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Application and Effects of Lean Management in the Management of Flexible Endoscopes

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Abstract: *Objective*: To evaluate the application value of lean management in the management of flexible endoscopes. *Methods*: From January to December 2023, routine management was implemented, and 200 flexible endoscopes used for examination and treatment were included in the control group; from January to December 2024, lean management was implemented, and 200 flexible endoscopes used for examination and treatment were included in the observation group. The average daily usage frequency, management effectiveness, and failure rate of flexible endoscopes were compared between the two groups. *Results*: The average daily usage frequency of flexible endoscopes in the observation group was higher than that in the control group ($P < 0.05$); the 3S retrieval rate and spot-check qualification rate of endoscopes in the observation group were higher than those in the control group ($P < 0.05$); the failure rate of flexible endoscopes in the observation group was lower than that in the control group ($P < 0.05$). *Conclusion*: Implementing lean management during the management of flexible endoscopes can improve the efficiency of endoscope retrieval, increase the average daily usage frequency of flexible endoscopes, and reduce endoscope failures.

Keywords: Flexible endoscope; Lean management; Management effectiveness

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1. Introduction

Flexible endoscopes are characterized by their flexibility, softness, and versatility, including bronchoscopes, gastroscopes, etc. However, flexible endoscopes are slightly more expensive. Due to the continuous increase in the number of patients undergoing endoscopic diagnosis and treatment, the difficulty of capital turnover in medical institutions has increased. Therefore, attention should be paid to the management of flexible endoscopes, ensuring proper cleaning and disinfection, and improving the operating efficiency of flexible endoscopes as much as possible. However, improper management of flexible endoscopes can lead to problems such as pollution and equipment damage, resulting in increased maintenance costs and wasted medical resources [1]. Conventional flexible endoscope management has issues such as irregular cleaning and disinfection procedures and incomplete

quality control measures. Lean management is a modern management strategy that requires managers to strive for excellence in every detail of their work. It can scientifically allocate medical resources and improve work efficiency, featuring practicality and inclusivity [2]. This article explores the value of lean management using 200 flexible endoscopes in 2023 and 200 flexible endoscopes in 2024 as samples.

2. Materials and methods

2.1. Materials

From January to December 2023, 200 flexible endoscopes for examination and treatment were included in the observation group under routine management. From January to December 2024, 200 flexible endoscopes for examination and treatment were included in the control group under lean management. Inclusion criteria: flexible endoscopes purchased within 6 years; complete records of endoscope manufacturers, usage, cleaning, and disinfection. Exclusion criteria: endoscopes meeting scrap standards; endoscopes purchased over 6 years ago.

2.2. Methods

2.2.1. Observation group

(1) Cultivating lean management awareness:

Regularly organize training for flexible endoscope managers to master lean management methods and stimulate their lean management awareness. Require managers to start with small things and strive for excellence in handling work details. Complete lean management knowledge training, combine it with clinical work situations, improve the flexible endoscope management process, and require all managers to participate in management to provide a basis for later management.

(2) Building a team:

The head nurse serves as the team leader, urging the orderly progress of various flexible endoscope management tasks; instrument nurses and cleaning nurses are team members, responsible for maintenance, cleaning and disinfection, recording endoscope usage and maintenance, etc.

(3) Implementing lean management measures:

(a) Sorting: Endoscope engineers detect all flexible endoscopes in medical institutions, immediately report losses for those with unrepairable faults, obsolete endoscopes, and long-unused endoscopes; timely repair endoscopes with repair value and complete numbering according to the endoscope type.

(b) Rectification: Reasonably plan the placement position of the flexible endoscope, make identifications for convenient location later. Design a material verification table and post it at the entrance of the endoscope storage department. Locate and store each endoscope, such as storing flexible endoscopes by zone according to laryngoscope, bronchoscope, enteroscope, gastroscope, and therapeutic endoscope, and assign a zone leader to manage the endoscope. Additionally, number all endoscopes and store them according to the number after clinical use to ensure consistency between the material verification table and the actual storage location of the endoscope.

