

Research on Optimizing Selection and Configuration Combined with Lean Management in Improving the Management Effect of Emergency Equipment in Ambulances

Qinfeng Liu¹, Bin Qiu^{2,*}, Tao Wang³, Enke Zhang¹

¹Medical Equipment Management Department, Shaanxi Provincial People's Hospital, Xi'an, Shaanxi, 710068, China

²Information Management Department, Shaanxi Provincial People's Hospital, Xi'an, Shaanxi, 710068, China

³Department of Medical Imaging, Hospital of Stomatology, Xi'an Jiaotong University, Xi'an, Shaanxi, 710004, China

*Corresponding author

Abstract: Objective To explore the optimizing selection and configuration combined with lean management in improving the management effect of emergency equipment in ambulances. Methods A hospital in Xi'an has adopted the strategy of optimizing selection and configuration combined with lean management in the management of ambulance emergency equipment, the management effect of emergency equipment was analyzed. Results In the statistics of emergency equipment management before the execution of ambulance missions, after the implementation of management measures, the incidence of emergency equipment with incomplete accessories, and the incidence of emergency equipment with stains on surfaces decreased significantly ($\chi^2=5.701$, $\chi^2=10.865$; $p<0.05$), the incidence of all emergency equipment passed in one inspection was significantly increased ($\chi^2=4.082$; $P < 0.05$); in the statistics of emergency equipment failures after the execution of ambulance missions, after the implementation of management measures, the incidence of failures caused by emergency equipment falling or bumping, and the incidence of emergency equipment affected by electromagnetic interference decreased significantly ($\chi^2=4.688$, $\chi^2=4.082$; $P < 0.05$). Conclusions In the management of emergency equipment in ambulances, the use of optimizing selection and configuration combined with lean management strategy can significantly improve the management quality of emergency equipment in ambulances, and improve the quality and efficiency of the execution of ambulance missions. Optimizing selection and configuration combined with lean management strategy has certain effectiveness in emergency equipment management in ambulances.

Keywords: Optimizing selection and configuration, Lean management, Emergency equipment, Ambulance mission

1. Introduction

The ambulance undertakes the task of emergency transport of critical patients. It is the first place to rescue patients. The emergency equipment in the ambulance plays an important role in the process of patient rescue [1]. In the actual use of emergency equipment in ambulances, due to the urgent condition of patients and unclear road conditions in the transport process, the moving and using process of emergency equipment is often accompanied by bumping, pulling, misoperation and other possibilities, resulting in a high failure rate of first-aid equipment. The condition of emergency equipment directly affects the effectiveness and safety of rescue [2,3]. In order to reduce the failure rate of emergency equipment, it is necessary to manage the emergency equipment effectively.

Because of the particularity of rescue and transport work, reasonable selection and configuration of ambulance equipment plays an increasingly important role in reducing the failure rate of emergency equipment. Ambulances have these characteristics, such as narrow space in the vehicles, unstable power supply voltage, poor control of temperature and humidity in the vehicles, poor cleanliness in the vehicles, severe vibration during vehicle driving, electromagnetic interference in the vehicles, and unstable oxygen source, all of which should be considered in the selection of emergency equipment. And the emergency

equipment suitable for on-board and long-distance transport should be selected as far as possible, so as to reduce the failure rate of emergency equipment and improve the effective running time of the equipment.

In order to ensure the normal operation rate of emergency equipment in ambulances, the pre-hospital emergency department of a hospital in Xi'an not only studied the reasonable selection and configuration of emergency equipment with the medical equipment management department, formulated the selection and configuration suggestions in line with the actual situation of ambulance use, but also adopted the lean management strategy in the actual management of emergency equipment. In this paper, the effect of emergency equipment management in ambulances were studied.

