

# Research on Application of PDCA Cycle Combined with Intensive Maintenance Quality Management Mode in Hospital Medical Equipment Maintenance Management

Qinfeng Liu<sup>1</sup>, Xianjiao Zhang<sup>2,\*</sup>, Enke Zhang<sup>1</sup>, Tao Wang<sup>3</sup>

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

<sup>2</sup>Scientific Research Management Department, Shaanxi Provincial People's Hospital, Xi'an Shaanxi, 710068, China

<sup>3</sup>Department of Radiology, College of Stomatology, Xi'an Jiaotong University, Xi'an Shaanxi, 710004, China

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**Abstract:** Objective To explore the application value of PDCA cycle combined with intensive maintenance quality management mode in hospital medical devices maintenance management. Methods In order to improve the maintenance management level of medical devices, PDCA cycle combined with intensive maintenance quality management mode was adopted in hospital medical devices maintenance, and the management efficiency of the maintenance quality management mode was verified. Results After PDCA cycle combined with intensive maintenance quality management mode, the stain-free rate of medical device surfaces and the integrity rate of maintenance registration information were significantly improved ( $t=37.425, t=21.218; P<0.01$ ), the pass rate of the first inspection was improved ( $t=5.684; P<0.05$ ). The maintenance quality satisfaction and maintenance timeliness satisfaction of medical staff to clinical medical engineers were significantly improved ( $t=-4.066, t=-6.902; P<0.01$ ). Conclusions PDCA cycle combined with intensive maintenance quality management mode can improve the quality and efficiency of maintenance service and improve the satisfaction of medical staff on maintenance service. PDCA cycle combined with intensive maintenance quality management mode is an effective method for hospital medical devices maintenance management.

**Keywords:** PDCA cycle, Intensive maintenance, Management efficiency.

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## 1. Introduction

With the development of medical technology, modern large hospitals have purchased all kinds of medical devices. Because of the large number of outpatient and inpatient patients in hospitals, some medical devices runs in clinical and medical technology departments for a long time without stopping, assisting medical staff to provide patients with examination, treatment, monitoring, life support and other kinds of diagnosis and treatment services[1]. These medical devices effectively reduce the work intensity of medical staff, improve the accuracy of diagnosis, improve the quality of life and survival time of patients, and play a huge role in medical health. How to manage these medical devices well in order to improve the start-up operation rate of medical devices and reduce the downtime is a difficult problem in front of the hospital management department. The medical equipment management department of a hospital is the department that manages the assets of medical devices in the whole hospital. It is responsible for the whole process management of the purchase, maintenance and scrapping of medical devices in the whole hospital[2]. Among them, the maintenance of medical devices is the focus of the work of the medical equipment management department. Efficient maintenance can effectively reduce the maintenance time of medical devices failure, reduce the maintenance cost of medical devices, improve the operation efficiency of clinical medical technology departments, better serve patients, and bring the improvement of the hospital's economic and social benefits[3].

In order to improve the maintenance management level of medical devices, the medical equipment department of a large hospital in Xi'an city, Shaanxi Province, China has added PDCA quality cycle management into the intensive

maintenance management. Intensive maintenance, as the name implies, is to transport some small and medium-sized malfunctioning medical devices to be repaired to the maintenance office of the medical equipment department for centralized and efficient maintenance and management on the premise of easy handling, so as to reduce maintenance costs and improve maintenance efficiency. PDCA quality cycle, also known as Deming cycle, was first proposed by Walter A. Shewhart, an American scientist, and recognized and promoted by Dr. W. Edwards Deming, a world-famous quality management expert[4]. It divides the quality management process into four stages: P(Plan), D(Do), C(Check) and A(Action). It is the basic method of efficient quality management in modern enterprises[5]. In recent years, some large hospitals in China have also used PDCA cycle quality management ideas, and achieved good management effects[6-8]. This study discusses the implementation and application of PDCA quality management combined with intensive maintenance management mode in this hospital, in order to verify the application value of this method in medical devices maintenance management.

## 2. Materials and Methods

### 2.1. Materials

The medical devices sent for repair within 60 days before and after the implementation of PDCA cycle combined with intensive maintenance management mode were taken as the research objects. The devices included multi-parameter monitors, infusion pumps, injection pumps, ventilators, air cushion bed pumps, extracorporeal vibration sputum extractor, ECG machines, etc.

