

# *Application Value Analysis of Fishbone Diagram Analysis Method in Improving the Effect of Medical Equipment Management in Medical Equipment Deployment Center of Hospital*

Qinfeng Liu<sup>1</sup>, Hui Liu<sup>1</sup>, Tao Wang<sup>2</sup>, Enke Zhang<sup>1,\*</sup>

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

<sup>2</sup>Department of Medical Imaging, Hospital of Stomatology, Xi'an Jiaotong University, Xi'an Shaanxi, 710068, China

\*Corresponding author

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**Abstract: Objective** To explore the application value of fishbone diagram analysis in improving the management effect of medical equipment in medical equipment deployment center of hospital **Methods** Fishbone diagram analysis method was used to find the root cause of management problems in the medical equipment deployment center of a hospital in Xi 'an, and corresponding improvement measures were formulated. The management effect after the implementation of improvement measures was analyzed. **Results** In the comparison of management effects of equipment to be deployed, after the implementation of the improvement measures of fishbone diagram analysis method, the ratio of times of equipment to be deployed with stains on surfaces and the ratio of times that equipment to be deployed not fully charged in the deployment center decreased significantly ( $\chi^2=13.075$ ,  $\chi^2=11.060$ ;  $p < 0.05$ ), the ratio of times that equipment to be deployed passed in one test increased significantly ( $\chi^2=10.526$ ;  $p < 0.05$ ); in the comparison of satisfaction survey of medical staff, after the implementation of improvement measures of fishbone analysis method, the satisfaction with the deployment equipment services of clinical medical engineers, the satisfaction with the use of deployment equipment and the overall satisfaction of medical staff with the deployment work were significantly improved ( $t=17.563$ ,  $t=-4.806$ ,  $t=-17.928$ ;  $P < 0.05$ ). **Conclusions** Fishbone diagram analysis method can improve the management and use effect of the equipment to be deployed, and significantly improve the overall satisfaction of medical staff with the deployment work. Fishbone diagram analysis method has high application and promotion value in the equipment management of medical equipment deployment center in hospitals.

## 1. Introduction

The medical equipment deployment center of hospital, which is part of the medical equipment

management department, is responsible for renting medical equipment to clinical departments that are under equipped due to a sudden increase in the number of patients. The types of equipment in the medical equipment deployment center mainly include monitors, infusion pumps, injection pumps, ventilators, defibrillators, and islet pumps, etc. In the medical equipment management of the deployment center, since the medical equipment is moved from the deployment center to many clinical departments, the equipment has to undergo the operation and management of clinical medical engineers and medical staff of different clinical departments. As a result, the failure rate of the medical equipment in the deployment center is high, the surface of the equipment is dirty, and medical accessories are easy to be lost or damaged. At the same time, the equipment is used in the department for a long time after being rented out without returning, which affects the use efficiency of the medical equipment resources.

Fishbone diagram, also known as causal diagram, is a method to find the root cause of a problem [1]. It takes the discovered problems as the fish head, and direct causes of the problem are found out through the five factors of man, machine, material, method and milieu. Then the root causes of the problems are found out from direct causes. Furthermore, corresponding improvement measures according to the root cause are formulated, so as to achieve the purpose of improving the problem phenomenon [2-5]. In order to improve the management effect of medical equipment in the medical equipment deployment center, a hospital in Xi 'an adopted fishbone diagram analysis method in the management of medical equipment. This study compared and analyzed the management effect of medical equipment in the medical equipment deployment center of hospital by fishbone analysis method.

## **2. Research materials and methods**

### **2.1. Research materials**

The medical equipment deployment center of a hospital in Xi 'an has been established for 15 years. There are 3 clinical medical engineers in charge and 154 sets of medical equipment, including monitors, infusion pumps, injection pumps, islet pumps, ventilators and defibrillators. In this study, all the medical devices in the medical equipment deployment center were selected as the research objects.

### **2.2. Research methods**

The equipment to be deployed in the medical equipment deployment center of the hospital is stored in the deployment center, and 3 clinical medical engineers are specially responsible for the deployment work. The deployment center has the management system software of deployment equipment, and all the information of deployment equipment in the account is recorded in the system database, and the special equipment labels of the deployment center are affixed on the equipment. Each clinical department is equipped with a medical equipment rental card. When the clinical department needs to rent equipment, medical staff brings the equipment rental card to the medical equipment deployment center, and engineers of the deployment center find out the equipment needed by the department, then they scan the two-dimensional code on the rental card with a scanning gun to enter the corresponding department management page, and they scans the two-dimensional code on the label of the equipment to indentify the deployment of the equipment. When the department returns the equipment, the medical staff will send the equipment to the deployment center, and the clinical medical engineers will check the status of the equipment, and then they scan the two-dimensional code on the equipment to confirm that the equipment is back to deployment center. During the renting period, the deployment system automatically records the

renting time, and deducts the department cost according to the renting time.

