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Approach to economic analysis in critical care

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ABSTRACT

There are 4 general economic analyses used in health care: cost minimization, cost-benefit, cost-effectiveness, and cost utility. In this review, we provide an overview of each of these analyses and examine their appropriateness and effectiveness in assessing critical care costs. In the intensive care unit setting, it is particularly important to consider the patients' quality of life following the treatment of critical illness and to adopt a societal perspective when conducting economic analyses. Therefore, of the 4 economic analyses we cover, we recommend the use of cost-effectiveness and cost utility analyses.

1. Introduction

Depending on the province and territory, it has been reported that approximately 52% to 87% of deaths in Canada occur in hospitals [1]. In hospitals that recorded number of deaths, it has been reported that between 7% and 25% of hospital deaths occur in special care units [1,2]. More recently, Bekelman et al [3] compared the site of death, health care utilization, and hospital expenditures of dying oncology patients in 7 developed countries: Belgium, Canada, England, Germany, the Netherlands, Norway, and the United States. Based on registry data from 2010, Bekelman et al [3] reported that of the 7 developed countries, Canada had one of the higher proportions of decedents die in acute care hospitals (about 52.1%) and the highest mean per capital hospital expenditures on acute care hospitalizations (US $21 840) compared with the other 6 countries. However, it remains to be investigated whether the resources and funds are optimally used.

Currently, it has been estimated that the cost to maintain intensive care unit (ICU) services is about 1% of the GDP [4]. But with the increasing life expectancies and aging population in Canada [5,6], resource consumption in the ICU will likely increase because of the increasing complexity of conditions, the need for increased surveillance and monitoring, and the prolonged duration of stay in the ICU. At the present time, many ICU patients have a guarded prognosis based on their comorbidities and functional status—therefore, a subset of patients has extended stays in the ICU. Given the increasing costs, the economic impact of medical interventions has recently garnered much attention.

Unfortunately, many of the existing studies assessing the economic impact of medical interventions use varying methodologies and assessment strategies and are of differing scientific rigor, rendering it difficult to evaluate and interpret the various findings. For instance, although there are more than 1000 studies investigating the economic evaluations in the ICU, there are arguably few studies that meet basic scientific rigor [7]. Given the amount of money allocated to maintain the ICU, costing data are particularly important for the ICU because it will allow for the optimization of resources and to determine whether the therapies and treatments are efficacious given the costs.

There are 4 general types of economic analyses that are used in assessing the economic impact of medical intervention and health care services: cost minimization, cost-effectiveness, cost utility, and cost-benefit. The purpose of an economic analysis is to compare the outcomes and costs of several different products—typically drugs, interventions, or therapies in the health care setting. There are advantages and disadvantages to each analysis (Table 1), but cost-effectiveness and cost utility are arguably the most appropriate economic analyses in the critical care setting. In this review, we will examine the different types of economic analyses and explore our recommended analyses in the critical care setting. We will also review the methodological considerations when conducting economic analyses in the critical care setting.

2. Overview of different economic analyses

2.1. Cost minimization

In cost minimization analyses, drugs, therapies, or interventions with comparable or equivalent outcomes are compared to identify the least costly option [8]. Singh et al [9], for example, noted that

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Table 1
Summary of the advantages and disadvantages of the discussed economic analyses.