2. Research Materials and Methods

2.1. Research Materials

There are 4 ambulances for pre-hospital emergency care in a hospital in Xi'an. Since in the equipment inventory process at the beginning of 2020, the department found that some centrally purchased emergency equipment had gradually reached the end-of-life period, from June 2020, the department and the medical equipment management department of the hospital adopted the purchase strategy of optimizing selection and configuration for the procurement of emergency equipment in ambulances. As of March 2021, the update of emergency equipment in 4 ambulances had been completed. In this study, the emergency equipment in the ambulance was selected as the research object. The equipment included in this study included: transport monitor, defibrillator, sputum suction device, cardiopulmonary resuscitation device, transport ventilator, oxygen cylinder, injection pump, infusion pump, blood glucose meter, etc.

2.2. Research Methods

2.2.1. Optimizing Selection and Configuration Strategy of Emergency Equipment in Ambulances

In order to optimize the selection and configuration of emergency equipment in ambulances, experts from pre-hospital emergency department and medical equipment management department met for many times to study, and referred to the relevant technical data at home and abroad. After six months of research, the selection and configuration strategy of emergency equipment in ambulances was finally formulated. There are mainly the following aspects.

(1) Shock resistance and fall resistance of the equipment.

Due to the bumpy road in the ambulance emergency transfer process, the emergency equipment is always in a state of vibration. If there is an accident, the equipment may fall, and it is inevitable to fall and knock when the equipment is moved from the ambulance to the rescue site. Therefore, the shock resistance and fall resistance of the equipment should be considered first in the selection process of emergency equipment in ambulances.

(2) Anti-electromagnetic interference of the equipment

In addition to emergency equipment, there are various kinds of communication equipment and broadcasting equipment in the ambulances, which are easy to produce electronic interference. Therefore, the characteristics of anti-electromagnetic interference must be considered during the selection of emergency equipment, so as to avoid the possibility of misdiagnosis due to the influence of electromagnetic interference on the examination and monitoring results [4,5].

(3) The simplicity and usability of the equipment

Because the task of rescuing patients is urgent, the operation of emergency equipment needs to be simple and easy, and the rescue operation of patients should be carried out without special cumbersome settings. If the operation of the equipment is too complicated, it is easy to lead to misoperation in the tense rescue process, and the effective rescue cannot be performed.

(4) The portability of the equipment

Since there is limited space in the ambulances, but a lot of emergency equipment needs to be placed inside the ambulance, so the emergency equipment should be as small as possible and not take up too much space. After reaching the nearest location from the rescue site that the vehicle can reach, medical

staff often need to carry the emergency equipment to the rescue site over a long distance, especially for the rescue of patients after disasters. Due to the serious damage of infrastructure such as roads after disasters, medical staff need to manually carry emergency equipment to the site where patients were injured for rescue. In this process, the physical and energy of medical staff might be consumed a lot. In order to reduce the physical burden of medical staff, the purchase of emergency equipment must consider portability. Emergency equipment should be small in size, light in weight and easy to carry [6].

(5) The equipment should be multi-functional

Some critical patients need multiple emergency equipment for coordinated treatment, such as electrocardiographs, monitors, defibrillators, pacemakers, etc. If multi-functional all-in-one equipment with these functions can be selected, the storage space in the ambulances can be greatly saved and a lot of physical consumption caused by medical staff carrying multiple equipment to the rescue site can be avoided.

(6) The equipment should have network function

With the network function, emergency equipment can timely transmit the examination data to the corresponding departments in the hospital for timely analysis and diagnosis, so as to give the corresponding treatment to the patients at the fastest speed after the patients are transferred to the corresponding departments, so as to seize the best treatment opportunity of the patients to obtain the best treatment effect.

(7) Good after-sales service from equipment manufacturers

The quality of after-sales service of the equipment manufacturer is an important reference for deciding whether to buy the equipment of the manufacturer. Good after-sales service can ensure that the emergency equipment can be effectively solved in the first time after failures, so as to minimize the impact of equipment failures on the efficiency of rescuing patients.

2.2.2. Lean Management of Emergency Equipment in Ambulances

In order to reduce the failure rate of emergency equipment in ambulances, the lean management strategy of ambulance first aid equipment is formulated, which mainly includes the following aspects.

(1) Medical staff should receive regular training on the operation and simple maintenance of emergency equipment to continuously strengthen their operation and maintenance skills of emergency equipment.