(c) Cleaning: Regularly clean the endoscope workplace, immediately report any abnormalities of flexible endoscope equipment to prevent pollution. Perform bedside cleaning immediately after using the flexible endoscope, wipe the external dirt with an enzyme-containing gauze, continuously send water and air for 10s, change the waterproof cap, and then complete cleaning and disinfection

work according to the department's "Endoscope Cleaning and Disinfection Technical Operation Specifications", and draw an operation flowchart for operators to learn. Maintain the endoscope once a week, observe whether the flexible endoscope body is damaged, whether it can be normally filled with water and air, whether there is button looseness, and whether the endoscope movement angle is normal. Immediately repair if any of the above abnormalities are found. Additionally, thoroughly clean the flexible endoscope storage area once a week, disinfect the air once a week, and maintain the cleanliness of the flexible endoscope storage area.

(d) Sustaining cleanliness: Maintain the clean state after cleaning, immediately identify influencing factors, and summarize solutions once endoscope storage problems are found. Standardize and plan lean management methods, requiring all staff to strictly implement them.

(e) Accomplishment: All staff participate in lean management, maintaining the cleanliness and tidiness of the work environment. Additionally, clarify the significance of applying lean management methods during flexible endoscope management, as well as the important value of functional evaluation and cleaning and disinfection quality assessment of flexible endoscopes to ensure normal endoscope operation, so that staff consciously comply with various systems.

2.2.2. Control group

Complete flexible endoscope cleaning and disinfection work according to department regulations, and implement management plans based on endoscope center management and maintenance requirements, namely, "who uses, who is responsible." Regularly check the function of flexible endoscopes, promptly address abnormalities, and truthfully record various repairs and maintenance of flexible endoscopes. Additionally, if a fault occurs during the use of the flexible endoscope, report it immediately for repair.

2.3. Observation indicators

(1) Usage of flexible endoscopes: Before using the flexible endoscope, medical staff scanned the QR code on the endoscope, which automatically generated and recorded the operator's name and usage time. Subsequently, the tracing system is utilized to retrieve the usage records of each endoscope, and the average daily usage frequency was calculated.

(2) Management effectiveness of flexible endoscopes: The retrieval rate of endoscopes within 3s and the qualification rate of random endoscope inspections are calculated.

(3) Failure rate of flexible endoscopes: The failure locations of the flexible endoscopes are recorded, and the failure rate is calculated.

2.4. Statistical analysis

Data are processed using SPSS 23.0. Count data are tested using the chi-square test (recorded as %), and measurement data are tested using the t-test (recorded as $\overline{X} \pm s$). There are comparative differences with $P < 0.05$.

3. Results

3.1. Usage of flexible endoscopes

The average daily usage frequency of flexible endoscopes in the observation group (4.41 ± 0.11 times) was higher

than that in the control group (4.29 ± 0.09 times), with a t-value of 11.9404 and $P < 0.05$.

3.2. Management effectiveness of flexible endoscopes

The retrieval rate of endoscopes within 3s and the qualification rate of random endoscope inspections in the observation group were 99.50% and 100.00%, respectively, which were higher than those in the control group (90.00% and 95.00%, respectively), with $P < 0.05$. Refer to **Table 1** for details.

Table 1. Analysis of management effectiveness of flexible endoscopes (n,%)

Group	Endoscopic 3s find rate	Endoscopic inspection pass rate
Observation group (n=200)	199(99.50)	200(100.00)
Control group (n=200)	180(90.00)	190(95.00)
X^2	18.1430	10.2564
P	0.0000	0.0014

Failure rate of flexible endoscopes: The failure rate of flexible endoscopes in the observation group was 1.50%, which was lower than that in the control group (10.50%), with $P < 0.05$. Refer to **Table 2** for details.

Table 2. Analysis of failure rate of flexible endoscopes (n,%)

Fault location	Observation group (n=200)	Control group (n=200)
Vertical angulation section	1(0.50)	3(1.50)
Horizontal angulation section	0(0.00)	4(2.00)
Cap	0(0.00)	2(1.00)
Light guide tube	0(0.00)	2(1.00)
Distal lens	1(0.50)	2(1.00)
Angulation rubber	0(0.00)	1(0.50)
Nozzle	0(0.00)	1(0.50)
Insertion tube seal/O-ring	0(0.00)	1(0.50)
Electrical connector flex	0(0.00)	1(0.50)
Button	1(0.50)	1(0.50)
Insertion tube	0(0.00)	1(0.50)
Drum wheel wire	0(0.00)	1(0.50)
Electrical connector pins	0(0.00)	1(0.50)
Total	3(1.50)	21(10.50)