### **2.2.1. Find the problem**

The CQI (Continuous Quality Improvement) team of the deployment center was established, which was composed of personnel from the medical equipment management department, medical department and clinical department [6]. The CQI team members firstly summarized the medical equipment management problems of the medical equipment deployment center of the hospital in the past two years, mainly including the following aspects. (1) There were many stains on the surface of medical equipment; (2) high failure rate of medical equipment; (3) medical equipment accessories were damaged, lost or replaced by accessories that did not belong to the deployment center; (4) the medical equipment was used for a long time after being transferred to a clinical department and was not returned in time; (5) the equipment was not repaired in time after failure; (6) some medical staff were unfamiliar with the operation of the deployment equipment; (7) the deployment centre had spare medical equipment but no corresponding accessories.

### **2.2.2. The direct cause of the problem**

For the above problems found in the medical equipment deployment center, the CQI team members summarized the direct causes of five factors including man, machine, material, method and milieu through investigation and data consulting [7].

#### **1) Man**

In terms of man factor, it mainly includes: (1) lack of care for the medical equipment rented from the deployment center, resulting in bumps and accessories damage during use; (2) unfamiliarity with the operation of the medical equipment rented from the deployment center led to equipment failure due to misoperation; (3) the number of engineers in the deployment center was relatively small, which led to the failure of timely repair after equipment failure.

#### **2) Machine**

In terms of man factors, it mainly includes: (1) the aging of medical equipment in the deployment center due to its long service life; (2) the medical equipment in the deployment center was not calibrated in time, leading to problems in use; (3) the equipment was not cleaned and maintained, resulting in a high failure rate of equipment; (4) the reliability of the equipment itself was insufficient, resulting in the equipment being prone to failure due to vibration and other factors in the process of handling.

#### **3) Material**

In terms of material factors, it mainly includes: (1) the deployment center did not prepare sufficient equipment accessories or consumables, so that some equipment could not be used without corresponding accessories or consumables, resulting in equipment idling; (2) equipment accessories or consumables in the deployment center were not clearly marked, when the equipment was lent to the clinical department, medical accessories or consumables of the equipment were transferred to other equipment for use, which led to the loss of accessories or consumables; (3) in the process of transferring the equipment from the deployment center to the clinical departments, the cart used for the transfer was unstable, which caused the equipment to fall, resulting in equipment damage.

#### **4) Method**

In terms of method factors, it mainly includes: (1) the equipment management and use system of the deployment center was not perfect, which led to the non-standard use of deployment equipment by medical staff of clinical departments and the non-standard management of deployment equipment by clinical medical engineers; (2) lack of preventive maintenance system for deployment equipment; (3) lack of regular measurement and calibration system for deployment equipment; (4)

the unit time cost of deployment equipment for clinical departments was too low, which made departments insensitive to the cost of deployment equipment, the rented equipment is not returned by the clinical departments for a long time, affecting the turnover rate of deployment equipment.

#### 5) Milieu

In terms of milieu factors, it mainly includes: (1) there was a lot of dust in the storage environment of the equipment in the deployment center and the use environment of the equipment in the clinical departments, dust particles enter the equipment from the heat dissipation hole and adhere to the circuit control board, causing instability of the equipment performance and even equipment failure; (2) when medical staff used carts to transport the equipment between the deployment center and clinical departments, the roads inside the hospital were uneven, resulting in severe vibration, jolting, and falling of the equipment during the transport process, leading to equipment failure; (3) Electromagnetic interference existed in the use environment of clinical departments, resulting in deviation of equipment detection results.

### 2.2.3. Determine the root cause of the problem

The direct causes of these problems were arranged on the fishbone diagram. After in-depth summary and analysis, the CQI team members qualitatively summarized the root causes of the problems [8], including the following aspects: (1) medical staff did not have a strong sense of responsibility for the management and use of the deployment equipment; (2) clinical medical engineers did not actively manage the equipment in the deployment center; (3) the equipment management and use system of the deployment center is not perfect.

### 2.2.4. Formulate improvement measures

In view of the direct and root causes of the above problems, corresponding improvement measures were formulated from the five aspects of man, machine, material, method and milieu.

