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Original Article

Analysis of factors related to the occurrence of incision infection in surgical patients and operating room nursing countermeasures

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Abstract: Objective: This study aimed to investigate the operating room-related factors and corresponding countermeasures for incision infection in post-surgical patients. Method: A total of 1,842 surgical patients were enrolled in the study, of which 930 patients were included in the intervention group (those given post-operative intervention) and the remaining 912 were included in the no intervention group. Data regarding the incidence of incision infection among surgical patients were recorded, a logistic regression analysis of operating room-related risk factors was performed. Results: Intraoperative blood loss, operation time, type of surgical incision, the number of personnel comprising the surgical team, and not disinfecting the incision site with povidone iodine (all $P<0.05$) were the primary operating room-related risk factors of incision infection. The results of the logistic regression analysis of different risk factors showed that the following were the independent factors influencing the occurrence of postoperative incision infection in surgical patients ($P<0.05$): intraoperative blood loss of ≥800 ml, long operation duration, long surgical incision, a larger number of operating room personnel, and not disinfecting the incision site with povidone iodine. The hospitalization time, hospital costs, infection rate, and quality of life score in the intervention group were higher than that in the no intervention group (all $P<0.05$). Conclusion: The factors related to the occurrence of incision infection in surgical patients include intraoperative blood loss of ≥800 ml, long operation duration, type of surgical incision, a larger number of operating room personnel, and not disinfecting the incision site with povidone iodine.

Keyword: Surgery, incision infection, operating room, countermeasures

Introduction

Incision infection is the most common complication after surgery [1]. This infection commonly occurs in patients who undergo general surgery and is the most severe postoperative complication [2]. The results of the study by Clayman et al. [3] showed that the rate of surgical site infection reaches up to 15.72%, and the delayed response to or mishandling of infection incision will most probably cause septicemia or even death. Postoperative incision infection has a direct influence on the prognosis of patients. The pathogenesis of this infection has been examined in many relevant studies [3-5] and is believed to involve a decrease in patients' immunity and infection caused by a pathogenic bacteria. The development of tissue necrosis, hematoma, and other related conditions at the incision site reduces the body's resistance to bacteria, thus resulting in bacterial invasion and reproduction, destruction in the normal metabolism of immune cells, and increase in the incidence of postoperative incision infection [6, 7]. The study conducted by Kiran, et al. [8] showed that as antibacterial agents have been popularly used in the clinical setting, patients' resistance to these drugs increases every year and the incidence of postoperative incision infection increases accordingly. Surgery is an invasive procedure. The patient's tissues are not only exposed to oxidative stress for long periods but are also extruded and burnt by different medical devices used during the procedure, which increases the exudation of patient's cell sap and induces incision infection [9]. Pathogenic bacteria mainly exist in microcosmic forms. Surgical delays can trigger the induction of postoperative incision infection [10]. Moreover, as most surgical patients have other underlying diseases, their immune system is already compromised and wound healing is impaired [11].

Therefore, understanding the pathogenesis of incision infection, adopting special nursing countermeasures, and providing appropriate treatments are important in improving the patients' prognosis. Future studies should also determine other methods to effectively minimize the incision infection rate in patients during surgery.

Materials and methods

Patients data

A retrospective analysis was conducted on 1,842 surgical patients treated in Jiyang Public Hospital, Jinan, Shandong, China, of which 960 were males and 882 were females. The 930 patients comprised the intervention group (patients aged between 30 and 60 years (mean age, 44.31±10.67 years) who were given postoperative intervention), of which 486 were males and 444 were females. The remaining 912 comprised the no intervention group (patients aged between 30 and 60 years old (mean age, 45.57±9.84 years) who were not given postoperative intervention), of which 474 were males and 438 were females.

Inclusion/exclusion criteria

Patients who underwent surgery in our hospital; patients diagnosed with postoperative incision infection; patients aged 30-60 years; and those who accepted the arrangement offered by the medical staff in our hospital were included in the study. Conversely, patients with tumors, patients with mental illness, patients with physical disability, pregnant patients, patients transferred to another hospital for further medical assistance, and patients who died during or after surgery were excluded from the study. All patients provided informed consent. This study was approved by the ethics committee of our hospital.

