

## Original Article

# Risk assessment of infection control in operating room based on hazard vulnerability and refined process management

Ling Wang<sup>1</sup>, Yan Chen<sup>2</sup>, Chunxiang Xia<sup>2</sup>, Ling Wu<sup>2</sup>, Yan Song<sup>2</sup>

Departments of <sup>1</sup>Operating Room, <sup>2</sup>Nursing, Nanjing Hospital Affiliated to Nanjing University of Traditional Chinese Medicine, Nanjing, Jiangsu Province, China

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**Abstract:** Objective: To evaluate the effect of risk assessment in operating room infection control based on a hazard vulnerability analysis and refined process management, to clarify the weaknesses of infection control in operating rooms, and to provide evidence for the clinical prevention and control measures. Methods: A refined risk assessment scale was designed based on a hazard vulnerability analysis and refined process management by screening the incidents related to operating room infections and determining the weighted coefficients. A total of 84 patients who underwent surgical treatment in our hospital from February 2018 to March 2020 were enrolled as the study subjects according to convenience sampling and randomly assigned into an observation group and a control group, with 42 patients in each group. The observation group patients were treated and cared for following a risk assessment based on a hazard vulnerability analysis and refined process management. The control group patients underwent conventional management. The effect of the risk assessment based on a hazard vulnerability analysis and refined process management for infection control was evaluated by comparing the hazard specific risk values, the infection incidents, and the two groups' nursing satisfaction. Results: After the intervention, the observation group had lower hazard specific risk values (all  $P < 0.05$ ), fewer infection incidents ( $P = 0.044$ ), and a higher patient satisfaction rate ( $P = 0.047$ ) than the control group. Conclusion: The treatment and nursing intervention for the patients based on the risk assessment improved the efficiency of the risk management, reduced the number of infection incidents, increased the patient satisfaction rate, and improved the clinical efficacy for the surgery patients. Our findings provide a data reference for operating room infection control and prevention.

**Keywords:** Hazard vulnerability, refined process management, operating room infection control, infection incidents

## Introduction

Hazard vulnerability analysis (HVA), an effective risk evaluation tool, is predominantly used to stratify the potential hazards and measure the importance and possibility of these hazards, so as to provide guidance for hazard prevention [1]. HVA has been widely used in various fields. Refined process management emphasizes the impact of refined service quality on events. In recent years, the application of HVA and refined process management has played a positive role in operating room infection prevention and control; also, many hospitals have carried out experiments to evaluate HVA and refined process management [2, 3]. In general, the hospital infection rate for patients undergoing surgi-

cal treatment is higher than it is for patients undergoing conventional treatment. The infection rate in surgical patients is closely related to the severity of their conditions, the sizes of their incisions, and their immune function [4-6]. Moreover, the infection rate is also affected by the operating room layout design as well as the medical staff's surgical and nursing techniques [7, 8]. Most previous studies use either HVA or refined process management alone to analyze the risk factors that affect operating room infections, which is not comprehensive enough for an analysis of the operating room risk factors. Based on the limitations of previous research, this study, for the first time, applies an integration of HVA and refined process management to evaluate the operating room infec-

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tion control risk factors and to analyze the patient satisfaction levels after a refined intervention for surgical patients based on HVA, in order to comprehensively analyze and reduce the operating room infection risk factors.

### Materials and methods

#### *Data collection*

A total of 84 patients who underwent surgical treatment in our hospital from February 2018 to March 2020 were enrolled as study subjects according to convenience sampling, and they were randomly assigned into an observation group and a control group, with 42 patients in each group. This study was approved by the Ethics Committee of our hospital and all the patients signed the informed consent.

#### *Research methods*

The observation group were managed and cared for following a risk assessment based on a hazard vulnerability analysis and refined process management. The control group underwent conventional management and care in the operating room.

#### *Risk evaluation team*

The professional and technical personnel who are good at HVA gave an HVA training to all the medical staff in the operating room for 2 class hours, so that all staff in the department had learned and mastered the HVA concepts and knowledge. The staff who passed the HVA-related professional knowledge assessment were included in the risk evaluation team.

