher levels of care
- Level 2 – more detailed observation or intervention; e.g. patients with a single failing organ system, or post-operative patients, or patients stepping down from higher levels of care

- Level 3 – advanced respiratory support alone, or basic respiratory support together with support of at least two organ systems.

A regional approach

In 1989, a King's Fund panel, considering intensive care services, suggested that there may be a case for concentrating intensive care provision in a smaller number of units, each of which would have a workload large enough to enable it to develop appropriate expertise.[8] The Intensive Care Society noted in 1990[1] that centralising the intensive care service would force units to become larger, a concept familiar in other countries of Europe, in Australia and in the US – certainly, large units are less vulnerable to fluctuation in demand.

To some extent, the National Intensive Care Bed register is already encouraging a more regional approach to critical care by having a wider perspective and by facilitating transfers accordingly. However, this is not a desirable way in which to move towards centralisation; transferring patients to locations where beds happen to be available does not guarantee that the appropriate expertise will be there as well.

An inevitable consequence of centralisation or stratification is the increased need to transfer patients between hospitals, and it needs to be ensured that this is accomplished safely. Wallace and Lawler[99] argue that transfer teams must be fully equipped and skilled, and note that dedicated teams are common in Europe, the US and Australia. They suggest that intensive care transfer teams should be established on a regional basis and should provide skilled attendants and appropriate equipment in order to ensure a safer service and to avoid the necessity for on-call staff in referring hospitals to accompany patients.

Paediatric critical care model

The new classification approach[11] mirrors the recent reorganisation of paediatric critical care services to some extent.

In July 1997, the National Co-ordinating Group on Paediatric Intensive Care reported on the future provision of that service.[24] The report identified three levels of high-dependency or intensive care, as shown in Table 22.

Table 22: Levels of high-dependency or intensive care.

Level	Distinction
Level 1	• Requirement for closer observation and monitoring than is available on a standard ward • Single-organ support, but excluding advanced respiratory support • Step-down from intensive care • Following major surgery: cardiac, neuro, spinal, etc. • Advanced analgesic techniques • Non-intubated children with moderately severe croup, bronchiolitis, etc. • The recently extubated child
Level 2	• Advanced respiratory support OR • Two or more organ systems requiring support OR • One acute organ failure receiving support, plus one chronic failure
Level 3	• Two or more organ systems requiring technological support, including advanced respiratory support of one of these systems; e.g. renal support or haemofiltration plus mechanical ventilation

The report recommended that within any defined geographical area there should be a service that provides care for each critically ill child in a facility that is best able to meet his or her needs. The system that is needed to care for critically ill children will involve accident and emergency departments and the ambulance service as well as hospitals.

Specialist weaning units

Although patients stay in intensive care usually for only one or two days, a small proportion remain for much longer. Many of them have suffered with very severe acute respiratory distress syndrome (ARDS) or sepsis complicated by multiple organ failure. Often, the major problem for the latter phases of these prolonged intensive care stays is continuing dependence on mechanical ventilation, with difficulty in weaning that support. One such patient on a unit will have a significant effect on its effective capacity by 'blocking' a bed for the duration of his/her stay. Specialist weaning units have been proposed to address this situation and to concentrate expertise in weaning such challenging patients.

Several such units in the United States have reported their experiences[100,101,102,103] and claim a high success rate in weaning from ventilation. It has also been suggested that they may represent a cost-saving alternative to intensive care units, and possibly that they may reduce mortality in such cases.[101]

In 1998, a survey was undertaken of 70 ICUs in the London area to see whether they would use a specialist weaning service if one were provided for such patients.[104] Intensive care units in district hospitals, teaching hospitals and specialist hospitals were included and a 71% response rate was obtained. The results showed that 68% of units would refer to a specialist weaning unit for advice, diagnosis and support, and that 74% would refer patients for long-term ventilator management.

At present, such specialist facilities are not widely available in this country, but the results of this survey suggest that there may be a case for reviewing this situation.