Methods

The interventions performed in the intervention group were as described by Schweizer et al. [12], and involved the rigorous monitoring of the incision infection in surgical patients, and the timely processing of the incision during initial infection. The medical personnel and clinicians developed the corresponding control measures by identifying the factors related to the occurrence of incision infection and patients' treatment experience. The interventions included disinfecting the area using an air disinfecting machine before and after surgery (bacterial content in the air <200 CFU/m^3), maintaining the temperature (20-25°C) and humidity (50-60%) in the operating room, sterilizing and disinfecting the surgical devices and materials regularly, increasing awareness about the prevention and control of incision infection among medical staff, scheduling surgeries, and ensuring that appropriate amounts of antibacterial agents are used. Data regarding the incidence of incision infection among surgical patients were obtained, a logistic regression analysis on the operating room-related risk factors was performed, and the differences in the rate of incision infection between the two groups were compared. Patients' quality of life 1 year after discharge was assessed through phone interviews, and the differences in prognosis among patients between the two groups were compared.

Evaluation criteria

Patients were diagnosed based on the diagnostic criteria for incision infection published in 2011 [13]. The criteria for evaluating patients' quality of life score were discussed in the study conducted by Prigerson et al. [14]. Among those were the activities of the daily living, mood, wound healing, disease recurrence, and average score. A hundred-mark system was used: a higher score indicates improvement in the patient's condition. The score was comprehensively given after patients and family members understood the significance of all scores.

Statistical method

SPSS 22.0 was used for the processing and analysis of data; the age, hospitalization time, hospital costs, quality of life score of patients, and other enumeration data were represented by mean ± standard deviation, and t-test was used to compare the differences between the two groups. Patients' data, infection rate, and other measurement data were expressed in ratio, and a chi-square test was used to compare the differences between the two groups. A logistic regression analysis was used to evalu-

Table 1. Comparison of clinical data between groups [n (%)]

	Intervention group (n=930)	No intervention group (n=912)	X^2 or t	P
Age			2.63	0.900
	44.31±10.67	45.57±9.84		
Gender			0.02	0.903
Male	486 (52.3)	474 (52.0)		
Female	444 (47.7)	438 (48.0)		
Marital status			0.38	0.540
Married	845 (90.9)	836 (91.7)		
Unmarried	85 (9.1)	76 (8.3)		
Basic illness			0.66	0.415
Yes	821 (88.3)	816 (89.5)		
No	109 (11.7)	96 (10.5)		
Course of disease			0.43	0.510
<1 Year	627 (67.4)	602 (66.0)		
≥1 Year	303 (32.6)	310 (34.0)		
Smoking			0.11	0.737
Yes	409 (44.0)	394 (43.2)		
No	521 (56.0)	518 (56.8)		
Drinking			0.18	0.671
Yes	349 (37.5)	351 (38.5)		
No	581 (62.5)	561 (61.5)		
Residence			0.61	0.434
City	494 (53.1)	501 (54.9)		
Rural	436 (46.9)	411 (45.1)		
Body weight			0.56	0.456
<70 Kg	348 (37.4)	326 (35.7)		
≥70 Kg	582 (62.6)	586 (64.3)		
Surgery type			3.91	0.563
Heart	186 (20.0)	172 (18.9)		
Abdominal	294 (31.6)	304 (33.3)		
Orthopedic	163 (17.5)	156 (17.1)		
Gynecology	142 (15.3)	127 (13.9)		
Urology	89 (9.3)	81 (8.9)		
Brain	56 (6.0)	72 (7.9)		

ate the operating room-related risk factors for the occurrence of incision infection. A *P* value of <0.05 was considered statistically significant.

Results

Comparison of patients' clinical data

To ensure that the experimental results were precise, accurate, and credible, the following variables were compared: age, gender, marital status, underlying disease, course of disease, history of smoking and drinking, body weight, and surgical type of patients between the two groups. Results showed that there was no significant difference in these variables between the two groups (P>0.05), proving that the patients between the two groups were comparable (**Table 1**).

