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Cost of surgical site infection in Egyptian University Hospital: Informing a decision to implement an infection control program using simulation

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ABSTRACT

Objective
To estimate the cost of surgical site infection in the Medical Research Institute hospital from the patient and hospital perspectives using simulation. The cost was estimated to support a decision on which infection control strategy to implement from strategies with different efficacies and costs.

Methods
Two economic models were developed to estimate the cost of surgical site infection, from hospital and patient perspectives, among a hypothetical cohort of 1000 surgical patients. The models were fed by data collected from a cohort of 351 surgical patients in the Medical Research Institute hospital through a 6-month period. A hypothetical example is proposed to show how this data can inform decisions on implementation of infection control strategies.

Results and conclusions
Nearly 12 out of every 100 surgical patients operated in the Medical Research Institute hospital developed surgical site infection. In 75% of patients, the cost of surgical site infection did not exceed 230 Egyptian Pounds, from the hospital perspective, and 6524 Egyptian Pounds, from patient perspective. Sixty per cent of the costs, tolerated by the hospital, were due to consumables; thus, they could be totally saved if all these surgical site infections had been prevented. From the cohort of 1000 surgical patients, around 110 cases would develop surgical site infection and sought treatment within the Medical Research Institute hospital. The estimated median total cost of treating them would be around 66,700 Egyptian Pounds from the hospital perspective, 76,800 Egyptian Pounds from the patient perspective. This data could help choosing one of three hypothetical infection control programs of different costs and efficacies.

1. Introduction

Surgical site infection (SSI) carries an enormous clinical and economic burden [1]. Up to 60% of SSIs have been estimated to be preventable [2,3]. In comparison to other nosocomial infections, the preventable proportion of SSI is relatively small but still substantial [4].

On the other hand, infection control programs (ICPs) are costly themselves [5]. Decisions, such as "Is it cost-effective to implement an ICP?" and "How much can we save if we implement an ICP of specified cost and efficacy?" are critical and should be informed. The first step to inform these decisions is accurate determination of the cost of SSI, which is the cost that could be saved by implementing an ICP.

In addition, it is important to figure out whether the cost of SSI is mainly due to lost bed-days or in the form of consumables. Such information can shed light on the type of benefit gained from implementing an ICP. In our setting where the medical services are delivered for free, if most of the costs attributable to SSI were due to

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Abbreviations: CBC, Complete blood count; CDC, Centers for Disease Control and Prevention; Cr, Creatinine; EGP, Egyptian pound; ICP, Infection Control Program; MRI, Medical Research Institute; OPC, Out-patient clinic; PT, Prothrombin time test; SGOT, Serum glutamic-oxaloacetic transaminase; SGPT, Serum glutamic-pyruvic transaminase; SSI, Surgical site infection; TDV, Total direct variable; U/S, Ultrasound imaging

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bed-days, then few cash-savings will arise to fund the prevention program. In this case, prevention of SSI can only help increase the efficiency of the hospital to treat more patients rather than generate cash savings [6,7]. But, if most of the costs were due to consumables, then the consumables saved can result in substantial cost savings.

2. Aim of the work

The goal of this study is to inform a decision to implement an ICP in the MRI hospital based on the expected savings. This is to be reached through building two economic models – from hospital and patient perspectives – to accurately estimate the total cost of treating SSI; then calculating the expected savings resulting from implementing different ICPs of known efficacies and costs. Costs from the hospital perspective were limited to the direct variable costs and costs of staff time whereas costs from patient perspective were limited to the treatment fees; i.e, the charges paid by the patient for any medical service needed for SSI treatment; e.g., costs of drugs, charges paid for admission to a private hospital; charges paid for wound care…etc.

3. Methods

The methods will be described in two main sections; the first one, Data collection, explains how the data needed to feed the model were collected and the second one, steps of simulation, explains how we fed the model and run the simulation.

3.1. Data collection

3.1.1. Incidence rate of SSI

To determine the incidence rate we followed all patients underwent any surgical procedure in the MRI hospital over a 6-month period, starting from October 1st, 2011 till March 31st, 2012.