#### *HVA risk evaluation*

Brainstorming and free discussion were adopted in a meeting to encourage active thinking and speaking based on retrospective analyses of the causes of operating room infection incidents in recent years. The evaluation was performed from the following perspectives: personnel management, preparation work, the implementation of infection control, the awareness of asepsis and life care for patients. A standardized questionnaire was developed using the KAISER model and distributed to all group members. A total of 35 questionnaires were issued and collected, with a collection

rate of 100%. The KAISER model used Excel to calculate the probability and severity of the potential risk events. Possibility refers to the incidence of the events. Severity included the human factors, financial factors, operations, preparations, as well as the internal and external emergency preparedness responses. Both possibility and severity were assigned to levels 0 to 3 [9, 10]. Risk value = (possibility/3) \* ((human factor + financial factor + operations + preparations + external response + internal response)/18) \* 100%. The risk values in descending order showed that the top four were the lack of attention to hand hygiene, the non-standard shifting of duties, belated checks or reports of laboratory results, and belated waste disposal, which were regarded as key improvement items in the refined process management. Refined corresponding strategies were developed to intervene and improve the above risk events, then the differences were observed and compared between the two groups.

#### *Implementation of refined process management*

The following refined interventions were carried out to deal with the above risk events. First, professional training. A doctor study group, a nurse study group and a study group of both doctors and nurses were set up to attend regular mini-lectures and to learn the latest treatment and nursing guidelines for common operating-room diseases. Mock exercises and regular assessments were carried out to deal with hand hygiene to improve the professional level of newly recruited medical staff and to help other medical staff reflect on improper operations and overlooked details at work, so as to reduce the occurrence of inappropriate procedures during the treatment and nursing processes. Second, personnel management. The doctors in charge were required to see the testing results promptly so that they could properly adjust the therapeutic regimen according to the test results. Good teamwork was required. The nurses in charge were required to pay close attention to the surgery patients' vital signs. Standard duty shifting was required for the doctors and nurses to prevent unnecessary mistakes due to inadequate information exchange. Third, instrument disinfection and waste disposal. One specially-assigned person

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**Table 1.** Comparison of the general data ( $\bar{x} \pm sd$ )

Parameters	Control group (n=42)	Observation group (n=42)	P
Age (years)	57.6±9.0	58.1±9.3	0.862
Sex (male/female)	19/23	20/22	0.827
Surgical incision (I/II/III)	9/18/15	10/19/13	0.895
Type of surgery (general surgery/neurosurgery/orthopedic surgery)	18/17/7	15/19/8	0.478
Preoperative antibiotic use (yes/no)	24/18	21/21	0.512

was required from the research team (taking turns) to manage and record the movement of the materials in the operating room so as to improve the awareness of the classification and the management of the materials. The taking and the use of disinfected items strictly followed the uniform deployment and management and were recorded according to the standards with the name and concentration. The responsible personnel promptly reported any difficulties and solutions encountered in their work by sharing and discussing them. The patients were always treated in a professional and dedicated manner.

### Outcome measures

The rankings of the top 4 risk events were compared between the two groups after the patients were treated with improved interventions and nursing methods based on HVA and refined process management. The hospital infection incidents were recorded and compared between the two groups of patients. The patient satisfaction levels with the overall treatment and care in the operating room during their hospital stays were compared between the groups. Satisfaction rate = (number of high satisfaction + number of general satisfaction + number of basic satisfaction)/total number of patients in the group \* 100%.

### Statistical methods

SPSS 23.0 software was used for the data analyses. The measurement data were expressed in the form of mean  $\pm$  standard deviation ( $\bar{x} \pm sd$ ), and the comparisons between the two groups were done using t-tests. The count data were expressed as percentages, and comparisons between the two groups were done using chi-square tests.  $P < 0.05$  indicated a statistically significant difference.