Other models

In recent years, several studies have suggested that earlier recognition and intervention of seriously ill patients on general wards is likely to reduce their need for intensive care and, more importantly, improve outcome.[105,106,107,108,109] 'Medical emergency teams'[105] or 'patient-at-risk teams'[108,109] have been proposed to address this problem, operating as outreach services from the intensive care unit. The Audit Commission, in its report on critical care services in acute hospitals,[14] identified as one of its highest priority recommendations the need to 'improve services for patients on wards who are at risk of deterioration into a need for critical care'. The mainstay of this approach was to 'develop an "outreach" service from critical care specialists to support ward staff in managing patients at risk'.

Mercer *et al.*[110] support this view, but warn that once severely ill patients are identified, there must be provision to monitor them closely; so medical emergency teams must be coupled with adequate high-dependency facilities. Fletcher and Flabouris also stressed this point.[109]

The role of intermediate care

Ridley[40] sees high-dependency care as a system of managing illness that matches the continuum of health needs. Developing intermediate care has been seen as a means of alleviating both the perceived lack of intensive care facilities and the increased burden of ill patients on general wards. There is evidence to suggest that the provision of high-dependency care may address some of the shortages created by a lack of intensive care beds.[111,112,113]

The critical care modernisation programme[11] introduced a new approach to classifying critical care services, using a spectrum of four levels, thereby matching more closely the continuum of health needs.

Wallis *et al.*[114] reviewed the outcome of 1700 patients admitted to an intensive care unit over a five-year period in a hospital with an HDU. Twenty percent died on the ICU, but a further 9% died after return to the general wards. When they were discharged from the ICU, of those dying on the wards, 25.5% were expected to die, 54.2% were considered at risk of death, but 20.3% were expected to survive. The authors felt that some of these deaths would have been preventable, given adequate care, and suggested that HDUs could have a key role in providing a level of care between the ICU and the general wards for compromised patients.

The rationale underlying the HDU is 'progressive patient care', a system in which patients are grouped together on the basis of their dependency or degree of illness, rather than their speciality or diagnosis. It is argued that grouping patients by level of need can enable the best use to be made of available technical resources and staffing.[15] This was a concept endorsed by the Royal College of Anaesthetists and the Royal College of Surgeons of England in their report on graduated patient care.[115]

The Intensive Care Society[1] recommended that there should be an HDU in each district general hospital with clear lines of communication to a central ICU. They argued that the HDU should not manage patients with multi-organ failure but should provide monitoring and support to patients at risk of developing organ system failure.

The Association of Anaesthetists[16] suggested that the type of unit developed should depend on local requirements and constraints. Planning for high-dependency care needed to take into consideration the size and case-mix of admissions to the hospital, the needs of particular sub-specialities and the numbers and skills of available medical, nursing and support staff. It was suggested that the number of beds should be ascertained by an audit of the numbers of patients who might have been admitted to such a unit over a six-month period.

The focus on high-dependency care was made somewhat redundant by the announcement of the modernisation programme for critical care,[11] which called for strategic change to modernise services and introduced a new approach to classifying critical care according to a spectrum of four levels of care. The following discussion of high-dependency care makes some general points about having a stratified system that reflects severity of illness.

High-dependency care has traditionally been provided in a dedicated area, either as part of a general ward or adjacent to an ICU. There are advantages in having the facilities and skills of the ICU close at hand if a patient suddenly deteriorates. Such a system may also make management easier. In some hospitals, the ICU and HDU are integrated to the extent that they share the same area, with beds to a degree being interchangeable. The advantages and disadvantages of this arrangement are summarised in Table 23.

Table 23: Advantages and disadvantages of mixing or separating ICU and HDU.

Advantages	Disadvantages
Separate units	
Protected step-down bed availability	No extra flexible intensive care capacity
Patients/relatives with lesser illness are not mixed with very anxious or bereaved relatives of intensive care patients	Less continuity of care for patients, and the anxiety of moving to a new and unfamiliar environment.
Mixed units	
If a patient has a crisis on the HDU, ICU doctors and nurses are nearby to help out	
Cost-efficiency for staffing, less duplication of equipment	In times of bed stress, high-dependency beds are lost because they are used for intensive care
A larger pool of nurses with specialist qualifications to draw upon	Some nurses may have less experience in either high-dependency or intensive care

Several studies have examined the impact on the ICU of opening a high-dependency unit. Fox *et al.*[116] found that the use of intensive care beds became more appropriate; the occupancy of intensive care beds by patients needing only high-dependency care was reduced; and the occupancy by patients needing intensive care was increased. There was also a significant decrease in re-admissions, suggesting that the presence of an HDU reduced the number of patients discharged prematurely to general wards.

