The costs of intensive care

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Key points

Accurately determining costs of intensive care is still difficult; there is no internationally agreed methodology.

The viewpoint of the cost analysis (i.e. ICU, hospital and health authority) will influence the selection of costs to be included.

The UK Cost Block Programme has provided a framework to determine major variable (patient-related) and stable (non patient-related) costs.

The International Programme for Resource Use in Critical Care has evaluated international cost comparisons; however, the difficulties in finding a universal and meaningful unit of cost persist.

Trials to evaluate health benefit of therapies (cost utility trials) are becoming increasingly important to justify the introduction of new and expensive treatments.

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Accurately assessing the costs of intensive care therapy continues to present the clinician with a significant challenge, as the most appropriate methodology to do so remains controversial. This paper aims to summarize the development of costing analysis and introduce the reader to its terminology, methodology and application.

Background

Intensive care units (ICUs) are a costly resource. They are oversubscribed and the treatments they offer are expensive and labour intensive. Resources within the NHS are finite; therefore, it is important that intensive care clinicians are aware of how the costs of an individual unit are incurred and how they relate to its therapeutic activity, case mix and clinical outcome. Despite huge variations in resource consumption between individual patients (influenced by factors such as case mix, illness severity, length of stay and variations in clinical practice), this parameter remains the ideal measure of cost.[1] Cost drivers (i.e. therapies that initiate other therapeutic interventions, thereby driving costs) can be identified, thereby aiding the calculation of these patient-specific costs. The process of cost analysis helps to allocate resources efficiently, thereby improving both quality and quantity of ICU provision.

Studies that calculated the cost per patient admission in ICUs have noted a significant variation (e.g. US$1783 to US$78 435[1]). These differences have been attributed to a number of different factors:

- Advances in healthcare technology, which may increase or decrease costs.
- ICUs are not of a standard size; they have different staff/patient ratios and research/training activities.
- Treatment options differ, thus influencing patient selection and costs (e.g. provision of MARS for liver failure).
- Most importantly, there is no agreed ICU costing methodology and methods differ substantially between studies. Examples of such include (i) US hospital bills are often used as an inaccurate substitute for costs. (ii) Costs calculated as an average bed-day price × length of stay do not accurately reflect patient-specific costs and how their resource use varies throughout their stay on ICU. In addition, no relationship between costs, therapeutic activity and outcome can be established. (iii) Inclusion or exclusion of certain cost components is often unclear (e.g. medical time and cost of capital equipment).

Given the above list of factors, it is obvious to see why it is extremely difficult to compare different published analyses of intensive care costs, particularly between different institutions.

Cost analysis

It has become clear that a more structured and reproducible approach to costing in intensive care is required, if only to allow for better comparability between published data. Gyldmark,[1] having reviewed the methodology of 20 costing studies in the intensive care setting, proposed a 'decision making tree' which included (i) the purpose of the study, (ii) the viewpoint of the study (i.e. from a patient, unit and hospital perspective) and (iii) the time span of the analysis. In addition, a precise description of the individual costs is required, rather than summarized figures, to produce an accurate cost analysis. Her systematic approach included three key points that must be clearly defined before embarking on any cost analysis:

- Which cost components should be included (Table 1); this may be affected by the viewpoint of the study (i.e. costs to the unit or hospital).
- Data collection method.
- Unit cost (e.g. cost of a test or item). This is often an estimate or an average.

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Table 1 Cost components used in the studies reviewed by Gyldmark[1]

• Overheads	• Medical time	• Nursing time
• Other staff	• Disposables	• Theatre
• Medicine	• Nuclear medicine	• Blood bank
• Radiology	• Ultrasound	• Biochemistry
• Microbiology	• Kitchen equipment	• Non-hospital costs

Cost components

Cost components (Table 1) include costs of disposables, staff and laboratory tests. However, the inclusion of some cost components (e.g. administrative overheads and capital equipment costs) depend upon the viewpoint of the analysis. For the analysis of 'internal' parameters (e.g. outcome, local resource use and patient characteristics) the components should be excluded, as they are borne by the hospital. However, if the analysis is to be conducted from an external viewpoint (e.g. hospital or local health authority), they need to be included. These considerations also apply to costs arising from research and ongoing educational activities.

Running an ICU can alter the costs to a hospital in a complex way. For example, taking patients from a ward to intensive care frees up a ward bed, which can be used for other patients. However, intensive care survivors can increase hospital costs owing to their prolonged stay. Costs to the health authority may increase as ICU survivors who leave hospital may have residual health problems relating to their stay in intensive care that require further long-term treatment.

Data collection

There are two components for collecting cost data: (i) time aspect (prospective/retrospective) and (ii) registration method ('Top Down' versus 'Bottom up' methodology).

