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Does Bedside Blood Gas Analysis Reduce Costs in the ICU?

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The design of studies to measure the costs of blood gas analysis in intensive care is difficult, with few studies reported to date. However, the authors advocate organizational strategies for quality of care maintenance/ improvement and cost containment: standardization of care, variable rather than fixed costs and internal price negotiations.

Introduction

Providing care influences outcome favourably, but also has a dramatic impact on costs in an intensive care unit (ICU). Policymakers have concerns over cost containment and cost effectiveness, in particular for various routine activities in medicine (Sperry 1997; Vitez 1994). Attending physicians therefore need to take a close look at various routine tasks in medicine, such as daily laboratory testing and X-rays. Many institutions have implemented standards and guidelines, or so-called patient paths. Firm evidence to support the cost-effectiveness or even the clinical effectiveness of routine tasks in the critically ill patient care is scarce. Evidence-based medicine as an approach itself is not cost saving, but may generate scientific knowledge to apply new techniques and therapies.

The assessment of arterial or venous blood gases on a routine basis is a typical example where cost containment and cost-effectiveness could be implemented in a sensible manner. A clear understanding of economic analyses is one step towards insuring quality of care for patients.

Blood gas analysis is a typical example where the progression of technology renders this technique at least questionable concerning usefulness and cost effectiveness. Since the introduction and routine use of capnographs

and oximeters in the ICU (Gottschalk et al. 1997; Shoemaker et al. 1996), it is evident that the frequency and need for arterial blood gas analyses has decreased considerably. Technology, however, is characterized by a continuous growth, with newer features becoming routinely available, such as blood lactate and glucose measurements. These additional options renew the appeal and interest in blood gas devices.

The best cost-containment strategy is to deliver the product at the highest acceptable quality with the lowest possible cost. Monitoring of the adequacy of oxygenation and ventilation is a cornerstone in the management of critical care medicine. In this respect, arterial blood gas monitoring is the golden standard for accurate and early detection of arterial hypoxaemia hypercarbia and changes in pH. Nevertheless, it requires invasive arterial pressure monitoring, which is not always available with ICU patients. In this overview, we focus on intermittent arterial and venous blood gas monitoring with respect to cost containment.

The difficulty is finding the balance between optimal financial expenditure to provide adequate care and restricting health care budgets. With respect to the latter, the threat is that budget control is so pronounced that an increase of the complication ratio is to be feared. Patients in an ICU, who undergo mechanical ventilator support for respiratory insufficiency, are evidently prone to cardiopulmonary complications, which could inherently prolong duration of mechanical ventilation, and therefore augment costs. In this respect, it seems logical to monitor ICU patients with arterial blood gases.

Definitions are required in order to gain an accurate idea of how to interpret cost containment and cost effectiveness. Cost definition, assessing economic outcome measures and managing care economically are important issues for today’s medical practitioners (Sperry 1997). Table 1 presents some important definitions. The irreversible use of a resource implicates a price to be paid to use this facility. Direct costs comprise the use of materials and products to utilize the facility. In contrast, indirect costs are related to expenses related to an individual or/and the society. In delivering medical care it is necessary to set priorities and to define (or to estimate) the benefit to harm ratio relative to the cost. Another important point is that prices do not represent cost and benefit. Furthermore, costs are not synonymous with charges (Vitez 1994).

Four types of analyses are commonly used:

a) cost minimization;

b) cost effectiveness;

c) cost benefit and

d) cost utility analyses.

Cost Minimisation

Cost minimisation identifies the financial consequences of care, but assumes that outcomes after different treatment modalities are equivalent for a distinct disease. Such studies seek cost minimization and are usually useful in low cost situations when outcomes are not essential. From an economical point of view, we have fixed costs and variable costs for a blood gas analysis. In a typical setting of an ICU, the blood gas analysis is priced as a variable cost. Making costs variable is an efficient tool for cost control. If patient paths are implemented, the ICU physician is forced to negotiate these prices. We stress that the most efficient manner to minimise costs for blood gas analysis is variability of all laboratory costs in an ICU. Blood gas analysis costs are clearly related to a patient and his or her disease state.

In the emergency department, use of a pulse oximeter may allow significant reduction of unjustified blood gas analysis, which may permit a cost saving (Le Bourdelles et al. 1998). However, it should also be taken into account that modern blood gas analysis provides more information than optimal oxygenation alone.

Cost Effectiveness

Cost-effectiveness analysis examines the net cost of care provided in correlation with outcome. This analysis technique considers life duration, quality of life, alternative treatments and incremental effectiveness. The natureand quality of evidence, the time horizon, the time value for money and all causes of mortality are also assessed. The key question is “Is it worth doing this (specific) intervention?“ If the cost for blood gas analysis is truly a variable cost in a daily clinical setting, the decision can be taken, knowing the price of the analysis. Another approach is the standardization of care, in particular in using clinical pathways, where services and therapies for a typical patient with a diagnosis are outlined. By standardization of care, the final goal is not only reduction of intravariance and intervariance of care, but also a reduction of the costs. Clinical pathways are supposed to have an effect on cost effectiveness and outcome (Imhoff 2000). To date, however, no study has shown rationing of blood gas analysis to have a beneficial effect. The importance is also minimal because of the low cost per blood gas analysis.