Dhond *et al.*[117] found, following the opening of an adjacent HDU, that the ICU patients' initial severity of illness was lower and their length of stay reduced. Also, fewer ICU patients were admitted directly from the general wards. They found no reduction in demand for intensive care – indeed, the HDU appeared to have generated new demand for critical care services overall. In their experience, the HDU was unlikely to relieve pressure on intensive care beds per se or to reduce the overall cost of critical care. There is other evidence that opening a high-dependency unit may reveal significant underlying demand. Parker *et al.*[118] studied the admissions to one critical care unit over a four-year period. The number of ICU beds was increased from 7 to 12, and then a 6-bed HDU was opened. Despite total capacity more than doubling from 7 to 18 critical care beds, overall occupancy decreased by only 16%, suggesting that demand was increasing to fill capacity.

The impact of opening an HDU in a given hospital will depend on the case-load and case-mix that it sees, as well as on the extent to which existing facilities meet that demand.

Peacock and Edbrooke,[119] reporting the effect of opening a high-dependency unit on numbers of cancellations of elective surgery and emergency transfers, also presented data that suggested some supply-induced demand, as shown in Table 24.

Table 24: The effect of opening a high-dependency unit.

	1992/3	**1993/4**	**1994/5**
Admissions to HDU	0	219	315
Cancellations	15	1	0
Admissions to ICU	310	268	346
Transfers out of ICU	19	2	0

With the opening of the HDU, admissions to the ICU decreased in 1993/4 as would be expected. However, the following year saw an increase over the pre-HDU level of ICU admissions. The authors also noted a significant reduction in the cancellation of elective surgery and in the number of patients transferred out of the ICU because of bed pressures.

How many beds are needed?

Previous recommendations

Hospital Building Note 27, published in 1970 and revised in 1974,[120] recommended that the number of beds in an ICU should be about 1%–2% of total acute beds, with additional allocation for any specialist services on site.

The more recent Health Building Note 27 avoids a specific formula, suggesting instead an occupancy of 65% as appropriate. Occupancy in units admitting a high proportion of elective cases and a low proportion of emergencies can safely be significantly higher.

The Royal College of Anaesthetists[121] states that the number of beds provided must be such that no elective patient is cancelled more than once because of the lack of critical care beds, and that immediate availability of beds for emergency admissions must be satisfied for more than 95% of requests.

Clearly, there is no fixed formula for the number of critical care beds needed by a trust, and it is important that the number is tailored to the workload and case-mix that the hospital treats.

The Intensive Care Society lists the factors to be considered when estimating the size of an ICU.[1] These are:

- number of acute beds in the hospital or catchment area
- type of acute bed (adult, paediatric)
- previously calculated occupancies of wards, HDUs and ICUs
- history of refusals
- location of other high-care areas (other ICUs or HDUs in hospital, other hospitals)
- number of operating theatres
- surgical specialities services and case-mix (e.g. vascular, cardiac, thoracic, emergency, urgent, elective)
- medical specialities (e.g. respiratory, cardiology)
- A&E department
- sub-regional or regional services (e.g. neurosurgery, maxillo-facial surgery, complex orthopaedic, renal services, oncology, etc.)
- ability to transfer patients to an off-site ICU (staff, equipment, transport)
- paediatric care
- location – motorways, holiday resort, mainline transport terminal (rail, coach, etc.).

There is no firm guidance as to the optimum size for an ICU. Units that are too small may not benefit from economies of scale, whereas units with more than eight beds may present problems of clinical management.

The number of beds needed will in part depend on how they are configured. Lyons *et al.*[122] calculated that to meet needs on 95% of occasions for a population of 500 000 would require 30 intensive care beds and 55 high-dependency beds if these were all in a single unit. For three separate units to meet an identical need on 95% of occasions, 10% more beds would be needed.