1) in the aspect of method factors, the main measures include: (1) establish the management and use system of medical equipment in the deployment center, standardizing the management behavior of clinical medical engineers and medical staff on deployment equipment; (2) establish the preventive maintenance system of the equipment in the deployment center, and clinical medical engineers should carry out the preventive maintenance of equipment in the deployment center; (3) establish the regular measurement and calibration system of deployment equipment, and clinical medical engineers should be responsible for regular contact to measure and calibrate the equipment; (4) change the deployment center system to moderately increase the rental rate per unit time, in which a gradual rate system would be adopted, the longer the rental time, the higher the rate per unit time.

2) In the aspect of man factors, the main measures include: (1) clinical medical engineers should check and count medical equipment every day, they should clean and disinfect the surface of the equipment, check the startup of the equipment, check whether the batteries of equipment are fully charged and whether the equipment is faulty, check the integrity and functional integrity of medical accessories, and place the faulty equipment in the fault maintenance area for treatment, they should register the damaged or missing accessories and get new accessories from accessory warehouse for use, and they should also place the checked normal equipment and accessories in the equipment deployment area and arrange them neatly according to the equipment type; (2) clinical medical engineers should regularly carry out preventive maintenance on the equipment, replace the aging consumables inside the equipment, clean the filter screen in time, check and eliminate the hidden safety risks inside the equipment; (3) increase the number of clinical medical engineers in the deployment center to ensure that faulty equipment can be handled in time; (4) medical staff should

be trained on the operation and use of the equipment in the deployment center :(5) medical staff and clinical medical engineers should be trained on staff literacy to improve personal literacy and improve the consciousness of active management.

3) In the aspect of machine factors, the main measures include:(1) the equipment with frequent failures in the deployment center should be removed from the deployment area and no longer used as the deployment equipment; (2) timely measurement and calibration of equipment; (3) carry out preventive maintenance of the equipment.

4) In the aspect of material factors, the main measures include:(1) engineer in charge should prepare sufficient equipment accessories and consumables in accessory warehouse in advance, and should replenish the inventory in time according to the consumption; (2) equipment accessories or consumables of the deployment center should be marked with obvious equipment marks of the deployment center to prevent loss; (3) Each clinical department should be equipped with a special transport cart for deployment equipment transport, which have shock absorption property, and should be regularly inspected for damage.

5) In the aspect of milieu factors, the main measures include:(1)clean and dedust the environment of the storage area of the deployment center, and require the clinical department to clean and tidy up the ward environment in time; (2) level and repair the roads inside the hospital, and plan the in-hospital transportation route for deployment equipment transport; (3) for areas where there is electromagnetic interference in the ward environment, find out the sources of interference, and take certain shielding measures[9].

#### **2.2.5. Supervise implementation**

The CQI team supervised the implementation of medical equipment management improvement measures, and regularly organized inspections on the management of equipment in the medical equipment deployment center.

### **2.3. Evaluation indicators**

#### **2.3.1. Comparison of management effects of equipment to be deployed in medical equipment deployment center**

Before and after the implementation of fishbone diagram analysis method, the management and use of equipment to be deployed in the medical equipment deployment center for 30 days were counted, including the total use times of medical equipment to be deployed,times of equipment to be deployed with stains on surfaces, times that equipment to be deployed not fully charged, and times that equipment to be deployed passed in one test.

#### **2.3.2. Comparison of satisfaction of medical staff**

Before and after the implementation of fishbone diagram analysis, 45 medical staff who had rented equipment from the deployment center and used deployment equipment in clinical departments were randomly selected to conduct a satisfaction survey on them. The content of the satisfaction survey included the satisfaction with the deployment equipment services of clinical medical engineers and the satisfaction with the use of deployment equipment. The full score of the satisfaction survey was 100. The content of satisfaction survey in both aspects accounted for 50%.

### **2.4. Statistical analysis**

The above data were input into SPSS20.0 software for analysis. Among them, the equipment

management effect data were count data, which were analyzed by chi-square test, and the satisfaction survey data were measurement data, which were analyzed by t-test.  $P < 0.05$  indicates statistical significance.

### 3. Results

#### 3.1. Comparison results of management effects of equipment to be deployed in medical equipment deployment center

Before and after the implementation of fishbone diagram analysis method, the statistical results of the medical equipment to be deployed in the deployment center for 30 days are shown in Table 1 below. It can be concluded that after the implementation of the improvement measures of fishbone diagram analysis method, the ratio of times of equipment to be deployed with stains on surfaces and the ratio of times that equipment to be deployed not fully charged in the deployment center decreased significantly ( $\chi^2=13.075, \chi^2=11.060$ ;  $p < 0.05$ ), the ratio of times that equipment to be deployed passed in one test increased significantly ( $\chi^2=10.526$ ;  $p < 0.05$ ).