(2) Establish the daily management system for emergency equipment by medical staff. Medical staff should manage emergency equipment according to the management system every day, including the maintenance of equipment, cleaning and disinfecting the surfaces of equipment, checking the start-up of the equipment, checking whether the batteries of the charging equipment are full, checking whether the oxygen cylinders are sufficient, checking whether equipment accessories are intact, checking whether the filter screens need to be cleaned or replaced, making regular quality control and calibration for emergency equipment, attaching the operating procedure instructions to the normally used emergency equipment, etc.

(3) The medical staff should take certain measures to ensure that the equipment is placed in a reasonable position in the ambulances and would not fall off after being fixed.

(4) Medical staff should clean and tidy the environment of the ambulance every day, they should ensure that the environment in the ambulance is neat and clean, and remove useless items in the ambulances in time to make the maximum available space for emergency equipment.

(5) The three-level preventive maintenance system for emergency equipment should be formulated. Medical staff, clinical medical engineers and equipment manufacturers should jointly take three-level preventive maintenance measures for emergency equipment. The first-level maintenance should be carried out by the medical staff on duty in the department, the second-level maintenance should be completed by clinical medical engineers, and the third-level maintenance should be completed by clinical medical engineers and the manufacturers' engineers.

(6) The regular inspection system for emergency equipment should be formulated. A supervision group consisting of personnel from the medical equipment department and the medical department, medical staff from other relevant clinical departments should regularly inspect emergency equipment of ambulances and record the inspection results.

(7) After the failures of the equipment, the record of the equipment failures should be made, and clinical medical engineers should be contacted in time to deal with it. During the maintenance period of the equipment failures, the emergency plan should be made before the new first aid task is received, and the replacement equipment of the fault emergency equipment should be prepared in advance.

(8) The ambulances should be equipped with a certain number of maintenance tools so that medical staff can deal with the emergency equipment in time when it has a simple failure.

2.3. Assessment Indicators

2.3.1. Comparison of Emergency Equipment Management Effects

Before and after the implementation of optimizing selection and configuration combined with lean management measures, the management situation of emergency equipment before the execution of ambulance missions for 60 days was counted. The statistics included the times of ambulance missions performed in 60 days, the times of emergency equipment with incomplete accessories, the times of emergency equipment with stains on surfaces and the times of all emergency equipment passed in one inspection.

2.3.2. Comparison of Emergency Equipment Failures after the Execution of Ambulance Missions

Before and after the implementation of optimizing selection and configuration combined with lean management measures, the emergency equipment failures after the execution of ambulance missions for 90 days were counted, including the times of ambulance missions performed in 90 days, the times of failures caused by emergency equipment falling or bumping, and the times of emergency equipment affected by electromagnetic interference.

2.4. Statistical Analysis

The above data were input into SPSS20.0 software for processing. All the above data were enumeration data, represented by [N (%)], and analyzed by chi-square test. $P < 0.05$ indicated statistical significance.

3. Results

3.1. Comparison Results of Emergency Equipment Management Effects

Before and after the implementation of optimizing selection and configuration combined with lean management, the statistical results of emergency equipment management effects are shown in Table 1 below. It can be seen that after the implementation of management measures, the incidence of emergency equipment with incomplete accessories, and the incidence of emergency equipment with stains on surfaces decreased significantly ($\chi^2=5.701$, $\chi^2=10.865$; $p < 0.05$), the incidence of all emergency equipment passed in one inspection was significantly increased ($\chi^2=4.082$; $P < 0.05$).

Table 1: Statistics on the management of emergency equipment before the ambulances' missions [n(%)]

Group	n	Times of emergency equipment with incomplete accessories	Times of emergency equipment with stains on surfaces	Times of all emergency equipment passed in one inspection
Before	547	42(7.68)	81(14.81)	523(95.61)
After	556	5(0.90)	9(1.62)	556(100.00)
χ^2	-	5.701	10.865	4.082
P	-	0.017	0.001	0.043

3.2. Comparison Results of Emergency Equipment Failures after the Execution of Ambulance Missions

Before and after the implementation of optimized selection and configuration combined with lean management measures, the statistical results of emergency equipment failures after the execution of ambulance missions are shown in Table 2 below. It can be concluded that after the implementation of management measures, the incidence of failures caused by emergency equipment falling or bumping,

and the incidence of emergency equipment affected by electromagnetic interference decreased significantly ($\chi^2=4.688$, $\chi^2=4.082$; $P < 0.05$).