Modelling bed availability

Detailed mathematical models have an established place in providing quantitative information about healthcare resource needs and, to be helpful, must be able to deal with complexity, uncertainty, variability and, sometimes, inadequate data.[123] Critical care involves all these features, with a complicated mix of planned and emergency patients, complex arrival patterns, variable lengths of stay, uncertain outcomes, high mortality and scarce resources, and with considerable variation in all these factors between hospitals. Despite these difficulties, operational models can be developed which, as well as predicting need, can also take account of the resources needed for treatment.[124]

Constructing a model requires enough information to describe the natural history of patients or categories of patients in terms of their requirements for critical care. It also requires information about the resources available to manage them and the operating rules that govern the way those resources are used. Average lengths of stay are inadequate for developing such a model and, if used, will seriously underestimate bed requirements.[125] Instead, within a unit's case-mix, clinically meaningful and statistically homogenous groups of patients can be identified from relatively basic information.[18] Rather than taking mean lengths of stay for each of these groups, the statistical distributions of actual lengths of stay are used to inform the model.

Having developed the model, simulations can be performed and used to estimate the following, for example:

- the number of intensive care and/or high-dependency beds needed to cope with a particular case-mix, or to achieve a given level of occupancy

- what the effect would be of changing operating rules
- what impact on critical care would result from the introduction of new medical or surgical services at the trust
- how, if similar models were available for critical care units in adjacent trusts, a collaborative service might best be developed and managed.

Appropriate use of critical care beds

It is important that the use of critical care facilities is limited, as far as possible, to appropriate patients. This will depend in part on the facilities available, but also on the presence of experienced, suitably trained, senior clinicians able to make timely decisions on admission and discharge and on withholding or withdrawing treatment, should this be indicated.

The modernisation programme for critical care[11] called for NHS trusts to ensure that admission to critical care Levels 2 and 3 should be by consultant-to-consultant agreement only.

It is likely that, despite attempts to define firm admission and discharge criteria for intensive care units, patients are still admitted who are too ill to benefit. Resisting such referrals is often difficult and can be done only by someone with the authority that comes from appropriate training and experience. There are currently too few consultant sessions allocated to intensive care for this important gatekeeping role to be fulfilled around the clock. Commissioners should discuss with trusts the need for additional consultant sessions which, as well as meeting this need, might be used to set up medical emergency teams as discussed earlier.

Configuration and provision of critical care services

Recurring crises because of the shortage of intensive care beds suggest that the present configuration of critical care services is failing, and have led to the belief that more intensive care beds are required. There are considerable data, on the other hand, to suggest that a large proportion of intensive care beds are used for patients needing only high-dependency care, although the extent to which this applies varies greatly from trust to trust. Against this background and in the absence of reliable information, it is impossible to generalise on the need for additional beds or on the split between intensive care and high dependency. Some trusts will need more intensive care beds, some will need more high-dependency beds and others will need more of both. Reliable information is urgently required to inform this area.

The frequent use of intensive care beds by high-dependency patients suggests an underprovision of high-dependency facilities, and this is reinforced by studies showing shortcomings in the ward care of such patients. A lack of high-dependency or even of general ward beds makes it hard to use an intensive care unit efficiently and difficult to discharge patients when they would otherwise be ready.

In the absence of adequate information, it is impossible to make explicit recommendations regarding the centralisation or stratification of intensive care services. Nonetheless, given shortcomings in current service configuration, greater collaboration between trusts would seem desirable.

These issues were recognised in the report of the National Expert Group to review adult critical care services in the UK,[10] established in 1999 by the NHS Executive. As a result of the report, in May 2000 a critical care modernisation plan was announced,[11] which injected extra resources for additional staff, beds and services, and introduced a new approach to the classification of critical care services.

Individual trusts should also have an operational policy, discussed and agreed in advance, to put into practice at times of pressure: perhaps a recurring winter crisis or an unexpected local emergency. This strategy should replace the crisis-management approach that more often applies at present. Such a policy could take into account:

- cancellation of major elective surgery
- flexible use of other, specialist intensive care beds where present
- flexible use of high-dependency facilities
- transfers to adjacent hospitals, given appropriate transport arrangements.