Type of economic analysis	Units	Purpose	Pros	Cons	Recommended for critical care analyses?
Cost minimization	Dollars	Typically used to identify the least costly option among a preselected range of treatments, therapies, or interventions.	Easier and less complex to produce.	Need to select therapies or treatments that are already known to have equivalent (or comparable) outcomes. Does not assess equivalence and there may be unforeseen secondary outcomes.	No. We do not recommend the use of this analysis for more complex medical domains. In critical care, it is also important to take into account the outcomes and risks associated with an intervention, but the nature of this analysis does not allow for such considerations.
Cost-benefit	Dollars	Comparison of costs and benefits of a given treatment, therapy, or intervention.	All costs and effects are expressed in dollars, thus easier to compare to other interventions.	Converting clinical events or effects to dollars can be subjective and controversial. There are also ethical concerns and objections in terms of placing monetary values on morbidity and mortality.	No. Although this approach provides a broad societal perspective of the therapy or intervention assessed, it fails to take the patient into consideration.
Cost-effectiveness	Cost per measure of effect	Assesses the resource costs of interventions for specific health outcome measures in natural units (eg, life-years gained, number of ICU admissions, number of deaths avoided)	Avoids converting clinical events or effects into dollars. Takes into consideration different types of costs.	Does not consider patients' quality of life. Need to use sensitivity analyses or incremental cost-effectiveness ratios to avoid misinterpretation.	Yes, but it is not our primary method of choice. This approach is able to produce concrete outcomes, which would be more practical and applicable in an ICU setting. We would recommend it for the assessment of therapies or interventions where the quality of life of patients may not be as affected.
Cost utility	Cost per QALY	Takes into account the functionality (ie, physical health, duration of life) and health-related quality of life—which yields what is termed as *quality-adjusted life-years* (QALYs).	Considers quality of life. Can compare to other clinical interventions. Patient-centric approach to economic analysis.	More difficult to produce because quality of life metrics are needed. The interpretation of QALYs is vague and ambiguous. Requires a large sample size and is more labor intensive. May encounter confounding variables or attrition.	Yes. This approach produces concrete outcomes, which is practical and applicable in an ICU setting. It is the preferred method of choice for critical care due to its patient-centered approach and the high costs and impact of critical therapies.

inappropriate antibiotic use is a common practice in the ICU—that is, patients tend to take antibiotics longer than necessary. To determine the appropriate antibiotic use and to test for the effectiveness of different treatments, Singh et al [9] conducted a cost minimization analysis between ciprofloxacin monotherapy and standard therapy for nosocomial pneumonia. Patients assigned to ciprofloxacin monotherapy received 400 mg of ciprofloxacin intravenously for 3 days followed by an evaluation, whereas patients in the standard therapy received regular antibiotics as recommended by their general physicians. The choice, number, and duration of antibiotics were at the discretion of their general physician, but in general, patients in the standard therapy group received 10 to 21 days of antibiotics. Singh et al [9] reported that a 3-day use of ciprofloxacin monotherapy yielded similar results as standard therapy, but it was almost $10 000 less expensive. Based on these results, decision-makers may therefore choose to use ciprofloxacin monotherapy rather than standard therapy. However, studies at such may not take into consideration other clinical outcomes such as secondary infections, whether patients had recurrent pneumonia, and whether there were hospital readmissions.

Cost minimization analysis has considerable appeals; however, it is rarely used in more complex medical domains such as critical care [10]. In critical care, for instance, the cost of intervention often needs to be considered in relation to outcomes and risks; but clinical outcomes must be equivalent to conduct a cost minimization analysis. In many other cases, such as therapy and interventions, cost minimization analysis is also not a recommended method because there is no reliable method to assess equivalence and there may be unforeseen secondary outcomes. Therefore, in the case of the study of Singh et al [9], cost minimization analysis may not be the most appropriate analysis because other clinical outcomes that can also significantly determine the choice of therapy were not assessed. This concern is also apparent in critical care sectors. Given the complexity of intensive care patients, it is rare that patient outcomes are predictable and equivalent. Hence, although cost minimization analyses may be appropriate for some scenarios (eg, testing the generic equivalent of a drug), we would not recommend the use of this analysis for therapy or interventions, especially in critical care.

2.2. Cost-benefit analysis

Cost-benefit analysis compares costs and benefits in the same unit, usually a monetary value [11]. The resulting cost-benefit ratio allows decision-makers to evaluate whether the benefits outweigh the costs. The cost-benefit ratio therefore provides a broad societal perspective of the therapy or intervention. In health care, cost-benefit analyses involve the comparison between health care expenditures and the medical outcomes or benefits. There are some controversies in assigning monetary values to health outcomes [12], but there are 3 general approaches in benefit valuation that are used [13]: human capital, revealed preferences, and contingent valuation.

The *human capital* approach is one of the first approaches toward benefit valuation. In this approach, the analysis involves the measuring of one's wages and earnings, which are assumed to be related to productivity [14]. There are ethical concerns and objections toward the human capital approach in terms of placing monetary values on morbidity and mortality, however [14]. Questions have also been raised as to whether one's wage can truly measure productivity [14]. *Revealed preferences* refer to observing individuals and using the observed behaviors as a basis for evaluating the benefits [14], such as wage-risk studies. *Contingent valuation* (or stated preferences), however, involves indirectly