## Results

### General data

There were no previous infections in the two groups of patients. The control group included 19 males and 23 females. The youngest patient was 36 years old, and the oldest was 70 years old, and the group had an average age of 57.6±9.0 years old. The observation group included 20 males and 22 females. The youngest patient was 35 years old, and the oldest was 72 years old, and the group had an average age of 58.1±9.3 years old. In the control group, there were 9 cases, 18 cases, and 15 cases of type I, II, and III surgical incisions, respectively. In the observation group, there were 10 cases, 19 cases, and 13 cases of type I, II, and III surgical incisions, respectively. In the control group, there were 18, 17, and 7 patients who underwent general surgery, neurosurgery, and orthopedic surgery, respectively. In the observation group, there were 15, 19, and 8 patients who underwent general surgery, neurosurgery, and orthopedic surgery, respectively. There were 24 patients in the control group and 21 patients in the observation group who were prescribed preoperative preventative antibiotics. Our statistical analyses found no significant differences between the two groups in terms of age, sex, surgical incision, type of surgery or preoperative antibiotic use (all  $P > 0.05$ ), indicating that the two groups were comparable. See **Table 1**.

### Comparison of the risk values after the risk evaluation based on HVA and refined process management

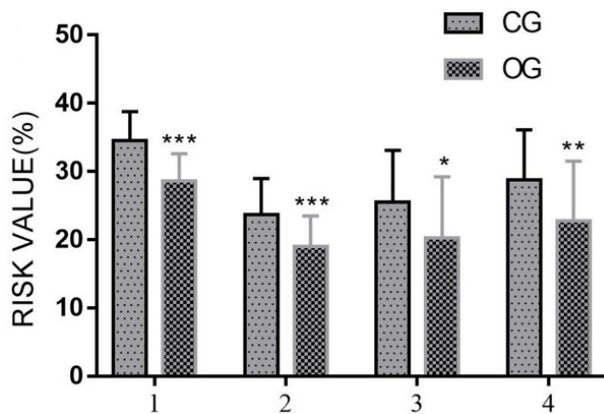
Through the evaluation based on HVA and refined process management, we found that the predominant risk factors that affect hospital infections in the operating room were attention to hand hygiene, standard duty shifting,

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**Table 2.** The effect of the risk evaluation on the risk values

Risk factors	Control group	Observation group	P
Attention to hand hygiene	34.55±4.23	28.59±4.03***	0.000
Standard shifting of duty	23.70±5.27	19.00±4.48***	0.000
Check/report laboratory results	25.46±7.64	20.24±8.98*	0.011
Waste disposal	28.83±7.29	22.78±8.72**	0.002

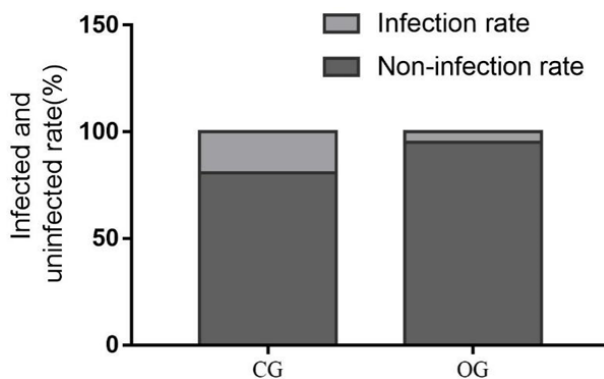
Note: Compared to the control group, \*\*\*P<0.001, \*\*P<0.01, \*P<0.05.



**Figure 1.** The effect of the risk evaluation on the risk values. Number 1: attention to hand hygiene; number 2: standard duty shifts; number 3: check/report laboratory results; number 4: waste disposal. CG: control group; OG: observation group. Compared to the control group, \*\*\*P<0.001, \*\*P<0.01, \*P<0.05.

**Table 3.** Comparison of the infection rates (%)

Group	Infections	Non-infections	Infection rate (%)
Control group (n=42)	8	34	19.05
Observation group (n=42)	2	40	4.76
$\chi^2$			4.086
P			0.044



**Figure 2.** Comparison of the infection rates (%). CG: control group; OG: observation group.

the checking or reporting of laboratory results, and waste disposal. The risk values of all the four factors above were lower in the observation group than they were in the control group, with statistically significant differences (all P<0.05). See **Table 2** and **Figure 1**.

### Comparison of the infection rates

Following the evaluation based HVA and refined process management, we further standardized the management of the risk events affecting the infection incidents in the operating room. After the extensive participation of the relevant staff and the improvement of the interventions, the infection incidence in the observation group was lower than it was in the control group, with a statistically significant difference (P<0.05). See **Table 3** and **Figure 2**.

