



Health economic evaluation of patients with sepsis after gastrointestinal tumor surgery—a cost consequences analysis in China

Ren-Xiong Chen^{1,2}, Zhou-Qiao Wu², Zi-Yu Li², Hong-Zhi Wang¹, Jia-Fu Ji²

¹ICU, ²Gastrointestinal Cancer Center, Key Laboratory of Carcinogenesis and Translational Research (Ministry of Education/Beijing), Peking University Cancer Hospital & Institute, Beijing, China

Contributions: (I) Conception and design: RX Chen, HZ Wang, JF Ji; (II) Administrative support: RX Chen, HZ Wang, JF Ji; (III) Provision of study materials or patients: ZQ Wu, ZY Li; (IV) Collection and assembly of data: RX Chen, ZQ Wu, ZY Li; (V) Data analysis and interpretation: RX Chen, HZ Wang, JF Ji; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Hong-Zhi Wang; Jia-Fu Ji. Peking University Cancer Hospital & Institute, No. 52 of Fucheng Road, Haidian District, Beijing 100142, China. Email: wanghz58@sina.com; Jiafuj@hotmail.com.

Background: The purpose of this study was to evaluate the health economics of patients with sepsis after gastrointestinal tumor operation in ICU.

Methods: This case-control study used 1:1 propensity-score (PS) matched method and patients were matched according to tumor type, age and gender. The study group was composed of 181 patients with sepsis after operation of gastrointestinal tumor in ICU, while the control group was composed of 181 patients without sepsis after operation of gastrointestinal tumor. The medical expenses and length of stay in the hospital of these patients were analyzed.

Results: The median of the total hospitalization cost for the study group was \$26,038, which was 1.7 times of the control group ($P<0.001$). The costs of drugs, laboratory test, examination, treatment, operation, anesthesia, materials, ward and other costs in the study group were higher than those in the control group ($P<0.001$). The median length of stay in the hospital in the study group was 26 days, which were 12 days longer than that of the control group ($P<0.001$). However, there was no significant difference in daily average cost between the two groups ($P=0.103$).

Conclusions: In ICU, patients with sepsis after operation of gastrointestinal tumor increased the cost of hospitalization and prolonged the length of stay in the hospital than those without sepsis.

Keywords: Health economic evaluation; sepsis; gastrointestinal tumor

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Introduction

Sepsis was a global problem, which had become one of the main reasons that affected the safety of patients and increased medical costs (1). It was estimated that there were 31.5 million patients with sepsis every year all over the world, and about 5.3 million patients died every year (2). In China, there were 5.68 million patients with sepsis every year (3). To our knowledge, inducing factors of sepsis included community-acquired infection and nosocomial

infection, and millions of people were affected by nosocomial infection every year around the world (4). In the United States, the cost of hospitalization for sepsis became the fourth largest, with an annual cost of 23.7 billion US dollars (5). However, the direct economic loss caused by sepsis in China was not obscure. A 1:1 matched case-control study was used to evaluate the economic loss caused by sepsis, to provide an evidence-based basis for control and prevention of sepsis.

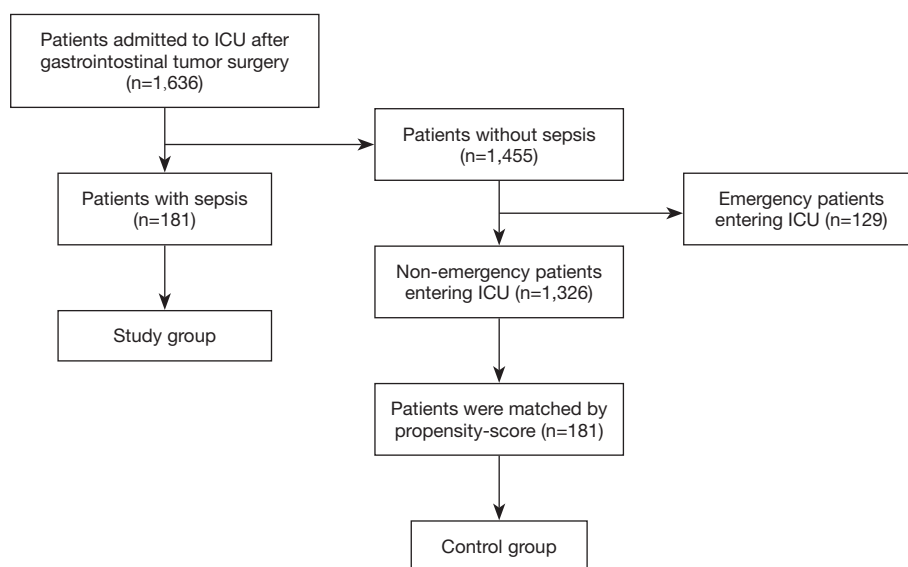


Figure 1 Flow diagrams of studying selection process.