Related factor analysis on the occurrence of surgical incision infection

Among 1,842 patients, postoperative incision infection occurred in 170. The operating room-related risk factors of incision infection mainly included intraoperative blood loss, operation time, type of surgical incision, a larger number of operating room personnel, and not disinfecting the incision site with povidone iodine (all P<0.05). By contrast, the type of surgery had no significant influence on the occurrence of incision infection (P=0.833). The incision infection rate in patients with intraoperative blood loss <800 ml was 7.0% (48 patients), which was significantly lower than that in patients with intraoperative blood loss ≥800 ml (10.5%, 122 patients, P=0.012). The incision infection rate in patients with an operation time of <3 h (4.5%, 39 patients) was less than that in patients with an operation time of ≥3 h (13.4%, P=0.001). Among 1,024 patients, the incision infection rates in patients categorized as class I, class II, and class III were 5.5% (56 patients), 10.8% (68 patients), and up to 24.3% (46 patients), respectively. This finding indicates that patients with high incision levels have higher probabilities of developing incision infection (P=0.001). The incision infection rate in patients whose surgeries involved ≤3 personnel (6.8%, 56 patients) was also significantly better than that in patients whose surgeries involved >3 personnel (11.2%, 114 patients, P=0.001). The infection rate in patients who were not disinfected with povidone iodine (12.0%, 105 patients) was higher than that in patients disinfected with povidone iodine (6.7%, 65 patients, P=0.001) (**Table 2**). The results of the logistic regression analysis showed that intraoperative blood loss of ≥800 ml, operation of longer duration, longer incision, a larger number of operat-

Table 2. Factors influencing the occurrence of incision infection

		n	Infection [n (%)]	X^2	P
Intraoperative blood loss	<800 ml	684	48 (7.0)	6.35	0.012
	≥800 ml	1158	122 (10.5)		
Operation time	<3 h	864	39 (4.5)	43.19	0.001
	≥3 h	978	131 (13.4)		
Surgical nature	Emergency	732	68 (9.4)	0.04	0.833
	Elective	1119	102 (9.1)		
Cut type	I	1024	56 (5.5)	70.67	0.001
	II	629	68 (10.8)		
	III	189	46 (24.3)		
Number of operating room personnel	≤3	824	56 (6.8)	10.54	0.001
	>3	1018	114 (11.2)		
Povidone iodine disinfection	Yes	964	65 (6.7)	14.92	0.001
	No	878	105 (12.0)		

ing room personnel, and not disinfecting the incision site with povidone iodine were the independent factors influencing the occurrence of postoperative incision infection in surgical patients (all $P<0.05$) (**Table 3**).

Differences in the prognosis of patients with incision infection between the two groups

The incision infection rate of patients in the intervention group was 6.7% (62 patients), which was significantly lower than the 11.8% (108 patients) infection rate of patients in the no intervention group ($P=0.001$). The average hospital stay and hospital costs of patients in the intervention group were 8.16±2.57 d and 10,000 Yuan (9.64±1.84), respectively, whereas that in the no intervention group were 13.62±3.42 d and 10,000 Yuan (12.86±2.04) ($P<0.05$) (**Table 4**). In the follow-up study, 1,172 patients had a success rate of 96.2%, including 907 patients in the intervention group and 865 patients in the no intervention group. The prognosis quality of life score of patients in the intervention group was 86.64±7.39 points, which was significantly higher than the score of the patients in the no intervention group (75.37±7.45 points, $P=0.001$). The scores of other variables in the intervention group were also higher than that in the no intervention group (all $P<0.05$), while the largest difference was observed in incision healing between the two groups (86.37±8.46 points in intervention group, and 72.36±6.52 points in the no intervention group; $P=0.001$; **Table 5**).

Discussion

During surgery, an external force is often used to remove the diseased tissues from the patient's body, change the existing structure, or implant a foreign body, which is the direct and the most effective method for the treatment of various diseases [15, 16]. The surgical success rate is not only decided based on the knowledge and experience of the surgeon, but is also affected by environmental factors in the operating room [17]. Postoperative incision infection in patients not only delays the healing of the surgical incision, but also increases the hospitalization time and economic burden, causes exacerbation or recurrence of disease, and even harms the patient's lives [18]. At present, post-surgical incision infections have not been effectively controlled, and this problem is more serious in some hospitals with limited medical facilities. With increasingly detailed studies, relevant literature [19-21] indicates that a key factor influencing incision infection is conditions in the operating room. As incision infections not only bring great physical and psychological pain and burden to patients, but also reduce the therapeutic effect and increase the risk of death, the analysis of operating room-related factors influencing the occurrence of incision infection in surgical patients and the corresponding nursing interventions are important considerations in surgery. This study aimed to analyze the operating room factors influencing the occurrence of incision infection in surgical patients and study the feasibility of interventions by retrospectively analyzing and following up 1,842 surgical patients treated in our hospital, providing a reliable and effective reference for future surgery.

