Major Article

Nosocomial infections among acute leukemia patients in China: An economic burden analysis

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Background: The economic burden associated nosocomial infections (NIs) in patients with acute leukemia (AL) in China was unclear. A prospective study was conducted to quantify the medical cost burden of NIs among AL patients.
Methods: Nine hundred ninety-four patients diagnosed with AL between January 2011 and December 2013 were included. Relevant necessary information was extracted from the hospital information system and hospital infection surveillance system. The primary outcome was incidence of NIs and the secondary was economic burden results, including extra medical costs and prolonged length of stay (LOS). We estimated the total incremental cost of NIs by comparing all-cause health care costs in patients with versus without infections. Prolonged duration of stay was compared in patients with different infections.
Results: Of 994 patients with AL, 277 (27.9%) experienced NIs. NI was associated with a total incremental cost of $3,092 per patient ($5,227 vs $2,135; $P < .01$) and infected patients experienced a longer LOS (21 vs 10 days; $P < .01$). Patients with multisite infection had the highest total medical cost ($8,474.90 vs $2,209.90; $P < .01$) and the longest LOS (25 vs 15 days; $P < .01$). Western medicine was the main contributor to the rise of total cost in all kinds of infections.
Conclusions: NI was associated with higher medical costs, which imposed an economic burden on patients with AL. The study highlights the influence of NIs on LOS and health care costs and appeal to the establishment of prophylactic measures for NIs to reduce the unnecessary waste of medical resources in the long run.

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Acute leukemia (AL) is gaining attention as a common hematologic malignancy with an incidence of 2.7/100,000 patient-years in China. Due to patients' impaired immune systems, large doses of chemotherapy drugs and broad-spectrum antibiotics are used in patients' therapeutic regimens; thus, AL patients are more vulnerable to nosocomial infections (NIs). These infections tend to increase number of medicines prescribed, extend chemotherapy intervals, and compromise therapeutic efficacy in the long term.[1]

Research about economic cost of NIs have been conducted in the United States, England, Germany, Denmark, and France.[1-3] Some studies have demonstrated that NIs increase health care costs due to prolongation of length of stay (LOS), and patients with NIs tend to have high incidence rates of morbidity and mortality. Previous studies in the United States have assessed that a confirmed NI case results in an extra cost of $15,275.[4] Additionally, another study from United Kingdom pointed out that patients with NIs incurred higher medical costs, even 2.9 times as much as costs incurred by uninfected patients, which was equivalent to an additional cost of $3,537.95.[5] There is no doubt that the continuous rising of medical costs would impose a huge economic burden on patients carrying out treatment and families as well. It is estimated that expenses due to NIs reach $296 million-$2.3 billion in the United States and $1.55 billion in the United Kingdom per annum.[5,6] Therefore, NIs also impose a substantial economic burden on national health care systems, in the form of unnecessarily occupied health care use, prolonged hospital days, and application of antibiotics for infection treatment.

NI has become a serious problem, especially in developing countries like China. However, there is no published literature about the

economic burden of NIs in patients with AL in China. Given the high prevalence and the severity of NIs, there is a need to identify additional medical costs and prolonged hospitalization days associated with the occurrence of NIs in the presence of AL.

METHODS

Sample and settings

The study hospital is a tertiary comprehensive hospital affiliated with Shandong University, which is staffed by full-time health care workers and equipped with more than 3,300 beds to cater to the medical needs of 2.5 million clinical outpatients every year. The hematology department with 60 beds is able to offer medical services for approximately 300 AL patients every year.

Inclusion criteria

Adult patients aged 18 years or older who were clearly diagnosed as having AL and participated in the study voluntarily were included. These patients should have been admitted to the hospital for > 48 hours. Those following high compliance with doctors' medical advice, particularly the discharge orders, were preferred. This is largely because numerous patients had poor compliance in their medical treatment in light of the heavy burden from their family, work, and economic conditions. The hospitalization costs would be inaccurate if the patients discharged on their own. Patients with serious cardiac or renal diseases and those with incomplete data were excluded from the study.

NI surveillance

The patients were examined and cared by physicians similarly during the study period (January 1, 2011-December 31, 2013). All patients were under an active surveillance program implemented by researchers in the department of hospital infection control from the admission day to the date of discharge or death. Each infection was diagnosed by doctors.