### Comparison of the satisfaction rates

The level of satisfaction with the treatment and care in the operating room during the hospital stays was classified into four levels: high satisfaction, satisfaction, basic satisfaction, and dissatisfaction. We found that the overall satisfaction rate in the observation group was higher than it was in the control group, with a statistically significant difference (P<0.05). See **Table 4**.

### Discussion

In the 1990s, risk assessment experts in the United States proposed the application of risk assessment to identify and evaluate the risks in medical treatment, so that medical institutions could use the minimum cost to discover and improve the weaknesses in hospital management, ensure patient safety to the greatest extent, and improve the quality of the medical care for human health

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**Table 4.** Comparison of the satisfaction rates

Group	Control group (n=42)	Observation group (n=42)	$\chi^2$	P
High satisfaction	14	21		
Satisfaction	13	14		
Basic satisfaction	10	5		
Dissatisfaction	5	2		
Satisfaction rate (%)	88.10	95.24	3.935	0.047

[11]. With the continuous development of risk evaluation, it has been widely applied to medical treatment. Scholars used HVA to evaluate the risk factors of hospital-related hazards [12-15]. As a commonly occurring hospital risk, hospital infections need scientific risk evaluation guidance for infection prevention and control.

The operating room is a place where infections commonly occur in the hospital. Most patients are in a critical condition, and the patients' immunity is more or less affected by the operation and their state of mind, so hospital infections are more prone to occur in the operating room. The application of HVA should not be limited to the assessment of acute emergencies or hazards. It can be applied flexibly according to the characteristics of the operating room and combined with refined process management to evaluate and improve the operating room management and nursing care. Following a risk assessment based on the HVA and refined process management, this study conducted a preliminary study of the infection risk in operating rooms. It was found that attention to hand hygiene, standard duty shifts, the timely checking or reporting of laboratory results, and timely waste disposal were the major risk factors for infection. Our results are consistent with those of previous studies [16-19]. The results of this study highlight the importance of standard operating room disinfection and the awareness of sterile conditions among the medical staff.

According to the results of our risk evaluation based on HVA, our key staff formulated and implemented relevant improvement measures based on the concept of refined process management and mobilized the enthusiasm of all the operating room staff. Therefore, all the staff members followed the improved measures and the refined care process in addition to following

the routine management procedures. As a more rigorous and meticulous method, refined process management can eliminate the weaknesses in hospital and department management, thereby improving the service quality of the hospital and the medical staff, positively affecting the doctor-patient relationships and helping patient recovery. A previous review

clarified that refined process management can reduce the occurrence of clinical risk events [20]. This study implemented refined process management, paying attention to hand hygiene, the standard duty shifts, the timely checking or reporting of laboratory results, and timely waste disposal. In addition, we carried out systematic training and division of labor, and we achieved favorable results. The results of our study indicate that HVA and refined process management can significantly reduce the incidence of infections in the operating room and greatly increase the patient satisfaction with the department management and service, and this is consistent with previous results [21, 22].

In summary, HVA and refined process management can complementarily form a favorable evaluation method, which shows promising results in risk management and adverse event avoidance in the operating room, we improved the management efficiency of the department and the clinical efficacy for the patients, and we enhanced the professionalism of the medical staff. Therefore, HVA and refined process management are worthy of promotion in clinical operating rooms, and possibly also in the management of other departments. However, this study also has certain limitations. First, the sample size and study timeframe were limited, so the stability of our results needs to be further verified. Second, this study only enrolled surgical patients in the past two years. The short time span may affect the overall research results. Finally, we didn't carry out multi-center study to determine the factors that may impact surgical infection control. We hope to conduct a study with more generalized and universal results to save social resources and to provide more help to patients.

### Disclosure of conflict of interest

None.

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**Address correspondence to:** Yan Song, Department of Nursing, Nanjing Hospital Affiliated to Nanjing University of Traditional Chinese Medicine, No. 1-1 Zhongfu Road, Nanjing 210003, Jiangsu Province, China. Tel: +86-025-83626512; Fax: +86-025-83626512; E-mail: songyan34rd@163.com

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