During the last 48h of life, blood gas analyses (Bamberger et al. 1996) are the most frequent requested analyses (20%) in surgical ICU patients, although the costs contribute only up to 5% of the total costs for these patients. The limitation of care in such situations is more a question of making a correct prognosis. The resuscitation status has a significant effect on the frequency with which these lab analyses are ordered.

Early goal directed therapy, based on central venous oxygen saturation monitoring, considerably improves the outcome of patients with severe sepsis or septic shock (Rivers et al. 2001). Although more blood gas analyses were undertaken, the knowledge from these assessments improved outcome significantly. With regard to the overall costs, these analyses were completely justifiable because of the low variable cost of blood gas analysis. Recently, this tool has been implemented into central venous catheters as an early warning system (Reinhart et al. 2004).

Cost Benefit

Cost benefit analysis tries to quantify a benefit in monetary terms at a specific cost. The key question is “Are the achieved outcomes worth the cost?“ Cost-benefitstudies, with the classical meaning of these study types, are difficult to undertake in a critical care setting. To the best of our knowledge, no study is available to date discussing this item. Such studies are required in the context of the specific health care situation and system for each country. Implementation of guidelines, however, for blood gas analysis, increases efficiency of test utilisation without negatively affecting outcome (Pilon et al. 1997).

Cost Utility

Typically all input costs are assessed with the generated output. The latter is measured in so-called utility units (see table 2). As costs for blood gas analysis are only a small part of all fixed and variable costs for ICU care, such studies are actually redundant.

Redesigning Processes

The product in an ICU is also often difficult to define: are these cases, hospital days, interventions etc.? The definitions of costs and products are an important step towards analyzing and benchmarking productivity – an important cornerstone for cost containment. For this task, many scoring systems to estimate the severity of illness burden for an ICU are not validated. The duration of time spent in the lab- and therefore cost-intensive environments by the patient really determines the cost of care per event. Nevertheless resources are limited. The first step and simplest way to reduce resource consumption is to control resource allocation. One of the major components and rate limiting steps in managing critical care is gate keeping a triage. Using a highly sophisticated approach in treating patients, a patient's need for the high cost parts in the process chain of a surgical event can be optimized. Therefore, the efficient, effective processing of patients has the best opportunity to optimize cost of medical care.

• The use of clinical pathways is suggested as a tool for intelligent rationing in health care. Again it is important not only to focus on critical care, but also to put intensive care in the perspective of the entire continuum of care. Many decisions relevant to outcome, acuity and cost of the critically ill are made before the patient reaches the ICU. In this respect, arterial blood gas monitoring is a cornerstone in ICU management. Devices to measure blood gases and other features, such as blood glucose and lactate within the intensive care unit, often reduce the cost in several ways: less time to results before decision making, more rapid follow up and adaptation of both respiratory and metabolic management, additional determination of important parameters, such as blood glucose and lactate.

• Attention to organizational issues: significant reductions in mortality rates and improvements in resource efficiency have been observed when intensivist teams are actively involved in a closed ICU format and systemic triage (Rivers et al. 2001).

Redesigning protocols for routine lab investigations is associated with cost changes although without impact on

quality of care in trauma patients (Jacobs et al. 2000).

Although few economic studies on blood gas analysis are available, a clear strategy is possible. To optimize costs, standardization of care and truly variable rather than fixed costs, together with internal price negotiations, are the most efficient strategies (fig. 1). However, blood gas analysis costs should not be overstressed, as they are only a small part of the complete ICU care package.

Conclusions

The ability to perform a reliable analysis of the costeffectiveness of ICU care in general and for specific aspects of critical care, in particular, will greatly assist the process of determining how to focus limited resources appropriately in future (see table 3).

Although the clinical management of patients is an art rather than pure science, many aspects should be taken into account to produce critical care cost effectively: microbiology, pharmacodynamics, pharmacokinetics and economics. Any debate about cost in intensive care needs to assess the entire continuum of care. Therefore an increase in productivity with the aim of improving/maintaining quality should first be focused when cost containment initiatives are implemented, before we start rationing care. Attention to organizational issues of ICU care will result in improvement in the quality of care and a reduction of costs (Reinhart et al. 2004).

In addition, the design of relevant economic studies of the four types outlined above is difficult. These analyses need to handle moving targets, such as contract price changes, losses of patents etc. The study design needs to cope with questions of economics with a straight forward focus and hypothesis on either the health care system or a group of patients with a valid end point and clear cost model (Drummond and Jefferson 1996).

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