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Blood stream infections as a predictor of length of hospital stay and cost of care in patients with cancer

Sara Devereux, Gaurav Goel¹, Kasturi Sengupta¹, Sanjay Bhattacharya¹

Abstract:

CONTEXT: Blood stream infection (BSI) is a serious clinical condition often associated with morbidity, hospital admission, significant health care costs and sometimes mortality.

AIMS: To investigate the correlation between suspected or confirmed BSIs with length of hospital stay (LOS) and cost of health care.

SETTINGS AND DESIGN: Retrospective study done in a cancer hospital in eastern India.

MATERIALS AND METHODS: Blood culture from patients admitted was used as a surrogate for suspected or confirmed BSI. Study was done over a 40 day period (in July-August 2015) involving 683 patients.

STATISTICAL ANALYSIS USED: Welch's unpaired *t*-test has been used to compare means between data groups.

RESULTS: The overall mean LOS, cost of management per patient admission, and all-cause mortality were 5.9 days (range: 0–64 days), Rs. 95,208 (USD 1,413) (range INR 220-27,50,653) and 5.7% (39 out of 683 patients) respectively. The LOS and the average health care costs increased progressively between the following patients cohorts: No blood cultures taken < blood cultures taken but negative < blood cultures taken and positive < blood cultures positive with multi-drug resistant organisms.

CONCLUSIONS: The data from this study would be useful to clinicians and hospital administrators, as well as help in counseling patients regarding approximate LOS and cost of health care related to infections.

Keywords:

Blood cultures, blood stream infection, cancer, cost of care, length of hospital stay

Introduction

Blood-stream infections are a major cause of morbidity and mortality in cancer patients. Getting an exact figure for infection related duration of hospital stay, and attributable mortality in such patients may be challenging, given the complexity and diversity of clinical situations. Several alternative indicators like length of hospital stay (LOS), cost of treatment, repeat admissions and number of positive blood cultures are suggested to assess morbidity in such patients.^[1,2]

This retrospective study was done in a 183-bedded not-for-profit tertiary care cancer hospital in eastern India. The study objective was to evaluate if suspected or confirmed blood stream infections (BSIs) were associated with increased LOS and cost of health care.

Materials and Methods

The study used blood cultures as a surrogate indicator for clinically suspected sepsis or BSI. Blood cultures were obtained in BacTAlert system (bioMérieux, USA). Data was retrospectively collected from

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Trinity College, University of Cambridge, Cambridge, UK, ¹Department of Microbiology, Tata Medical Center, Kolkata, West Bengal, India

Address for correspondence:

Dr. Sanjay Bhattacharya, Department of Microbiology, Tata Medical Center, 14 Major Arterial Road (E-W), New Town, Kolkata - 700 156, West Bengal, India. E-mail: drsanjay1970@hotmail.com

all discharged patients and analyzed for LOS, total hospital bill at discharge, number of blood cultures taken, multi-drug resistant organisms (MDRO) isolated and all cause mortality.

There were 816 discharges from 683 patients as some patients were admitted multiple times during the 40 days study duration from July 1, 2015 to August 9, 2015. Welch's unpaired *t*-test has been used to compare means between data groups.

Results

Patients belonged to Hematology (139; 17%), Pediatric Oncology (103; 12.6%), Radiation Oncology (97; 11.9%), Surgical Oncology (287; 35.2%), Medical Oncology (45; 5.5%), and others (145; 17.8%; e.g., Digestives Diseases, Pulmonary Medicine, Palliative Care, etc). There were 52% men, and 48% women. Age ranged from 0 to 90 years (median, 52 years). Out of 815 patient episodes of admission, there was no blood culture taken in 575 (71%), while the remaining 240 (29%) admissions had ≥ 1 blood cultures taken. Among them 181 episodes had all blood cultures negative while blood cultures were positive in 59 episodes (59 in 815 episodes or 72.3 per 1000 hospital admissions), amongst which 19 out of 815 (2.3%) admissions had ≥ 1 MDRO in blood. These included 8 ESBL (extended spectrum beta lactamase) producing Gram-negative bacilli (GNB), 14 carbapenem resistant GNB, other GNBs (20), Gram-positive bacteria (19) and yeasts (5). Amongst yeasts, 2 isolates of *Candida albicans* and *Candida parapsilosis* each were detected, while there was an isolate of *Candida tropicalis*. *Escherichia coli* was predominant (62%; 5/8) amongst extended-spectrum beta-lactamase (ESBL) producers, while *Klebsiella pneumoniae* predominated in carbapenem resistant GNB (56.3%; 9/16). In few cases possibility of blood culture contamination could not be excluded (isolates like coagulase negative *Staphylococcus*, *Micrococcus* spp, *Kocuria*, and other Gram-positive bacilli were detected in 14 blood cultures).