'Top Down' approach

By definition, this approach is retrospective, as it calculates costs by dividing the intensive care budget by the number of patients or patient-days. It has been used widely and is an easy way of facilitating inter-ICU comparisons. Using this approach, it was calculated that the median cost of an ICU per patient-day in the financial year 1999–2000 was £955.[2] This method allows, for example, the calculation of the costs incurred in establishing an additional ICU bed or changing the nursing skill mix. Unfortunately, as this technique assumes an equal distribution of resources between patients, it will not allow comparisons of patients with differing treatment methods or illness severity scores.

'Bottom up' approach

This approach is based on the detailed assignment of costs to individual patients according to their use of resources. It is labour intensive, requires accurate knowledge of nursing and medical activity and identifies the unit costs of factors such as drugs, consumables and clinical support services. Its advantages are that it can be applied prospectively; allowing the analysis of individual patient costs with respect to their treatment, severity of illness and outcome. This detailed approach, which is often unnecessary and unrealistic, has been used by several authors to determine such specific costs as the median costs for survivors and non-survivors of severe sepsis (£4838.51 versus £1165.22)[3] and a detailed analysis of certain cost drivers (e.g. chest radiographs constituted 50% of the diagnostic imaging costs in a unit that performed daily chest radiographs on most patients)[4].

Unit cost

Unit costs are those of a test or item (e.g. full blood count and syringe) which, in the bottom up approach, are multiplied with units of resource use. It is often difficult to define unit costs accurately, as they are simply unavailable, borne by other departments or only specified as an average cost per unit of production.

Cost block methodology

In 1994, the Intensive Care Working Group on Costing was formed under the auspices of the Intensive Care National Audit and Research Centre (ICNARC). Its aim was to divide ICU costs into reproducible areas, allowing for the easy comparison of ICU costs nationwide.[5] After initially trying to include as many costs and resources as possible into the analysis, it became evident that this was not feasible, as reliability of data and ease of collection were of prime importance. During the review of non-clinical support services, it was decided to include costs for administration, management and cleaning, but exclude those for laundry, uniform provision, portering, security and chaplaincy. This process resulted in the identification of six 'cost blocks' (i.e. costs of staff, clinical support services, consumables, estates, non-clinical support services and capital equipment). Table 2 shows the six cost blocks, their individual cost elements and their contribution to total costs.

Cost Block 1 (*Capital Equipment*): All assets that were valued >£1000, <10 yr old and were expected to last at least 1 yr were identified.

Cost Block 2 (*Estates*): Depreciation, maintenance, utilities and so on were expressed as a percentage of total ICU floor area.

Cost Block 3 (*Non-Clinical Support Services*): Expressed as a percentage of hospital floor area.

Cost Block 4 (*Clinical Support Services*): Pharmacy and dietetics services were subsequently excluded, as their contributions were both small and difficult to measure.

Cost Block 5 (*Consumables*): These included drugs, piped gases and equipment with a life span of <1 yr.

Cost Block 6 (*Staff costs*): Allowances were made for the out-of-hours commitments of medical and technician staff and the additional costs of bank and agency nursing staff.

Table 2 Cost blocks, their elements and proportion of costs[4]

	Capital equipment 1	Estates 2	Non-clinical support 3	Clinical Support 4	Consumables 5	Staff 6
i	Linear standard depreciation	Building depreciation	Administration/ management	Physiotherapy	Drugs, fluid, nutrition	Consultants
ii	Total maintenance	Water, sewage, waste disposal, energy	Cleaning	Radiology	Blood, blood products	Non-consultants
iii	Annual lease/hire charge	Maintenance engineering, decoration	–	Other (renal, cardiology)	Disposables	Technicians
iv	–	Rates	–	Laboratory	–	Nursing staff
v	–	–	–	Pharmacy	–	–
vi	–	–	–	Dietetics	–	–
%	**6.0**	**2.7–3.4**	**7.0–7.8**	**7.0–8.5**	**21.5–24.7**	**53.6–54.7**

To validate the methodology, two pilot studies were undertaken, involving 11 ICUs in the UK; costs were analysed according to the cost block principle.[5] Patient-related costs in cost blocks 4–6 (clinical support services, staff) accounted for 85% of annual ICU costs. The remaining 15% of non-patient related costs (cost blocks 1–3) were very difficult to collect and remained relatively constant over the 2 yr study period. Staff costs are consistently the single biggest ICU cost, representing >50% of total ICU expenditure. In the pilot studies, it was evident that expenditure decreased in two ICUs after a period of reorganization leading to an alteration in nursing skill mix. Consequently, the cost block methodology, based on the three patient-related cost blocks (blocks 4–6), has been used since 1998 to collect and validate data on ICUs throughout the United Kingdom. For the majority of other countries, this is not the case; hence, the adaptation of the UK cost block methodology for the development of IPOC (The International Programme for resOurce use in Critical care).[6]