Table 1: Statistics on the equipment to be deployed in the medical equipment deployment center for 30 days before and after the implementation of the improvement measures [n (%)]

Group	n	Times of equipment to be deployed with stains on surfaces	Times that equipment to be deployed not fully charged	Times that equipment to be deployed passed in one test
Before	1213	236(19.46)	154(12.70)	1095(90.27)
After	1352	37(2.74)	13(0.96)	1348(99.70)
$\chi^2$	-	13.075	11.060	10.526
$P$	-	0.000	0.001	0.001

#### 3.2. Comparison of satisfaction of medical staff

Before and after the implementation of fishbone analysis method, the satisfaction survey results of 45 medical medical staff are shown in Table 2 below. It can be concluded that after the implementation of improvement measures of fishbone analysis method, the satisfaction with the deployment equipment services of clinical medical engineers, the satisfaction with the use of deployment equipment and the overall satisfaction of medical staff with the deployment work were significantly improved ( $t=-17.563, t=-4.806, t=-17.928$ ;  $P < 0.05$ )

Table 2: Comparison statistics of satisfaction survey of deployment work (score,  $\bar{x} \pm s$ )

Group	Satisfaction with the deployment equipment services of clinical medical engineers(score)	Satisfaction with the use of deployment equipment(score)	Overall satisfaction of medical staff with the deployment work(score)
Before	31.63±3.82	38.74±3.17	70.37±4.33
After	43.84±2.68	41.68±2.60	85.52±3.66
$t$	-17.563	-4.806	-17.928
$P$	0.000	0.000	0.000

### 4. Discussion

The medical equipment deployment center of hospital plays a role in regulating the use of medical equipment in clinical departments, which avoids the excessive purchase of medical equipment by some clinical departments. When the number of patients in clinical departments suddenly increases or patients have certain complications and need equipment with specific

functions, the problem can be solved by renting equipment directly from the medical equipment deployment center instead of requesting equipment from other clinical departments. Medical equipment deployment center can enhance the ability of clinical departments in hospital to respond to emergencies. At present, the development of medical equipment deployment center is still in the primary stage. The lack of effective management of equipment in the deployment center leads to many problems, such as high failure rate of equipment, high loss rate of equipment accessories, long-term non-return of deployment equipment rented by clinical departments, and low turnover rate of deployment equipment, which result in the lack of reasonable utilization of public medical equipment resources in hospitals.

In order to improve the equipment management effect of the medical equipment deployment center, the medical equipment deployment center of a hospital in Xi'an adopted fishbone diagram analysis method to analyze the equipment management and use problems of the deployment center. Firstly, the direct causes of the problems were found out from the five factors of man, machine, material, method and milieu, and then the root causes of the problems were obtained through deep qualitative analysis. Then the corresponding improvement measures were formulated according to the direct causes and root causes of the problems, which were supervised for effective implementation by CQI team. In the comparison of the management effects of the equipment to be deployed, clinical medical engineers checked and counted the deployed equipment every day, cleaned and disinfected the surface of the equipment, checked the startup of deployment equipment, checked whether the batteries of deployment equipment were fully charged, checked whether the equipment was faulty, and carried out preventive maintenance of deployment equipment. As a result, the ratio of times of equipment to be deployed with stains on surfaces and the ratio of times that equipment to be deployed not fully charged in the deployment center decreased significantly ( $\chi^2=13.075, \chi^2=11.060; p<0.05$ ), the ratio of times that equipment to be deployed passed in one test increased significantly ( $\chi^2=10.526; p<0.05$ ). At the same time, the working area of the deployment center was clean, the rental management and equipment maintenance of clinical medical engineers were in place, the medical equipment was maintained and corrected in time, and the medical equipment deployed to the clinical department was in good working condition and had a low failure rate. As a result, the satisfaction with the deployment equipment services of clinical medical engineers, the satisfaction with the use of deployment equipment and the overall satisfaction of medical staff with the deployment work were significantly improved ( $t=-17.563, t=-4.806, t=-17.928; P < 0.05$ ). The improvement measures of fishbone diagram analysis significantly improved the management and use effect of medical equipment in medical equipment deployment center of the hospital.

## 5. Conclusions

In the equipment management of the medical equipment deployment center of the hospital, fishbone diagram analysis method was used to find the root cause of management problems, and corresponding improvement measures were formulated. This method can improve the management and use effect of the equipment to be deployed, and significantly improve the overall satisfaction of medical staff with the deployment work. Fishbone diagram analysis method has high application and promotion value in the equipment management of medical equipment deployment center in hospitals.

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