At present, on general wards, some patients deteriorate in an unrecognised manner, to the point where intensive care becomes necessary. If these patients were identified earlier, it is likely that the need for intensive care might be avoided by earlier intervention either on the ward or in a high-dependency unit. One solution is the wider introduction of 'medical emergency teams' based on the intensive care unit, but which could be called whenever patients met defined criteria that identified them as being at risk. Consultant appointments will be needed to establish such teams, but the costs might be offset by a reduced need for intensive care.

This notion was also acknowledged in the report of the National Expert Group[10] and resulted in a call for the establishment of outreach teams.[11]

Commissioners should be involved in decisions on the allocation of resources to intensive and high-dependency care, but, as with other high-cost, low-volume services, it is probably appropriate for critical services to be specifically identified and considered outside the remit of PCGs. The current regional reviews of these services may address this. The only exception to this might be for episodes of intensive or high-dependency care following major elective surgery. In these instances, the level and duration of such care is usually fairly predictable and thus easily costed and built into overall contractual costs for these procedures.

A suitable currency for clinical care services remains to be defined, although work is currently underway on HRGs, and progress in this area would be welcomed.

Recommendations

Provision and configuration at trust level

The provision of critical care beds must be sufficient to meet the needs of emergency referrals on at least 95% of occasions, while at the same time allowing major elective surgery to be undertaken without frequent cancellations. It is not possible to generalise, and so fixed recommendations relating numbers of critical care beds to total hospital bed numbers are unhelpful. The numbers and types of critical care beds should be tailored to the workload and case-mix of each individual trust. To achieve this, some trusts will need more Level 1 and 2 beds, some will need more Level 3 beds, and some will need more of all levels. For some trusts, it might be appropriate for a proportion of Level 3 beds to be replaced by Level 1 and 2 beds.

When assessing the need for critical care services in a trust, as well as considering refused admissions, premature discharges, transfers and cancelled operations, the numbers of patients being managed on general wards who would benefit from critical care also need to be taken into account. This information can be obtained by conducting repeated, one-day snapshots using, for example, the ACP dataset or something similar to identify patients for whom critical care admission would be appropriate. Mathematical modelling can be used to provide a more accurate picture of need, as it can take into account the various uncertainties and complexities associated with critical care.

Once need has been defined, the next thing to consider is the configuration of the service in terms of the geographical, operational and management relationships between different levels of critical care beds. The integration of critical care beds, or at least the positioning of units next to one another, seems to offer advantages of flexibility and ease of management. Where a new unit is being developed in an existing building, however, limitations on space may make this difficult.

Outreach services should be developed so that seriously ill patients elsewhere in the trust can benefit from the expertise and skills of the intensive care staff, both medical and nursing. There should be agreed and widely publicised criteria which, when met by a patient, would trigger referral to a 'medical emergency team' or a 'patient-at-risk team' based on the intensive care unit. The aim would be to recognise seriously ill patients early, and certainly before they deteriorate to the point of suffering cardiorespiratory arrest. For some of these patients, early recognition and prompt appropriate treatment might avoid the need for subsequent critical care. For others, however, critical care facilities will be needed and must be available if outreach services are properly to achieve their aims.

To embrace all of these areas, there needs to be a process of strategic planning for critical care services in the trust, ideally conducted at board level.

Operational policies at inter-trust level

Since critical care is a scarce, expensive resource, trusts and their patients would benefit from a more collaborative approach than currently exists, particularly at times of pressure. Where appropriate, operational policies should be developed between trusts to ensure that resources are used to the greatest overall benefit. This will require strategic planning by a regional critical care group, with the whole exercise overseen by some corresponding national body. In the same way in which mathematical modelling can help with planning at trust level, it can also help to define optimal working relationships over wider geographical areas. It is at this level that data are helpful on population needs for critical care.

A possible model would be one based on centralisation, along the lines of that adopted for paediatric intensive care. This provides a clear operational structure and concentrates skills and expertise where they will be used, although there is no evidence that such a model would produce better patient outcomes. It must also be remembered that the scale of need for adult critical care services is far greater than that for children.

By implication, greater collaboration between trusts will entail more frequent patient transfers. If so, it must be ensured that these are conducted safely, according to agreed policies and guidelines, and that they are properly audited. Funding arrangements will also need to be in place to ensure that receiving trusts are not penalised.