## 2.2. Research Methods

The PDCA cycle is divided into four stages. The process and specific implementation methods of the application of PDCA cycle combined with intensive maintenance management mode in the maintenance management of the medical equipment department of the hospital are explained from these four stages.

### 2.2.1. P(Plan) Stage

In the planning stage, the Medical Equipment Management Department should hold a meeting to discuss the methods and implementation rules of PDCA cycle combined with intensive maintenance quality management, assign the responsibility of management and supervision to engineers, and formulate quantitative assessment measures.

Invite management experts to train engineers on PDCA quality management content to ensure that they understand the spiritual connotation of PDCA quality management system and are familiar with the operation and management process, so as to make full preparations for the implementation of PDCA quality management measures.

Invite medical device manufacturers to train engineers in maintenance skills, consolidate their basic maintenance skills, broaden their maintenance thinking and master the latest circuit maintenance technology.

Except for the first cycle, the problems encountered in the last cycle should be discussed in the Plan stage for each subsequent cycle and the rectification and implementation methods should be implemented in this cycle.

### 2.2.2. D(Do) Stage

In the Do stage, engineers should implement the requirements of intensive maintenance management mode and carry out effective implementation.

(1) After the medical staff send the faulty medical devices to the maintenance office, they should first place the devices in the registration and sorting area, and the engineers in charge of the area should test and check the devices. If the devices are normal and the failure phenomenon cannot be repeated, the medical staff should take away the medical devices in time to minimize the occupation of maintenance space and reduce the non-failure idle time of the devices; If there are some faults described by the medical staff of the test devices, the departments of the faulty devices, the device models, the host numbers of the devices, the fault phenomenon, and other information should be registered in time, and the devices should be placed in the fault area to be repaired, and the corresponding maintenance status signs should be hung.

(2) The engineers should classify and place all medical devices in the maintenance office. The faulty devices should be placed in the faulty devices area, hanging the red fault signs; the repaired devices should be placed in the repaired devices area, hanging the green normal use signs; the unreparable devices should be placed in the unreparable devices area, hanging the yellow signs to be scrapped. Medical devices in each area are placed according to device types and models. For the repaired medical devices, the engineers should contact the corresponding department staff to take them out in time according to the registration information, and record them in the equipment registration book. For the devices that cannot be repaired, the engineers should timely contact the department personnel to confirm the unreparable devices on site and apply for scrapping of them.

(3) The engineers should clean and tidy the environment

and devices in the maintenance office. The maintenance office is cleaned by the engineer on duty to ensure that the environment in the office is clean and dust-free. The surfaces of medical devices should be wiped with anhydrous alcohol to ensure that there is no stain on the surfaces of the devices. Meanwhile, the accessories should be sorted and placed in time.

(4) The engineers should register the consumption of accessories in the accessories area every day to master the stock and usage of all kinds of commonly used accessories on that day. The engineer on duty should timely report to the engineers in charge if the stock of commonly used accessories is insufficient, and replenish the stock timely, so as to reduce the waiting time for the purchase of maintenance accessories when the accessories are out of stock and improve the maintenance efficiency.

(5) For medical devices in the faulty devices area, engineers should first check the signs of the devices to determine whether the devices are within the warranty period. If the devices are within the warranty period, the engineers should contact the manufacturer's engineers for on-site maintenance or take away the devices for maintenance in time, and record the maintenance information of the devices manufacturer in the equipment register book. If the devices are out of warranty, engineers should check the operation manual and circuit schematic diagrams to find out the cause of the faults. If a fault cannot be solved, engineers should consult the engineer in charge or the engineer of the manufacturer to determine the cause of the fault. When high-value maintenance accessories need to be replaced, the engineers should timely report to the engineer in charge and the department director, and ask the manufacturer to appropriately reduce the price of the accessories through bidding or negotiation, so as to reduce the maintenance cost. After the devices are repaired by the engineers, the devices can be moved to the waiting area and green signs can be hung only after the on-site tests by the engineer in charge confirm that the medical devices are back to normal.

### 2.2.3. C(Check) Stage

The medical equipment management department should form a quality supervision group to supervise and evaluate the whole process of maintenance management by means of regular inspections and random sampling inspections.

### 2.2.4. A(Action) Stage

The department director, quality supervision group and all engineers should convene a maintenance quality management improvement meeting to summarize the problems found in this cycle, discuss the next rectification measures, and evaluate the implementation of the rectification plan of the last cycle in this cycle.