Exposure definition

NI is also called hospital-acquired infection (HAI). An HAI manifesting after 48 hours of admission to the hematology department that was neither incubating nor present at admission.[7] Infectious outcomes contained all types of infections occurred during hospitalization. Urinary tract infection, oral cavity infection, gastrointestinal tract infection, site and soft tissue infection, upper respiratory tract infection (URI), and lower respiratory tract infection (LRI) were main outcomes in our study. The diagnoses of those infections were made based on Centers for Disease Control and Prevention guidelines.[7] In addition to the above diagnostic criteria, clinical manifestations, laboratory tests, and imaging examination results should also be considered.

Process of matching

We estimated the economic burden of HAIs among patients with AL by comparing all-cause cost outcomes in patients with versus without HAIs using a matched sample, which consisted of the patients with HAIs and 1:1 matched patients without HAIs. The matched adjusted analysis aimed to estimate incremental health care costs and LOS in patients with versus without an HAI event, who otherwise had similar characteristics during the baseline period, such as diagnosis of AL, age, gender, chemotherapy, severity of disease, and admission date.

Data collection

The hospital infection surveillance system and hospital information system were applied for detection of infected cases and analysis of health care costs. Statistical information such as patient's age, gender, LOS, and hospitalization costs were extracted from the hospital information system, which provided inpatients' personal information, diagnosis, treatment process, nursing records, and hospital bills. Western medicine mainly included chemotherapy drugs and antibiotics in our study. Two well-trained investigators, an infection control nurse and a researcher from the department of infection control, collected data independently. A discussion between the attending physicians and hospital infection professionals was encouraged whenever discrepant figures were reported by the independent researchers.

Statistical analysis

Measurable elements included number of NI cases, LOS, prolongation of hospital stay, and extra costs associated with NIs. Descriptive data were analyzed for median in continuous outcomes, or number and percentage in categorical outcomes. Between-group differences were assessed using χ^2 tests for categorical variables. Mean LOS and medical costs were calculated and compared using Wilcoxon's signed rank test. All significance tests were 2-tailed, and values of $P < .05$ were considered significant. SPSS version 17.0 software (IBM-SPSS Inc, Armonk, NY) was used for all statistical analyses.

RESULTS

Patient characteristics during the baseline period

A total of 994 AL patients were evaluated and 277 (27.9%) cases of infection were detected. One hundred eighty-one patients fulfilled the inclusion criteria and forming 181 pairs in total with 178 women (49.2%) and 184 men (50.8%). Table 1 presents the comparison of characteristics between patients with and without HAIs at baseline. The average age of patients in our study was 42.9 ± 16.9 years (range, 18-75 years). Women comprised 48.1% of patients with HAIs versus 50.3% of those without HAIs ($P = .376$). Age distribution showed no significant difference between infected group and control group ($P = .955$), with a similar proportion of patients with HAIs falling into every age category. Distribution in the number of comorbidities was also similar in the 2 groups ($P = .971$).

As for infection type, the incidence of URI was the highest with 82 cases, and then followed by LRI, multiple-site infection, gastrointestinal tract infection, and oral infection ($P < .01$).

Additional direct medical costs and LOS attributable to HAIs

Table 2 reported total medical cost and LOS outcomes in the infected group versus control group. All infected cases had a higher hospitalization cost than those in the control group. The extra medical cost due to multisite infection was the highest, reaching $6,265 ($8,474.90 vs $2,209.90; $P < .01$). LRI ranked the second and the incremental cost was $6,240.90 ($8,450.80 vs $2,209.90; $P < .01$). Next are the other unknown-site infections and oral infections, with $4,287.40 ($6,497.30 vs $2,209.90; $P < .01$) and $3,661.60 ($5,871.50 vs $2,209.90; $P < .01$), respectively. Finally, the least economic losses were attributed to URI, with $1,406.0 (3,615.90 vs $2,209.90; $P < .01$).

Likewise, duration of hospital stay was different based on type of HAI. Patients with multisite infection and LRI had the longest hospital stays (25 vs 10 days; $P < .01$). Mean LOS in patients with URI was 18 days and 17 days for LRI ($P < .01$).