Coping with pressure

It is unrealistic to assume that trusts will have enough critical care beds to cope with every peak of demand. Rather than relying on crisis management, therefore, strategies for coping with pressure should be agreed beforehand. At trust level, a plan needs to be formulated to escalate response to meet escalating pressure, defining how and under what circumstances other resources will be called into play – for example, other specialist critical care beds where present, or theatre recovery areas.

Similar strategies should be agreed between trusts for occasions when demand exceeds local provision. If bed availability is continuously monitored across a group of trusts, pressure can often be seen developing and therefore can be anticipated before the situation reaches crisis point.

Appropriate use of resources

It needs to be ensured that available beds are used for appropriate patients and that, where necessary, decisions on withholding and withdrawing treatment are made in a timely manner. This, in turn, requires input from appropriately trained and experienced consultants with sufficient sessional allocation for the task. Trusts should therefore review their allocation of consultant sessions to critical care to ensure that this need is being met.

The number of beds and the balance of provision should ensure that, as far as possible, critical care beds are occupied by appropriate patients. This also requires enough general ward beds to ensure that patients no longer needing critical care can be discharged promptly.

Given the paucity of suitably trained nurses, it is essential that those in post are used appropriately. To this end, the allocation of nurses to patients should be tailored to individual patient need rather than according to rigid 1:1 or 1:2 ratios.

Finally, units should have clear policies and guidelines covering issues such as admission, discharge, clinical care and patient transfers.

Data requirements

Information on critical care activity is urgently needed to inform strategic planning at trust, regional and national level. This must include data on the need for, the use of and the outcome from critical care.

The needs assessment should take into account patients currently managed on general wards who would benefit from critical care services. This exercise will require trust-wide surveys using, for example, the ACP dataset or similar criteria to identify such patients. In order to keep pace with changing activities and workloads, these surveys will need to be repeated at regular intervals.

Universal and accurate completion of the ACP dataset should be encouraged and will provide valuable data on the use of critical care facilities.

Reliable, case-mix-adjusted hospital outcome data should be available for all intensive care units through participation in ICNARC's Case Mix Programme. The same information will also be necessary for clinical governance purposes. While obviously important, hospital survival after intensive care has been perhaps over-emphasised as a measure of performance. For other life-threatening illnesses such as cancer and AIDS, long-term survival is the prime consideration, and more information of this sort is urgently needed in the intensive care setting. This is particularly important given that intensive care units seem to be admitting an increasingly elderly population of patients. While many of these patients survive to leave hospital, not enough is currently known about their longer-term outcome and quality of life.

In the absence of any current measures of process for critical care services, performance indicators should be defined and introduced. For intensive care units, these might include details of delayed or refused admissions, transfers to other units for non-clinical reasons, premature discharges because of pressure on beds, and readmission rates.

To be of value, data collection must be reliable and robust, and staff should be identified for the purpose. This will require appropriate funding and should be recognised as a priority by commissioners.

Staffing needs

The allocation of consultant sessions to intensive care should be reviewed in all trusts to ensure that decisions on admission, discharge, transfers and withholding or withdrawing treatment are made by experienced, appropriately trained senior clinicians. Any increase in the numbers of such consultants will clearly have implications for workforce planning and training.

Trusts should also ensure that critical care nursing staff are being used optimally, with nurse:patient ratios tailored, as far as possible, to individual patient need. The issues of nursing recruitment and retention should receive active attention, with consideration given to employing other staff to take over any non-nursing roles.

Outreach services, or any other expansion of clinical responsibilities outside the critical care unit, are likely to need additional staff, both medical and nursing.

Commissioning for critical care services

At present, for the majority of critical care units, costs are theoretically built into block contracts for the major clinical specialities. As a result, intensive care clinicians rarely deal directly with commissioners, and negotiations are conducted on their behalf by clinicians who may have little understanding of the service. This system may be appropriate if the need for intensive care is regular and predictable as, for example, following elective cardiac surgery. It is unsatisfactory when the need is unpredictable and comprises mainly emergencies – the pattern of work for most ICUs. When block contracts are being negotiated, intensive care needs and costs are frequently underestimated or forgotten. Current arrangements also fail to recognise the impact of specialities that use intensive care only rarely and so make no allowance for it in negotiating contracts. Cumulatively, however, such patients account for a significant proportion of intensive care admissions. As a result of these anomalies, the service is inevitably underfunded.