## 2.3. Implementation Effect Evaluation

### 2.3.1. Comparison of Quality Effect of Medical Devices Maintenance Management before and after the Implementation of Management Measures

Evaluate and record the status of 150 multi-parameter monitors processed by maintenance office engineers before and after the implementation of PDCA quality management combined with intensive maintenance management. The evaluation content included whether there were stains on the medical devices surfaces, whether the registration record information was complete, and the qualification of the first inspection, etc. The evaluation results were compared.

### 2.3.2. Comparison of Maintenance Service Satisfaction of Medical Staff before and after the Implementation of Management Measures

50 medical staff were randomly selected in clinical departments. Before and after the implementation of PDCA quality management combined with intensive maintenance management, a questionnaire survey was conducted on the satisfaction of the same group of medical staff on the maintenance of medical devices, and the results of the satisfaction survey were statistically analyzed.

### 2.4. Statistical Analysis Method

SPSS20.0 software was used for statistical analysis of the obtained data. The statistical data of 2.1 were statistical data, represented by n (%) and analyzed by Chi-square test; the statistical data of 2.2 were quantitative data, represented by  $\bar{x} \pm s$  and analyzed by T test.  $T < 0.05$  indicated that the difference was statistically significant, and  $t < 0.01$  indicated that the difference was significant.

**Table 1.** State Evaluation table of multi-parameter Monitor after repair before and after implementation of management measures (N (%))

Group	n	Stain-free rate of medical device surface	Integrity rate of maintenance registration information	Pass rate of the first inspection
Before	150	102(68.00)	112(74.67)	138(92.00)
After	150	143(95.33)	141(94.00)	147(98.00)
$\chi^2$	-	37.425	21.218	5.684
P	-	0.000	0.000	0.017

### 3.2. Comparison of Satisfaction of Medical Staff to Maintenance Service before and after the Implementation of Management Measures

The statistical analysis results of the maintenance service satisfaction survey of medical staff before and after the

## 3. Results

### 3.1. Comparison of Quality Effect of Medical Devices Maintenance Management before and after the Implementation of Management measures

The comparative statistical analysis of the implementation effect of medical devices maintenance management quality before and after the implementation of management measures is shown in Table 1. It can be concluded that after PDCA cycle combined with intensive maintenance quality management mode, the stain-free rate of medical device surfaces and the integrity rate of maintenance registration information were significantly improved ( $\chi^2=37.425, P=0.000$ ), the pass rate of the first inspection was improved ( $\chi^2=5.684; P < 0.05$ ).

implementation of management measures are shown in Table 2 below. It can be concluded that after the PDCA cycle combined with intensive maintenance quality management mode, the maintenance quality satisfaction and maintenance timeliness satisfaction of medical staff to clinical medical engineers were significantly improved ( $t=-4.066, t=-6.902; P < 0.01$ ).

**Table 2.** Comparison of maintenance service satisfaction of medical staff before and after the implementation of management measures (Score,  $\bar{x} \pm s$ )

Group	n	Maintenance quality satisfaction	Maintenance timeliness satisfaction
Before	50	87.40±4.98	84.35±5.18
After	50	90.69±2.81	90.29±3.20
t	-	-4.066	-6.902
P	-	0.000	0.000

## 4. Discussion

Medical devices is an important support for the medical level of modern large hospitals. Medical devices maintenance service is a necessary condition to ensure the normal operation of hospitals. If the medical equipment management department of a hospital does not carry out effective management on the maintenance of medical devices, it will cause the maintenance response is not timely, the time is too long, the maintenance cost is too high, the devices are shut down for maintenance for a long time, affecting the diagnosis and treatment services of the department, and even cause medical safety accidents[9]. Effective maintenance quality management is an important guarantee to improve maintenance quality, improve equipment opening rate, improve the operation efficiency of clinical departments and reduce the incidence of medical device adverse events[10].

In this study, due to the adoption of PDCA cycle combined with intensive maintenance quality management mode, the maintenance service quality and efficiency have been improved through strict supervision and continuous management improvement. The stain-free rate of medical device surfaces, the integrity rate of maintenance registration information were significantly improved, and the pass rate of the first inspection were improved. The maintenance quality satisfaction and maintenance timeliness satisfaction of medical staff to clinical medical engineers were significantly improved.

## 5. Conclusions

To sum up, PDCA cycle combined with intensive maintenance quality management mode can improve the quality and efficiency of maintenance services, and improve the satisfaction of medical staff on maintenance services.

PDCA cycle combined with intensive maintenance quality management mode is an effective method for hospital medical devices maintenance management.

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