We present the following article in accordance with the MDAR reporting checklist (available at <http://dx.doi.org/10.21037/jgo-20-242>).

Methods

Study population

From January 2015 to December 2019, 1,636 patients were admitted to the ICU after gastrointestinal tumor surgery in the gastrointestinal cancer center of Peking University Cancer Hospital. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Review Board of Peking University Cancer Hospital (No. 2020KT) and informed consent was taken from all the patients or their next of kin. One hundred eighty-one patients with sepsis were enrolled in the study group. According to the tumor type, age and gender, we did 1:1 greedy matching using a caliper of 0.1 standard deviations of the propensity-score (PS) to identify clinically similar matched controls for each patient. The control group was composed of 181 patients who were admitted for selective gastrointestinal tumor surgery at the same time. See *Figure 1* for the screening flow. We collected the cost of hospitalization and length of stay, and evaluated the health economics of patients with sepsis. Considering the impact of inflation and cost changes, the conversion between RMB and US dollar was based on the average value of each month's exchange rate

calculated by the People's Bank of China from January 2015 to December 2019.

Statistical analysis

The normal distribution continuous variables were described by mean \pm standard deviation, and t-test was used for statistical analysis. The non-normal continuous variables were described by median and quartile (P25, p75), and were analyzed by Mann-Whitney U test. Chi-square test was used to analyze categorical variables. Statistical analyses were carried out using SPSS version 24.0 and P values less than 0.05 (two-tailed) were considered significant.

Results

The 90-day all-cause mortality rate was 11.1% in the study group, while 1.1% in the control group. The baseline characteristics of patients in the two groups were shown in *Table 1*. There was no significant difference in age, tumor type, body mass index (BMI) and length of operation time between the two groups except for sex and coexisting conditions between the two groups. Coexisting conditions were shown in the *Table S1*.

Direct economic loss caused by sepsis

The median of the total hospitalization expenses of the

Table 1 Baseline characteristics of patients in the two groups

Items	Study group	Control group	P value
Age, years			0.426
<50	20	25	
≥50	161	156	
Sex			0.001
Male	145	61	
Female	36	120	
Tumor type			0.058
Tumor of upper digestive tract	97	79	
Tumor of lower digestive tract	84	102	
BMI, mean (SD), kg/m ²	23.5 (4.1)	23.9 (3.5)	0.419
Operation time, median (P ₂₅ , P ₇₅), min	194 [140, 246]	173 [128, 238]	0.093

Table 2 Costs between the two groups

Cost category	Study group, \$	Control group, \$	Z value	P value
Drugs	7,353 [5,039, 12,218]	3,222 [2,247, 4,479]	-11.653	<0.001
Laboratory test	1,327 [1,001, 1,908]	502 [376, 697]	-13.883	<0.001
Examination	934 [536, 1,249]	503 [308, 848]	-6.248	<0.001
Treatment	2,635 [1,611, 4,061]	1,157 [797, 1,481]	-10.847	<0.001
Operation	780 [512, 994]	581 [490, 700]	-5.323	<0.001
Anesthesia	143 [81, 172]	78 [68, 94]	-8.077	<0.001
Materials	10,432 [7,738, 13,320]	8,313 [6,892, 10,093]	-5.254	<0.001
Ward	217 [133, 413]	100 [73, 156]	-8.452	<0.001
Other costs	632 [339, 1,219]	204 [54, 353]	-10.699	<0.001
Total cost	26,038 [18,269, 33,901]	15,131 [13,306, 18,169]	-10.662	<0.001

study group was \$26,038, while the control group was \$15,131. The cost of the study group was 0.7 times higher than that in the control group, with an average of \$10,907 for each case. The difference between the two groups was statistically significant ($Z=-10.662$, $P<0.001$). The costs of drugs, laboratory test, examination, treatment, operation, anesthesia, materials, ward and other costs in the study group were higher than those in the control group ($P<0.001$). Among the hospitalization cost, the cost of drugs increased the highest, followed by the cost of materials and treatment. See *Table 2* for details.