Diagnosis of surgical site infection and determination of its type were based on criteria defined by the Centers for Disease Control and Prevention (CDC) for surveillance purposes [8]. According to the protocol for surveillance of Surgical site infection proposed in 2008 [9,10], data were collected over two follow-up phases; the post-operative inpatient stay, through regular visits to surgical wards, and after hospital discharge for 30 days post-operative, through examining the patients coming for wound care in the outpatient clinic (OPC).

We estimated the incidence rate of SSI by dividing the number of cases developed SSI during the follow-up phases by the number of patients who were successfully followed-up (patients who underwent surgical procedures during the study period and examined in the OPC). Rather than using the estimated SSI incidence, we fed the model with a beta probability distribution that is specified by the estimated SSI incidence rate; as it is continuous and restricted to the interval 0 to 1.

3.1.2. The cost per SSI-patient

The cost per SSI-patient was estimated from two perspectives: the patient and the hospital. All the costs were expressed in 2012 EGP (Jan 2012: 1 EGP = 0.166 US dollars).

To estimate the cost of SSI, 3 major steps were taken:

1. Identifying and quantifying the resources utilized for treatment of SSI
2. Determination of the cost of the resource identified in step 1
3. Calculation of the cost per SSI-patient by multiplying the resources, identified in step 1, by their costs, identified in step 2.

3.1.2.1. The first step: identifying and quantifying all drugs, consumables and services used for treatment by every patient in the study. For patients treated in the hospital, bed-days could be attributed either to SSI or to the cause of admission. When the SSI-inpatient was admitted to the hospital for SSI management as the original cause of the admission, the number of inpatient days was counted, with inclusion of the day of admission and exclusion of the day of discharge.

For patients who developed SSI during their post-operative inpatient stay, We determined the bed-days attributable to SSI only, using Appropriateness Evaluation Protocol (AEP) based on the methodology provided by Wakefield et al. [11]. AEP is composed of 29 criteria related to need for medical and nursing services, life support services, and patient condition. This methodology assumes that the information in the medical records can be divided conceptually into two categories: Information related to the original causes of hospitalization, and information related to SSI. These information is used to determine whether each inpatient day is justified by a care needed for the original cause of hospitalization only (original cause-only days), for SSI only (SSI-only days), or for both (original cause and SSI-days). SSI-only days were counted and attributed to SSI.

3.1.2.2. The second step: determination of the cost of resources. Different costs were used to feed the two models. For the patient-perspective model, prices paid by the patients were used. These data were collected from the patients.

For the hospital-perspective model, we used the actual costs of drugs and consumables as well as the cost of staff time to estimate the total direct variable (TDV) costs of the services. Costs of labor, supplies and equipment were obtained from purchasing, accounting departments and local pharmaceutical and medical product providers. As inpatient services were free of charge, their costs were equal to the TDV cost. The cost of outpatient services, which were delivered at modest charges, were calculated by subtracting the fees paid by the patients from their TDV costs.

To estimate the TDV cost of services, combined bottom-up and top-down approaches were used. Cost analysis tool (CAT) [12], which adopts bottom-up approach, was used for services directly needed to manage SSI. Cost of bed days were estimated as follows:

1. Costs of intermediate services, as laundry, sterilization and meal preparation, were estimated using top-down approach.
2. We took portions of the costs estimated in the previous step according to the consumption rates of surgical inpatient ward.
3. The portions estimated in the previous step were added to the costs of staff time and other consumables needed and the whole sum was divided by the average number of occupied beds. [Average occupancy rate was around 50%(SD = 8)].

3.1.2.3. The third step: calculation of the cost of treatment per patient. The amounts of the resources, determined in the first step, were multiplied by either the prices, in the patient perspective model, or by their estimated TDV costs, in hospital perspective model.

At the end of step 3, for every SSI patient (32 patients), there were two costs—one from the patient perspective and the other from the hospital perspective; thus, there were two sets of cost per SSI-patient with 32 observations per set. Guided by Kolmogorov–Smirnov Goodness of fit test, we chose a continuous distribution that best fit each set of cost per SSI-patient. Thus, we ended up with two distributions for the cost per SSI-patient, one from hospital perspective and the other from patient perspective. They were used to feed the models rather than using a fixed estimate, e.g., the median cost per SSI-patient.

3.1.3. Total cost of SSI

The per-patient costs in each set were added together to find the total cost of treating the 32-SSI patients from the hospital and patient perspectives.

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