A Department of Health working group[15] recommended that commissioners should be involved in decisions about the allocation of resources to critical care and contracting for these services. It is clearly important for clinicians actually involved in providing such services also to be closely involved in these discussions. The development of HRGs for critical care would greatly facilitate this process.

The call in May 2000[11] for NHS trusts to establish Critical Care Delivery Groups with the involvement of both medical and nursing critical care clinicians may provide an avenue for clinicians to become more involved in contracting.

Critical care services should be specifically identified in discussions with commissioners, and intensive care clinicians should be involved in that exercise. As with other high-cost, low-volume services, it may be appropriate for critical care to be considered outside the remit of PCGs except where it occurs as a planned episode following major elective surgery. In these instances, the level and duration of such care is usually fairly predictable and thus easily costed and built into overall contractual costs for these procedures.

A suitable currency for critical care services remains to be defined, although work is currently underway on HRGs, and progress in this area would be welcomed.

8 Outcome measures

Traditionally, the most commonly used outcome measure has been patient survival, both from the intensive care unit and, more especially, from hospital. The APACHE II method has been validated on a British population and allows a case-mix-adjusted probability of hospital death to be calculated for each adult patient. From that, the number of deaths expected in a group of patients can also be calculated. If this is compared with the actual number of hospital deaths, a standardised mortality ratio (SMR) can be derived and, with some reservations, be used as a basis for comparisons between units. Such comparisons rely on a robust process for data collection and analysis and it is therefore important to ensure that all units participate in the ICNARC Case Mix Programme (*see* above).

Even with case-mix adjustment, the importance of hospital survival has been somewhat overemphasised and would not be considered adequate for other life-threatening pathologies. In cancer and AIDS, for example, it is considered more helpful to examine long-term survival over periods of months and years, and similar data should be collected routinely for intensive care patients.

Similarly, not enough is known about restoration of function and quality of life in survivors of critical illness. Patients should be evaluated in terms of their ongoing health and the extent to which they are restored to their previous lifestyle. It has been suggested that, six months after hospital discharge, 9% of patients admitted to intensive care have severe limitations to daily living, 38% have some limitations but are able to live independently, and only 16% enjoy good health with no limitations.[17]

Given that intensive care units are admitting an increasingly elderly population of patients, more information on long-term survival and quality of life is urgently needed. While many elderly patients survive to leave hospital, not enough is currently known about their prognosis thereafter. Djaiani and Ridley[126] followed 474 patients aged over 70 years and admitted to intensive care, and found their survival at one year to be significantly poorer than that of an age- and sex-matched normal population.

Many of the considerable number of quality-of-life measures available are disease-specific, and few have been formally assessed in the critical care setting for acceptability, reliability and validity. The Sickness Impact Profile[127] has been validated in 3655 Dutch intensive care patients six months after hospital discharge,[128] and the Short Form 36 (SF-36)[129] was found to be a robust tool when assessed in a smaller population of British adult intensive care patients.[130] Using SF-36, Ridley *et al.*[131] found that the pre-morbid quality of life of patients admitted to intensive care was not the same as in a normal population. They showed that patients who were previously fit and with a normal quality of life suffered significant decreases following their illness, while those with pre-existing ill health showed some improvement in quality of life six months after intensive care admission. Increasing severity of illness and length of intensive care stay were associated with decreases in quality of life after critical illness.

Targets

There is an urgent need for performance indicators to be agreed and introduced for critical care services. For intensive care patients, these should include the routine collection of data on:

- refused or delayed admissions
- transfers for non-clinical reasons
- premature discharges because of pressure on beds
- re-admissions following discharge to ward areas.

The National Intensive Care Bed Register collects data on bed availability, enquiries about possible transfers and transfers actually undertaken, but unfortunately the data are not robust enough to be of great value.