The median length of stay in the hospital

The median length of stay was 26 [18, 42] days in the study group and 14 [11, 19] days in the control group. The median length of stay in the study group was 12 days longer than that of the control group ($Z=-8.985$, $P<0.001$).

The average daily cost of the two groups

The average daily cost was \$957 [774, 1,235] in the study group, and \$1,019 [819, 1,298] in the control group. There was no significant difference between the two groups

($Z=-1.629$, $P=0.103$).

Discussion

Twenty-eight years ago, Bone *et al.* (6) reported a consensus document that provided the initial definition of sepsis. With people's understanding of sepsis, a new definition of sepsis was made in recent years. That was life-threatening organ dysfunction caused by the host's maladjusted response to infection, which was manifested in the sepsis-related organ failure score greater than or equal to 2 points (7). The study group in our study was screened out by the new definition. Sepsis was associated with high mortality, and the economic loss caused by sepsis would bring a great financial burden to the family members and the society. At present, there are many foreign reports on the health economics evaluation of sepsis-related interventions (8-12), however, few domestic reports in China.

This study showed that the costs of drugs, laboratory test, examination, treatment, operation, anesthesia, materials, ward, other costs and total hospitalization costs in the study group were higher than those in the control group. In addition to increasing the cost of hospitalization, sepsis also extended the length of stay in the hospital and affected the turnover of hospital wards. In addition, the actual losses of death, work delay, family care and other indirect costs caused by sepsis were greater. However, in this study, the difference in patients' daily average cost between the two groups was not statistically significant, which might be related to the higher cost of drugs and consumables in the first few days of operation.

The evaluation of health economics for critical patients was mainly based on the study of cost-effectiveness, cost-utility, cost-benefit and cost-minimization (13-15). By analyzing the health economics of patients with sepsis, it can directly reflect the importance of sepsis management, sepsis prevention, reducing the incidence of sepsis, saving medical resources, reducing the cost of single disease treatment, reducing the economic burden for patients and bringing reputation and benefits to the hospital. With the deepening of the reform of the medical insurance system in China, the medical insurance payment methods such as single disease payment and total prepayment will be gradually improved, and the excess payment will be partially or completely borne by the hospital, which will also bring challenges. Therefore, it will bring significant economic and social value to carry out the research on cost-effectiveness, cost-utility and cost-benefit of sepsis and integrate the economic evaluation of

sepsis health into the daily management.

Limitations

Certainly, this study has some limitations. First, the control group of this study was matched from the patients entering ICU with more chronic diseases than the study group, and more chronic diseases than the general population; however, this did not affect our conclusions. Second, the gender difference between the matched control group and the study group was obvious, but we had observed that gender had the little effect on the cost in clinical practice, so we thought that gender had the little effect on the conclusion. Third, the object of this study was the patients with sepsis who entered ICU after the operation of gastrointestinal tumor. Whether the conclusion can be extended to all sepsis patients need more researches to confirm. Finally, this study is a retrospective study and unable to evaluate the cost of the interventions. We hope that there will be more prospective studies to evaluate the interventions in health economics in the future in China.

Conclusions

In ICU, patients with sepsis after operation of gastrointestinal tumor increased the cost of hospitalization and prolonged the length of stay in the hospital than those without sepsis.

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Footnote

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[org/10.21037/jgo-20-242](https://doi.org/10.21037/jgo-20-242)). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Review Board of Peking University Cancer Hospital (No. 2020KT) and informed consent was taken from all the patients or their next of kin.

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Supplementary

Table S1 Comparison of coexisting diseases in two groups

Coexisting disease	Study group	Control group	P value
Hypertension			0.002
Yes	64	93	
No	117	88	
Diabetes			0.024
Yes	32	50	
No	149	131	
Coronary heart disease			<0.001
Yes	17	50	
No	164	131	
Arrhythmia			<0.001
Yes	9	31	
No	172	150	