Patients were reclassified into 2 broad groups, viz., clinical hematology and pediatric oncology put together as 'hemato-oncology' and others as 'solid cancers'. The overall mean LOS, cost of management per patient admission, and all-cause mortality were 5.9 days (range: 0–64 days), Rs. 95,208 (USD 1,413) (range INR 220-2,750,653) and 5.7% (39 out of 683 patients) respectively. Distribution for the 2 groups with regards to blood culture and mortality is detailed in Table 1. The LOS and the average health care costs increased progressively between the following patients cohorts: no blood cultures taken < blood cultures taken but negative < blood

Table 1: Comparison of length of hospital stay, cost of hospital care and mortality in patients in relation to blood cultures taken

	Hemato-oncology	Solid organ cancers
Number of patients	242	441
Mean LOS (days)	6.83	5.59
LOS if no blood culture was taken	4.03	4.2
LOS with all negative blood cultures	8.23	7.7
LOS if positive blood culture with no MDRO	15.5	16.3
LOS if positive blood culture with ≥ 1 MDRO	17.5	25.7
Average health care cost per episode of admission - INR (USD)	Rs. 113,505 (\$1,687)	Rs. 89,599 (\$1,332)
Average health care cost per episode of admission if no blood culture taken	Rs. 60,247 (\$895)	Rs. 69,233 (\$1029)
Average health care cost per episode of admission if all blood cultures were negative	Rs. 156,674 (\$2328)	Rs. 113,162 (\$1682)
Average health care cost per episode of admission if blood culture(s) had no-MDRO	Rs. 162,559 (\$2416)	Rs. 267,310 (\$3973)
Average health care cost per episode of admission if blood culture(s) had ≥ 1 MDRO	Rs. 369,080 (\$5485)	Rs. 337,898 (\$5022)
Number of patients who died in the hospital in study period	11	28

LOS: Length of hospital stay; MDRO: Multi-drug resistant organisms; INR: Indian rupee

cultures taken and positive < blood cultures positive with MDRO. There was statistically significant difference with regard to LOS if no blood culture was taken versus if all blood cultures were negative in both the groups individually ($P < 0.05$). Similarly statistically significant difference was noted in cost of management if no blood culture taken versus if all blood cultures were negative in both the groups individually ($P < 0.05$). As opposed to what we initially hypothesized there was no significant difference in any of 2 groups when it comes to LOS if positive blood culture with no MDRO versus LOS if positive blood culture with ≥ 1 MDRO ($P > 0.05$). Cost of management if blood culture(s) had ≥ 1 MDRO was significantly more than cost of management if blood culture(s) had no-MDRO in hemato-oncology group ($P < 0.05$), although it was not significantly different in solid organ cancers group. Overall mean LOS was more in hemato-oncology group (6.83 days) as compared to solid organ cancers group (5.59). However no statistically significant difference was noted in average cost of management of the 2 groups.

Discussion

It was reported from a study from the USA that the LOS was longer for patients with positive cultures (5.1 days) than with negative (<1 day), and concluded that a positive blood culture could be a predictor of an increased hospital stay.^[1] In our study also LOS was more in patients with positive blood cultures. Another USA study reported that MDRO-GNB contributed an additional 29.3% increase in cost of management, and a 23.8% increase in LOS, as compared to patients without MDRO. Other variables positively associated with total hospital cost and LOS were pneumonia, Intensive Care Unit (ICU) stay, neutropenia, and transplantation.^[2] Our findings were consistent with previous studies. The Johns Hopkins Hospital in Baltimore reported a relative risk of 1.47, 1.51 and 5.02 in case of development of MDRO for increase in LOS, cost and mortality respectively. Median attributable LOS and cost was 9 days and USD 29, 379. Apart from development of ESBL, ICU admission during hospitalization, and increased number of underlying co-morbidities were found to be associated and predictors of mortality.^[3] We have previously reported the high prevalence of MDROs in stool surveillance cultures.^[4,5] The current data puts into context the sepsis related clinical and economic implications of the BSI and MDRO data.

The cost of managing cancer varies significantly between the public and the private sector hospitals. Data from India suggests that a majority of the patients (76%) faced financial problems while undergoing cancer treatment.^[6] In India an average cancer patient according to one survey would have to bear an economic burden of Rs. 36,812 for the entire cancer therapy course.^[6] The cost of managing oral cancer in an Indian private hospital was found to rise from Rs. 149,995 for stage 1 patients to Rs. 182,859 for stage 3 patients.^[6] A USA study found that the mean hospitalization costs were \$18,042 for patients with neutropenia, and \$27,587 for patients with neutropenia plus infection. Mean LOS were 9 days in patients with neutropenia and 12.6 days in those with neutropenia and infection. Mortality showed a similar trend with rates increasing from 8.3% in those with neutropenia alone to 19.4% in those with neutropenia and infection.^[7]

There were some limitations in the study such as the number of dead patients did not include patients discharged for palliative care in terminal stages of life. We looked into blood cultures only, although there were other systemic infections in some patients not extending to blood, not described here. Impact of source of bacteremia on LOS or cost was not taken into consideration. In some cases

organism isolated in blood cultures might have been contaminants, although the numbers are likely to be few, they are sometimes known to cause serious infections in immunocompromised patients. The cost of management included cost of managing infections as well as the cost of non-infection related management for cancer related surgery/chemotherapy/radio-therapy/laboratory or imaging investigations.

Conclusion

Prevention of BSIs is critical not only to reduce mortality and morbidity, but also LOS and healthcare cost. The present study done in a cancer center in eastern India provides data which would be important for health policy-makers, administrators, clinical consultants and infection control specialists.

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Conflicts of interest

There are no conflicts of interest.

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