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A cost-effectiveness analysis of two different antimicrobial stewardship programs

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ABSTRACT

There is a lack of formal economic analysis to assess the efficiency of antimicrobial stewardship programs. Herein, we conducted a cost-effectiveness study to assess two different strategies of Antimicrobial Stewardship Programs. A 30-day Markov model was developed to analyze how cost-effective was a Bundled Antimicrobial Stewardship implemented in a university hospital in Brazil. Clinical data derived from a historical cohort that compared two different strategies of antimicrobial stewardship programs and had 30-day mortality as main outcome. Selected costs included: workload, cost of defined daily doses, length of stay, laboratory and imaging resources used to diagnose infections. Data were analyzed by deterministic and probabilistic sensitivity analysis to assess model's robustness, tornado diagram and Cost-Effectiveness Acceptability Curve. Bundled Strategy was more expensive (Cost difference US$ 2119.70), however, it was more efficient (US$ 27,549.15 vs 29,011.46). Deterministic and probabilistic sensitivity analysis suggested that critical variables did not alter final Incremental Cost-Effectiveness Ratio. Bundled Strategy had higher probabilities of being cost-effective, which was endorsed by cost-effectiveness acceptability curve. As health systems claim for efficient technologies, this study conclude that Bundled Antimicrobial Stewardship Program was more cost-effective, which means that stewardship strategies with such characteristics would be of special interest in a societal and clinical perspective.

Introduction

Antimicrobial stewardship programs (ASP) promote adequate use of antimicrobial drug therapy (ADT) to infected patients. They are meant to reduce undesired events due to inappropriate use of antibiotics, which is known to lead to worse clinical and economic outcomes, such as development of resistant bacteria, hospitalizations and mortality, in addition to increased ADT-related expenditures.[1–4]

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Nowadays, due to increasing health care costs, cost-effectiveness analysis (CEA) are the watershed of many health systems, as they provide better planning, financial and human resources allocation.[5]

ASP economic outcomes have been analyzed with cost-reduction studies and positive results due to decreased antibiotics consumption[6] and lower hospital length of stay were observed. However, these results are controversial[7,8] and the final outcome may be subject to many confounders.[6] Therefore, the incorporation of clinical data and sensitivity analysis are necessary to assess whether one intervention could lead to robust economic outcomes.

As a matter of fact, cost-reduction studies are not formal economic analysis[6] and, to our knowledge, there is only one publication that investigated whether ASP are cost-effective.[9] Furthermore, this single cost-effectiveness publication was not free of bias, as there were many theoretical assumptions when assigning clinical probabilities, leading to results that could be unclear to clinicians due to complex reporting and modeling methods. Moreover, the aforementioned CEA employed diverse research outcomes (i.e. risk of death), while costs were estimated from other health institutions and specific wards, such as critical care units.

Since 2001, some authors have been advocating that well designed investigations with economic outcomes are needed, especially on ASP.[6,10] In addition, one recent publication has suggested that different ASP strategies could lead to different clinical outcomes. In that study, an ASP with proactive characteristics lead to improved 30-day mortality results.[11]

In this context, considering that international literature lacks direct comparison among ASP strategies, our hypothesis was that different ASP strategies could also lead to different economic outcomes. The objective of this research was to assess whether two different ASP strategies could lead to different performance results.

Methods

Ethics and reporting

The present study complies with Helsinki's Declaration and Local Bioethics Committee approved it. We followed the suggestions of a Panel of Experts to conduct adequate reporting.[4]

Definitions of two different strategies: conventional and bundled ASP

This CEA compared two different modalities of ASP. We used a previous cohort study that evaluated how Conventional or Bundled ASP differed in terms of mortality and antibiotic doses consumption.[11]

Conventional Strategy was defined as a simplified stewardship program, which included a clinical pharmacist screening for antimicrobial drug-related problem (ADRP), case discussions with infectious disease physicians (ID-MD) and telephone-based interventions.

On the other hand, the Bundled ASP had a more active design, which included: prospective auditing and local education/feedback about antimicrobial therapy prescription; microbiological data discussion with laboratory personnel to guide empirical or preemptive therapy; and face-to-face interventions to improve antimicrobial drug therapy.

Study perspective and other nation-related issues

The perspective of this study was a Southern Brazilian University Hospital, which is a 550-bed public and clinical reference institution with an average of 55–65% occupation rate. The Brazilian Health-System, namely *Sistema Único de Saúde* (SUS), is a primary care-centered system with universal access to all Brazilian citizens. More information regarding the aforementioned health system should be consulted in excellent reviews published elsewhere.[12]

Costs and definitions

All costs were collected and analyzed as local currency (R$, Brazilian Reais) and converted to United States Dollars (US$). Exchange values were collected at <reuters.com> and they were expressed as mean value from February to September 2013, so R$ 1.00 was equivalent to US$ 0.47.

There were four relevant costs included in this CEA, namely: (I) hospital length of stay/patient-day, (II) cost of defined daily doses (DDD)/patient, (III) resources to provide microbiological and imaging diagnosis of infections, and (IV) human resources workload per day. These variables were collected through institutional databases, such as medication purchasing receipts and data from hospital's Human Resources and Planning Department. Table 1 summarizes all costs accounted for in this study and supplementary material provides detailed information.

Hospital length of stay was defined as the average cost per patient/day admitted to intensive care units or general wards, which included water consumption, human resources, medical material costs, and other relevant costs, except cost-related to ADT (see supplementary material).

DDD is a validated tool to standardize the number of doses consumed from each medication, allowing comparison of drug consumption between different health settings. Therefore, DDD was collected according to the original method developed by the World Health Organization.[13] DDD was calculated based on pharmacy dispensation registries. Each unit of DDD was multiplied by the cost of drug, so antimicrobial therapy was expressed as "cost-DDD per patient".[13]

Regarding the costs related to bacterial infections diagnosis, we defined all diagnostic criteria according to international guidelines.[14–21] Prevalence of infections and their respective topographies were collected from the same previous cohort study,[9] while costs of antibiograms, cultures, and other laboratory and imaging methods were calculated by means of microcosting bottom-up method.[22]

At last, cost of human workload per day was calculated by estimating the amount of time spent by each health care staff involved with ASP, whereby Bundled ASP accounted for a full-dedication clinical pharmacist resident and two partially dedicated ID physicians (one preceptor and one third-year post-graduate MD).