9 Information and research requirements

Information requirements

Information is required on the need for, the use of and the outcome from critical care in order to inform strategic planning at trust, regional and national level. It was noted earlier in this chapter that a paucity of such data had plagued previous attempts to review adult critical care services and that it still makes planning difficult. In part, this is because the need for critical care relates primarily to severity of illness rather than specific diagnoses (*see* Section 1) and so, until recently, was not captured in the diagnostic and activity-related information routinely collected by trusts. With the introduction of the mandatory Augmented Care Period (ACP) dataset[132] in October 1997, this situation has changed and a responsibility for critical care data collection now rests firmly with acute trusts. This was reinforced by the critical care modernisation programme,[11] which noted that only 63% of NHS trusts were complying with the ACP data collection and called for all trusts to do so.

The ACP dataset was introduced as an extension to the NHS Contract Minimum Dataset. Its function is to provide standardised data on intensive and high-dependency care activity to support contracting, internal management, national statistical analysis and policy development. Having been only recently introduced, there are currently concerns about the quality of the data and, despite being mandatory, it is still not universally collected. Also, because the dataset focuses on defined critical care areas and excludes general wards, it records only activity and not need. There needs to be a concerted effort to ensure that the ACP dataset is collected accurately and universally, as intended.

In March 1999, a twice-yearly national census of adult intensive care and high-dependency beds was introduced because of a lack of basic information in this area. This, the KH03a data, should provide further valuable information for policy and planning purposes.

Historically, most intensive care units have collected data on their activity for local use and, as well as basic demographics, this has usually included information about numbers and sources of admissions, interventions, length of stay and outcome. Some measure of severity of illness was usually included, most often using the APACHE II method. Unfortunately, since definitions were not standardised and data were collected by untrained, often very busy staff, the results were not comparable with those from other units and sometimes were of doubtful value even in-house.

In January 1994, the Intensive Care National Audit and Research Centre (ICNARC) was established, offering as its main audit activity a national Case Mix Programme for intensive care units. Under this Programme, data are collected by trained staff using standardised definitions, and with external validation. The result is a high-quality, comparative audit exercise providing valuable information on activity, case-mix and case-mix-adjusted outcome. At present, participation in the Case Mix Programme is not mandatory, and units have to pay an annual registration fee to take part – only about 60% of units in England and Wales participate.[11] It is important to ensure that, in the future, all units are registered with ICNARC and participate in the Case Mix Programme. This was reflected in the circular announcing the critical care modernisation programme,[11] which called for all trusts to join ICNARC.

To be of value, any data collected must be reliable and robust, and staff should be specifically identified for the purpose. This will require appropriate funding and should be recognised as a priority by commissioners.

Research priorities

A major criticism of intensive care practice is that, despite its rapid development over the past 50 years, it is not sufficiently underpinned by a firm basis of research. In 1996, a Department of Health working group[15] identified several areas requiring further work. It recommended that further research be undertaken to evaluate the outcome of intensive and high-dependency care. One of the difficulties, however, is that patients are perceived inevitably to have a poor outcome if denied intensive care. As a result, it is not considered ethical to conduct randomised controlled trials allocating patients arbitrarily to intensive care or to an alternative level of care in order to compare outcomes.

The group also recommended that work should be done to examine the role of nurses and other members of the multi-disciplinary team in intensive care and, in particular, to look at the relationship between patient dependency and the use of nursing resources.

In 1997, a joint Medical Research Council/Department of Health working party on intensive and high-dependency care highlighted the need for high-quality research and specifically identified five priority areas:

- the development and validation of risk-adjusted methods for adult, paediatric and neonatal intensive care and high-dependency care in order to be able validly to compare different models of care and to compare the performance of similar models of care
- the development of models for costing adult, paediatric and neonatal intensive and high-dependency care

- the evaluation and comparison of new and existing forms of care for adult, paediatric and neonatal intensive and high-dependency care
- the development of methods of needs assessment to identify the need for and appropriate targeting of adult, paediatric and neonatal intensive and high-dependency care and
- health technology assessment of specific interventions commonly used in adult, paediatric and neonatal intensive and high-dependency care.

Vella *et al.*[133] recently explored clinicians' views of research priorities in critical care, and reported that topics related to research into the organisation and delivery of critical care predominated, with less support for evaluation of specific healthcare technologies.

ICNARC has a key role in identifying and co-ordinating research needs and is currently involved in work relating to a number of the above points. This includes research into both adult and paediatric risk adjustment, and randomised controlled trials into the benefits of high-dependency care and the use of pulmonary artery catheters.

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