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The Application Progress of Swiss Cheese Model in Safety Management of Nursing Care

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Abstract

As an important part of medical and health field, nursing safety management plays a vital role in ensuring patients' life safety. Swiss cheese model is an efficient system security management strategy, covering four dimensions: organizational influence, poor supervision, potential unsafe behavior and unsafe operation behavior. Through in-depth analysis of the risk factors of accidents, this model constructs a multi-level defense system from the above four dimensions in order to prevent accidents. In order to continuously improve nursing safety management and nursing service quality, and promote the sustainable development of nursing work, this study mainly summarized and analyzed the Swiss cheese model and its application progress in the field of nursing safety, aiming at providing theoretical reference for subsequent researchers' research and clinical practice.

Keywords

Swiss Cheese Model, Reason Model, Nursing, Safety Management

1. Introduction

With the continuous development and improvement of China's medical and health system, the public's expectation for the quality of nursing service is increasing. In the field of health management, nursing safety management occupies a vital position. The effectiveness of nursing safety management is directly related to the quality of medical care service, the level of hospital management and the progress of the whole medical and health cause. Patient safety is the top priority of medical care. In February 2020, the global consultation meeting held by WHO in Geneva drew up the Global Action Plan for Patient Safety 2021-2030 [1], which put forward the goal of "minimizing avoidable injuries caused by unsafe medical

care and minimizing unsafe medical and health incidents worldwide", thus showing the importance of patient safety management. Swiss cheese model is an efficient system safety theory, which explains the role of multiple defense mechanisms in accident prevention. It emphasizes that accidents are caused by systematic defects rather than a single factor [2]. As a classical theoretical model of accident root cause analysis, this model has been applied to aerospace [3], tunnel engineering [4] and power system [5]. In recent years, the model has been gradually applied to medical and health fields [6] [7], and has played an important role in nursing safety management through continuous development. This paper aims to summarize the application research of Swiss cheese model in the field of nursing safety management, in order to provide reference for subsequent researchers.

2. Overview of Swiss Cheese Model

2.1. The Concept of "Swiss Cheese Model"

Swiss cheese model was put forward by James. Reason, a professor of psychology at Manchester University in England, in his famous psychological monograph "Human Error" in 1990, also known as "Reason Model" [8]. The model mainly includes four aspects, namely, the influence of the organization, unsafe supervision, the precursor of unsafe behavior and unsafe operation behavior [9]. In this model, each defense mechanism is likened to a cheese slice, in which holes symbolize system loopholes or defects. These holes are not constant, and their size, position and shape are constantly changing dynamically. At a certain moment, if dangerous factors appear, the defense mechanism may fail, thus exposing defects and loopholes, leading to holes in cheese. However, the accident is not inevitable, because there are other defense barriers that may prevent the penetration of dangerous factors. Only when the dangerous factors break through all the defense barriers and act on the core of the system, resulting in the holes in the cheese being connected in a line, will a dangerous accident be caused [10]. This is shown in Figure 1.

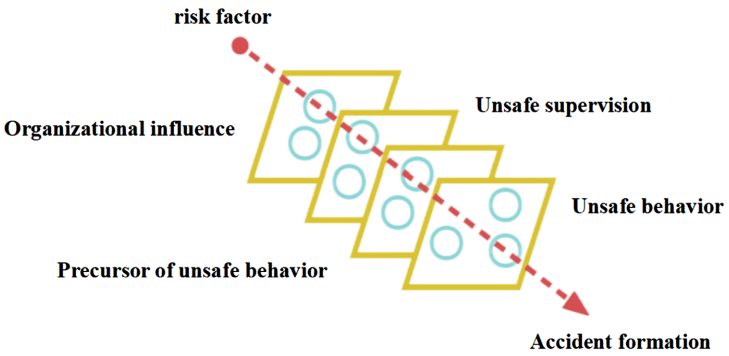

Figure 1. Swiss cheese model diagram.