The results of this study showed that the independent factors influencing the occurrence of surgical incision infection are intraoperative blood loss of ≥800 ml, operation of longer dura-

Table 3. Multivariate analysis of incision infection

	Intervention group (n=930)	No intervention group (n=912)	P	OR	95% CI
Intraoperative blood loss (ml)	1100±100	1200±120	0.049	0.83	0.68~1.00
Operation time (h)	2.5±0.3	3.5±1.1	0.043	1.44	1.01~2.04
Cut type (II)	16±8.2	32±2.1	0.015	0.67	0.48~0.93
Number of operating room personnel	26±6.8	48±11.2	0.006	2.40	1.27~4.52
Povidone iodine disinfection	30±6.7	24±12	0.028	1.51	1.04~2.18

Table 4. Comparison of the length of hospital stay, costs, and incidence of incision infection among patients between the two groups

	Intervention group (n=930)	No intervention group (n=912)	X^2 or t	P
Incision infection rate (%)	62 (6.7)	108 (11.8)	14.72	0.001
Hospitalization time (d)	8.16±2.57	13.62±3.42	38.78	0.001
Hospital costs (million)	9.64±1.84	12.86±2.04	35.59	0.001

Table 5. Comparison of the prognosis quality of life score among patients between two groups

	Intervention group (n=907)	No intervention group (n=865)	t	P
Daily activities	88.34±9.64	75.36±7.18	32.03	0.001
Mood	81.25±6.16	71.42±8.62	27.72	0.001
Healed at the incision	86.37±8.46	72.36±6.52	38.91	0.001
Disease recurrence	90.62±5.28	82.36±7.46	27.00	0.001
The average score	86.64±7.39	75.37±7.45	31.96	0.001

tion, type of surgical incision, a larger number of patients who underwent surgery, and not disinfecting the incision site with povidone iodine. The incision infection rate in the intervention group was 6.7%, while that in the no intervention group was 11.8%; furthermore, the results of the follow-up study showed that the prognosis of patients in the intervention group was better than that of those in the no intervention group, indicating that the interventions used in this study are effective. Intraoperative blood loss is primarily caused by surgical delays or incorrect performance of the procedure. Incorrect incision of the surgical site can cause hematoma, leading to insufficient oxygen supply to the incision site and resulting in the occurrence of infection. The surgeons are strictly required to follow the standard surgical protocol to reduce the incidence of incision infection caused by human factors. In patients whose operation is of longer duration, the bacteria and air particles are more likely to enter the tissues, which is the main reason for the occurrence of incision infection. Therefore, increasing the operating personnel's familiarity with the surgical protocols and having a mutual understanding on the reason for minimizing the operation time and reducing the incision infection rate can help improve the prognosis of patients. During surgery, the incision is more easily infected due to overflow of massive pollutants. If the number of operating room personnel involved in the surgery is larger, the more likely are the bacteria to be carried. Povidone iodine, which is typically used as a wound disinfectant, has a strong bactericidal effect, reducing the occurrence of incision infection. This finding is in agreement with the results of the studies conducted by Maoz et al. [22] and Sandy-Hodgetts et al. [23]. The operating room countermeasures not only involve following the standard surgical procedures, but also include the interaction between medical staff in the operating room. The proficiency and tacit understanding of the operating personnel play a key role in the prevention of incision infection. Furthermore, all instruments and equipment in the operating room need long-term and regular maintenance, and the operating room needs to be processed and sterilized carefully [24]. The preoperative communication with patients can also effectively reduce the discomfort of patients during surgery, thus improving the success rate following surgery. Disinfection before and after surgery should be strictly performed in accordance with the operating room protocols to achieve the optimal surgical condition. The number of operating room personnel should be minimized. Medical personnel should also pay close attention to the condition of the patient's postoperative incision to ensure early finding and early treatment. The results of the study by Muysoms et al. [25] prove that strictly standardizing the operating room nursing interventions and increasing the medical personnel's awareness regarding the prevention of incision infection can effectively reduce the incidence of post-surgical incision infection. Thus, a longer follow-up study is required, and further studies are needed to identify other operating room-related factors in order to provide more accurate experimental results.

In conclusion, the related factors influencing the occurrence of incision infection in surgical patients include large amount of intraoperative blood loss, operation lasting for a long duration, type of surgical incision, large number of operating personnel, and not disinfecting the site with povidone iodine. Improving the standard surgical procedure as well as the tacit understanding of operating room personnel, strictly assessing the incision site for the presence of postoperative infections, and analyzing the factors related to the occurrence of incision infection can effectively improve the prognosis of patients.

Disclosure of conflict of interest.

None.

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