4. Discussion

Flexible endoscopes have complex structures and special material characteristics. The insertion part is made of flexible materials such as polyurethane and silicone, which can enter the patient's body through natural cavities, and the endoscope head can be bent at multiple angles, facilitating operation by physicians. Additionally, when

a lesion is detected with a flexible endoscope, instruments such as hemostatic clips and biopsy forceps can be directly inserted to complete diagnostic and therapeutic procedures in an integrated manner, resulting in high utilization rates in medical institutions. In the "Top 10 Health Technology Hazards in 2022" report published in the United States, medical care risks were analyzed, and for the first time, inadequate supply of medical devices was included, highlighting the importance of managing flexible endoscopes [3]. With the advent of the "super endoscope" era, flexible endoscopes have been widely used in clinical examination and surgical treatment, leading to increased workload and higher technical requirements in endoscopy centers. During routine flexible endoscope management, issues such as non-standard operation, lack of cooperation, and negative management attitudes among staff often arise, resulting in poor quality of flexible endoscope management [4].

Lean management is a modern management strategy that requires all staff to participate in daily management activities. It actively mobilizes staff to identify and resolve flexible endoscope failures proactively, making the storage, cleaning, disinfection, and retrieval of flexible endoscopes more streamlined and standardized. This simplifies the quality management of flexible endoscopes and avoids the influence of human factors on disinfection quality [5]. The application of lean management in flexible endoscope management can improve endoscope turnaround efficiency and reduce waiting times for patients undergoing flexible endoscope diagnosis and treatment. Reasonable storage and allocation of flexible endoscope resources during management can reduce equipment idle time. Improving processes such as maintenance, disinfection, and cleaning of flexible endoscopes ensures that staff operations are based on evidence, thereby avoiding equipment failures caused by non-standard operations.

Lean management also ensures that endoscopes are arranged in a specific order, facilitating precise positioning of flexible endoscopes by staff and improving work efficiency. Regular repair and maintenance of endoscopic equipment during the management period, as well as prompt resolution of potential risks associated with flexible endoscope use, can avoid endoscope damage due to improper maintenance or use, thereby reducing the difficulty of endoscope maintenance and repair costs. Dynamically adjusting inventory based on the actual situation of the medical institution during the management period can avoid shortages or excess idle issues with flexible endoscope equipment. Requiring staff to complete cleaning and disinfection work in a standardized manner during the management period can avoid infection incidents in various stages and reduce endoscope-related infections [6, 7]. Additionally, during lean management, regular training of flexible endoscope management staff enables them to master lean management methods and stimulates their awareness of lean management, thereby avoiding quality fluctuations caused by human factors [8].

Based on the data analysis in this paper, the average daily usage frequency of flexible endoscopes in the observation group (4.41 ± 0.11) was higher than that in the control group (4.29 ± 0.09). The 3-second retrieval rate of endoscopes in the observation group was 99.50%, and the pass rate of endoscope spot checks was 100.00%, which were higher than the 90.00% and 95.00% in the control group, respectively ($P < 0.05$). The reason for this is that during routine management, there was insufficient attention paid to the storage management of flexible endoscopes, with no labeling of each endoscope and no prominent signs in each storage area, leading to reduced turnover efficiency and difficulty in retrieval. During lean management, endoscopes were stored according to their types, and prominent signs were posted in the storage room, which facilitated staff in verifying materials and accurately locating endoscopes, thus enabling correct retrieval of flexible endoscopes within 3 seconds and improving work efficiency [9].

Additionally, after implementing lean management, regular maintenance and care of flexible endoscopes, as

well as emphasis on disinfection management, further improved the pass rate of endoscope spot checks [10]. The final set of data showed that the failure rate of flexible endoscopes in the observation group was 1.50%, which was lower than the 10.50% in the control group ($P < 0.05$). The reason for this is that after implementing lean management, training enabled management personnel to master the usage methods, performance, and maintenance knowledge of various flexible endoscope equipment. Regular maintenance and care allowed for early identification of potential damage issues, avoiding damage to endoscopes caused by water or air leaks in the tubing, thereby extending the service life of flexible endoscopes, reducing maintenance costs, optimizing endoscope performance, and facilitating the smooth progress of various diagnostic and therapeutic procedures [11].

5. Conclusion

In summary, the application of lean management during the management of flexible endoscopes can improve the turnover rate, reduce failure rates, and also enhance the 3-second retrieval rate and the pass rate of endoscope spot checks. Therefore, it is worthy of promotion.

Disclosure statement

The authors declare no conflict of interest.

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