2.2. Swiss Cheese Model Significance and Development

Swiss cheese model constructs a multi-layer defense system thinking. Firstly,

different defense systems can deal with the invasion of different risk factors and protect the organization or system through different defense levels. secondly, any accident is not caused by a single factor, and the risk factors need to break through the multi-layer defense system, leading to the failure of defense. Therefore, when a safety accident occurs, we should not simply pursue the cause of a certain level, but comprehensively and systematically look for factors at all levels, so as to find the root cause of the accident and establish multiple defense mechanisms, thus reducing the probability of the accident [11].

After many iterations and improvements, the Swiss cheese model has gradually built a detailed analysis framework, which deeply discusses the whole process from the emergence of risk factors, the failure of defense mechanism to the accident. Within an organization or system, potential risk factors are ubiquitous. Although the occurrence of a single risk factor may not directly lead to accidents, with the continuous accumulation of errors and the continuous breakthrough of defense barriers, it will eventually lead to catastrophic accidents [12]. Guo Ideality and others [13] think that from the "Swiss cheese model", it can be seen that the accident is the result of the accumulation of security risks to a certain extent, and the loopholes at all levels coincide. Therefore, it is very important to promptly investigate the loopholes at all levels, analyze the induced causes, and nip in the bud. Ji Jing *et al.* [14] introduced the theory of "Swiss cheese model" into laboratory biosafety management, analyzed the existing risk factors from four aspects of the model, and then put forward targeted solutions to avoid possible loopholes and establish a multi-layer defense system, thus reducing accidents and ensuring biosafety management. At present, Swiss cheese model has become a key theoretical framework for safety accident prevention and analysis, and it plays a vital role in the field of safety accident prevention and analysis.

3. Application of Swiss Cheese Model in Nursing Safety Management

Nursing safety management is a key factor to improve nursing quality. The national nursing career development plan (2021-2025) [15] puts forward: "It is necessary to continuously improve the scientific management level of nursing, continuously improve the quality of nursing and promote the high-quality development of nursing". With the deepening of research, Swiss cheese model has been widely used in the analysis of nursing adverse events, nursing risk management and nursing safety prevention. The model has shown remarkable results in reducing the incidence of adverse events, strengthening nursing risk management, optimizing nursing safety preventive measures and improving nursing safety quality.

3.1. Swiss Cheese Model in the Management of Nursing Adverse Events

At present, the handling and reporting of adverse events has become the focus of the World Health Organization [16]. The occurrence of adverse events may cause

patients to suffer injuries other than their own diseases, and increase their pain and economic burden, even death. Therefore, it is of great significance to systematically and comprehensively analyze the causes of nursing adverse events, find out the loopholes in nursing safety management, formulate scientific and effective preventive measures, and reduce the incidence of nursing adverse events [17] [18]. Adverse events of nursing safety directly threaten the life safety of patients, and the adverse events during hospitalization have disastrous effects on individuals, medical institutions and society. Studies have shown that among the beneficiaries of hospitalization medical insurance, 13.5% of patients had adverse events during hospitalization, and 44% of them were considered to be preventable [19].