Table 2: Statistics on failures of emergency equipment after the execution of ambulance missions[n(%)]

Group	n	Times of failures caused by emergency equipment falling or bumping	Times of emergency equipment affected by electromagnetic interference
Before	1072	71(6.62)	48(4.48)
After	1105	9(0.81)	4(0.36)
χ^2	-	4.688	4.082
P	-	0.030	0.043

4. Discussion

The state of emergency equipment in the ambulance determines the flow of the rescue process and the success rate of the rescue. In recent years, due to the heavy task of rescuing critical patients, the pre-hospital emergency departments of many hospitals have been equipped with more and more high-end precision medical equipment for the rescue and treatment of critical patients. However, in the process of purchasing emergency equipment, the hospital would focus on the function and price of emergency equipment. The quality and performance of the ambulance emergency equipment purchased are comparable to that of the medical equipment in ordinary clinical departments. But the actual use environment needs of the ambulance emergency equipment are usually ignored, resulting in the large volume and heavy weight of the purchased equipment. Handling these emergency equipment brings a great challenge to the physical strength of the medical staff. At the same time, the performance of these equipment is unstable when it is actually used in the ambulance, and it is easy to be interfered by electromagnetic signals, and the situation of bumping and falling is also easy to cause equipment failures. If the actual use of emergency equipment in ambulances is taken into consideration in the procurement, the purchase strategy of optimizing configuration is adopted to purchase equipment that meets the actual needs of ambulance rescue, and the effective management method of emergency equipment is adopted to manage the emergency equipment, the failure rate of emergency equipment can be effectively reduced [7].

In this study, in order to improve the management level of ambulance emergency equipment, the pre-hospital emergency department and the medical equipment management department of a hospital in Xi'an firstly selected the emergency equipment most in line with the actual needs of rescuing patients through the optimizing selection and configuration strategy of emergency equipment in ambulances. Then the lean management strategy of emergency equipment was adopted and the management effect of emergency equipment was analyzed. In this process, medical staff cleaned and tidied emergency equipment every day, checked the start-up of emergency equipment, and carried out the first-level preventive maintenance of the equipment, and clinical medical engineers and manufacturers' engineers regularly carried out the second-level and the third-level preventive maintenance of emergency equipment, so that in the statistics of the management of emergency equipment before the execution of ambulance missions, the incidence of emergency equipment with incomplete accessories, and the incidence of emergency equipment with stains on surfaces decreased significantly ($\chi^2=5.701$, $\chi^2=10.865$; $p < 0.05$), the incidence of all emergency equipment passed in one inspection was significantly increased ($\chi^2=4.082$; $P < 0.05$). At the same time, as optimizing selection and configuration strategy was adopted in the procurement process of emergency equipment in ambulances, the purchased equipment had certain anti-fall, anti-vibration, anti-electromagnetic interference performance, so that in the statistics of the emergency equipment failures after the execution of ambulance missions, the incidence of failures caused by emergency equipment falling or bumping, and the incidence of emergency equipment affected by electromagnetic interference decreased significantly ($\chi^2=4.688$, $\chi^2=4.082$; $P < 0.05$).

5. Conclusions

In conclusion, in the management of emergency equipment in ambulances, the use of optimizing selection and configuration combined with lean management strategy can significantly improve the emergency equipment management effects before the execution of ambulance missions. At the same time, it can also significantly reduce emergency equipment failures after the execution of ambulance missions. This management measures can significantly improve the management quality of emergency equipment

in ambulances, and improve the quality and efficiency of the execution of ambulance missions. Optimizing selection and configuration combined with lean management strategy has certain effectiveness in emergency equipment management in ambulances.

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