International programme for resource use in critical care

IPOC was a collaborative project undertaken with the support of the European Society of Intensive Care Medicine. Its objective was to develop a simple methodology for accurately comparing intensive care resource use, costs and provision between countries. This would allow for the inclusion of international cost comparisons in future international trials, something that has not been evident in the literature until recently. IPOC was to develop this methodology by creating an internationally acceptable questionnaire based on standardized cost block methodology. The questionnaire was based upon the UK cost block study and looked at the annual total costs incurred within the ICU. The three UK cost blocks [i.e. staff, support services and consumables (drugs and disposables)] were used along with an additional block for major capital equipment. The addition of a major capital equipment block was to allow understanding of the differences in resource use between countries. The majority of the questionnaire was to be completed with actual costs. Where this was not possible, owing to integration of certain cost components within the hospital accounting system, estimates were used. The four countries involved in the pilot study were the UK, France, Germany and Hungary. The costs were converted to international dollars, using the Purchasing Power Parity (PPP—see below) exchange rates developed by the World Health Organization. This allowed, for the first time, the comparison of ICU costs from one country to another using a common reference point.

Cost comparison

Accurate and unbiased cross-country cost comparisons, allowing comparison of alternative treatments, in which the costs and consequences of the treatments vary, are yet to be achieved. The ideal methodology would have the following characteristics: universally applicable; easily attained; accurate; stable over time; compare costs and resources, not charges; and reflect purchasing power.

Cost comparisons require a method of converting local currency into a meaningful and universally applicable unit of cost. Exchange rates have been used previously but are far from ideal as they are subject to market and governmental influences, tending to reflect variations in traded goods, rather than non-traded goods. Another method is the use of PPPs, simply defined as 'The rates of currency conversion that eliminate differences between different countries'. PPPs are constructed by creating a price index (deflator) for a certain currency in order to calculate that currency's purchasing power in any country at any time. This helps to remove any of the financial, political or institutional influence that supports the currencies exchange rate. A well-known and simple PPP method is the 'Big Mac Index' (i.e. the cost of a Big Mac in 120 different countries). The difficulty with comparing a bundle of health care commodities is that there is no free market to determine their prices. They are often influenced by governmental intervention. Despite this, the World Health Organization (WHO) and IPOC uses PPPs, derived from the Gross Domestic Product of 160 individual countries, to compare health care costs. The unit of this cost is the International Dollar, a universal hypothetical currency.

Trials assessing cost versus benefit

Increasingly, new drugs or therapeutic strategies are not only judged on their medical effectiveness, but also on cost versus health benefit or costs saved. There are various types of analysis:

- *Cost effectiveness analysis*: A method of comparing treatments in which the costs and consequences of the treatments vary. The outcomes of the alternative treatments are measured in a non-monetary unit (life-years gained, irrespective of quality).
- *Cost utility analysis* is similar to the above except the benefits are expressed as measures that reflect the value of ill health avoided (i.e. quality-adjusted life years).
- *Cost benefit analysis*: All costs incurred and the resulting benefits are expressed in monetary units and a net monetary gain/loss or cost:benefit ratio is calculated. Any alternative where the benefit is greater than the cost may be deemed 'worthwhile'.
- *Cost minimization analysis* is used to compare the costs of those treatments that are assumed to have an equivalent medical effect. This method does not take into account such things as side-effects (or their potential costs).

With the introduction of human recombinant activated protein C as a treatment for severe sepsis, the significant expense of this new treatment needed to be justified. This provided the catalyst for the publication of two cost-effectiveness trials. These were based on the original PROWESS (Recombinant Human Activated Protein C Worldwide Evaluation in Severe Sepsis) dataset and used two different methods of cost comparison.[7] The first trial[8] calculated the life-years, costs and incremental cost per life-year gained. The costs were converted from Canadian to US dollars, producing an estimate of the cost of care for the ICU and hospital stay, in addition to the continued health care of hospital survivors. The second trial[9] used direct and indirect healthcare costs. Their endpoints were the number of life-years gained with treatment and the quality-adjusted life-years, a combination of the quantity and quality of life gained, both estimated from hospital billing records. Both studies adequately demonstrated the cost effectiveness of human recombinant activated protein C. However, they were criticised for their use of estimated costs and inability to combine results from different countries within the PROWESS study.

Conclusions

The increasing financial demands placed upon healthcare systems dictate that clinicians need to allocate and utilize resources responsibly. In order to achieve this, accurate and comparable costing information is vital. This requirement is becoming increasingly important as we begin to consider the cost-effectiveness or cost per quality of life-years saved of current and future ICU interventions. For the first time, IPOC achieved this by providing a detailed cost comparison of ICU care in different countries. These data, when combined with data regarding patient outcome, can be used as a comparative tool to establish the ideal provision of ICU beds and their costs.

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Please see multiple choice questions 20–24.