MD *et al*. [20] put forward in the Swiss cheese discipline conference on the integration and coordination of quality improvement education and hospital patient safety measures that the occurrence of adverse events is not a single man-made factor, but caused by complex system reasons. This conference improved the ability of medical staff to analyze safety problems from a systematic perspective, made clear potential safety hazards and avoided dangerous accidents. Research [21] shows that the causal relationship of Swiss cheese model accident is used to analyze the root causes of patients' falls, find the potential risk factors of patients' falls, narrow the gap of safety hazards at different defense levels, and increase the defense barrier, so that it can prevent patients from falling more effectively. Fubo [22] also used root cause analysis in the management of falls of elderly patients, systematically analyzed the whole process of the adverse event of falls, understood the process and root cause of the event, and attached importance to the improvement of the system, instead of pursuing personal mistakes, which not only improved the reporting rate of nursing events, but also increased the enthusiasm of nursing staff to learn. Zhai Yu [23] conducted a survey on adverse events in hospitals and found that falls, impulsive aggression, and self-harm are common incidents in psychiatric patients, with the peak hours being the day shift and the night shift, and the high-risk group being junior nurses. Using the Reason model, we will conduct a thorough analysis of the existing problems and then propose targeted improvement strategies. By strengthening the training of medical and nursing staff, their professional skills and safety awareness can be improved, with the aim of enhancing the professional quality of nursing staff. At the same time, improve the nursing safety prevention and control system, strengthen supervision, and ensure that all safety measures are effectively implemented. In addition, health care workers should be encouraged to proactively report adverse events and potential risks to create a positive safety culture, thereby reducing the frequency of unsafe behaviors. Yu Chenge [24] found that the most frequent places of fall/fall are bedside and bathroom, with more low risk and high risk events, and the incidence of patients ≥60 years old is higher. Based on the four defense levels of the Swiss cheese model, it systematically analyzed the causes of patients' fall/fall events, but did not develop comprehensive strategies for intervention. High-risk patients should be evaluated as a whole, focused on them, and effective preventive

measures should be developed to prevent patients from falling/falling. Zhang Ling [25] applied the Reason model in the perioperative nursing safety management of patients undergoing interventional surgery for liver cancer. First, a Reason model management team was set up, headed by the head nurse, and senior nurses were arranged to give intensive lectures through lectures. The contents include theoretical knowledge of Reason model, interpretation of safety culture, common nursing safety problems in oncology department, reporting and handling of nursing adverse events, nursing risk and assessment, safety protection and communication, etc. The Reason model was used to analyze adverse nursing safety events from four aspects, and the loopholes were filled, such as strengthening the training on the use of chemotherapy pumps and the safety management of anti-tumor drugs, improving the shift process of nurses, avoiding nursing faults, strictly controlling the quality of teaching and control, supervising the implementation process, and unifying the evaluation and prevention standards of delirium. The incidence of nursing safety adverse events was significantly reduced. In addition, the strategy helps to change the attitude of healthcare professionals towards the reporting of adverse events, thereby ensuring patient safety. Guo Li [26] applied the Swiss cheese model to conduct a comprehensive analysis on the human factors of drug adverse events in hospitalized children, and concluded that the occurrence of adverse events was mainly caused by system defects, for which corrective measures were also made. For example, the implementation of dynamic management of nurses, increase the deployment of nursing staff in key periods, strengthen the safe drug use and risk education and training of young nurses, improve communication with hospital information departments, use information means to escort children's safe drug use, pay attention to the safe drug use of families of children, and provide references for managers to further optimize nursing workflow and improve nursing quality. In summary, the Swiss cheese model is applied to adverse nursing events, and the causes of adverse events can be found out fundamentally from the four aspects of organizational influence, unsafe supervision, the precursor of unsafe behavior and unsafe behavior, and then targeted measures can be formulated according to the causes to effectively reduce the occurrence of adverse events, ensure patient safety and optimize the quality of nursing services.

3.2. Application of Swiss Cheese Model in Nursing Risk Management

Swiss cheese model is a model for risk assessment and risk management. It analyzes the reasons behind the accident from a systematic perspective. It compares the human body system to Swiss cheese slices placed side by side, and different layers can prevent the risk of accidents [27]. The core of risk management using Swiss cheese model is to identify the characteristics of loopholes, deeply understand the evolution process of loopholes, and formulate corresponding risk control strategies accordingly, so as to plug loopholes and avoid accidents. Gong Mingyue *et al*. [28] applied Swiss cheese model to the management of patients with gastrointestinal intolerance of enteral nutrition after esophageal cancer surgery,

which can significantly reduce the incidence of gastrointestinal intolerance, improve the postoperative nutritional status of patients and promote their postoperative recovery process. Wang Yang *et al*. [29] applied the nursing management model of Swiss cheese model in the safe use of drugs for patients undergoing chemotherapy in day wards, which can enhance the professional ability of nursing staff in the safe use of drugs, reduce the incidence of adverse drug events during chemotherapy in day wards, and further improve patient satisfaction. Tian Hui *et al*. [30] used Swiss cheese model in the management of safe drug use in cardiology department. In their research, the incidence of irrational drug use events was significantly reduced in cardiology department, and at the same time, the nurses' mastery of drug knowledge was significantly improved, thus promoting the significant improvement of nursing management quality in cardiology department. Kong Deyou [11] established a monitor safety risk defense system based on the theory of "Swiss cheese model", and set up a defense level to reduce the safety risk of the monitor, improve the safety of patients, and effectively prevent and reduce the occurrence of abnormal events related to the monitor. Yu Qingmei [31] applied the risk nursing model based on Swiss cheese model to the prevention of adverse events of children's convulsions, which shortened the first aid time of children's convulsions, effectively relieved the clinical symptoms of children, accelerated the recovery process of children, and promoted the family members of children to form good care behavior. Therefore, Reason model plays an active role in nursing risk management.

3.3. Application of Swiss Cheese Model in Nursing Safety Prevention

In the health system, the premise of all work is safety, therefore, safety prevention is the most important. Swiss cheese model believes that the most important thing in safety prevention is to prevent accidents through multiple defenses, or to prevent accidents from causing injuries, thus playing a role in safety defense. Studies [10] have shown that 2700 patients are injured every year because of the wrong site surgery. In order to reduce the incidence of wrong site surgery, the World Health Organization has created a surgical safety checklist. By using Swiss cheese model root cause method to analyze its research results, it shows that the surgical checklist can effectively reduce the incidence of wrong site surgery and other medical accidents. Hu Xiangxia [32] applied the theory of "Swiss cheese model" to the drug safety management in ICU, which significantly reduced the incidence of drug errors. The implementation of this model promoted the medical staff to master the knowledge of medication in ICU, and effectively improved patient satisfaction. Zhou Lina *et al*. [33] applied Swiss cheese model to the prevention and management of unplanned extubation in ICU, which significantly reduced the incidence and severity of unplanned extubation adverse events, effectively filled management loopholes, and improved management quality and patient safety. Wang Guanyu [34] and others set up a Swiss cheese model research group, using this theory to deeply explore the causes of gastric retention caused by enteral nutrition, identify related influencing factors, and formulate corresponding improve-

ment strategies for the defects found. Through these measures, the incidence of gastric retention was successfully reduced, and then the nutritional status of patients was improved, and the success rate of 7-day feeding was significantly improved.

4. Summary

In clinical nursing safety management, in-depth analysis of nursing adverse events plays a vital role. So it is very important to choose the appropriate analysis method. In view of the differences in the emphasis and scope of application of different analytical methods, and their specific advantages and limitations, in addition, nursing adverse events are complex and multi-layered, which requires comprehensive consideration of their characteristics when analyzing such events. Can refer to foreign analytical methods such as Learn Form Defect, Swarm and Concise Incident Analysis. By selecting appropriate analytical methods, quality and safety issues in clinical practice can be more accurately identified, nursing risks can be prevented, and care management can be achieved efficiently and patient safety can be ensured. To sum up, Swiss cheese model constructs the framework of nursing risk management based on four levels, and proposes that the model theory has significant guiding significance for the construction of nursing risk management framework. For bottom-up management, the model is akin to a series of interconnected "cheese layers", and the security performance of the entire system depends on the stability of each layer. Even if a failure occurs in one part of the management, it will not affect the security of the entire system. By integrating the entire safety management system, the model ensures that each link can fulfill its responsibilities, which is the core strength of the model. Therefore, the model should be widely used in various management fields. However, the application of this model in the current clinical research field is still insufficient, and there is a lack of multicenter and large-scale intervention studies. It is suggested that future researchers expand the clinical empirical study of this theoretical model in the field of nursing safety management.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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