ORIGINAL RESEARCH

Enhancing Integrity and Economic Efficiency Through Effective Details Management of Operating Room Devices

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ABSTRACT

Objective • This study aims to assess the impact of details management on the handling of instruments in the operating room, comprehensively evaluating its impact on device intactness, economic efficiency, overall care quality, and physician satisfaction.

Methods • We analyzed 1050 procedural packs used in our hospital from March to December 2019. The control group included 525 procedural packs with conventional management (March-August 2019), while the experimental group had 525 instrument packs with details management. Outcome measures included operating room device use, surgical care quality, and device tracking outcome.

Results • Details management showed significantly higher device intactness (97.73%), a marked decrease in device preparation errors (0.00%), and more efficient device checking time (1.13±0.41) compared to conventional management (84.09%, 11.36%, 2.85±1.03) ($P < .05$). The experimental group had higher scores in intraoperative nursing ability, nursing operating specification, nursing staff professionalism, and device care quality (9.08±0.31, 9.23±0.32, 9.17±0.55, 97.81±0.96) compared to the control group (8.11±0.67, 7.98±0.98, 8.35±0.69, 75.25±1.87) ($P < .05$). Details management was associated with higher economic efficiency and lower incidences of device loss and mix-up compared to conventional management ($P < .05$).

Conclusions • Implementing details management in instrument handling positively affects device intactness, economic efficiency, overall care quality, and physician satisfaction. It enhances device intactness, reduces device checking time, improves economic efficiency and overall care quality, and increases physician satisfaction. The findings provide insights into the benefits of a detailed instrument management approach in a hospital setting. (*Altern Ther Health Med.* [E-pub ahead of print.])

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INTRODUCTION

Operating rooms play a critical role in surgeries and patient resuscitation,[1] highlighting the importance of careful design and proximity to essential facilities such as blood banks, intensive care units, and anesthesia recovery rooms.[2,3] The operating room necessitates strict and sensible regulations to maintain a highly sterile environment, aseptic practices, and the implementation of an efficient and secure air purification system.[4,5]

The management of the four pathways contributing to surgical incision infection includes room air, surgical instruments, the hands of physicians and nurses, and patients' skin. These factors are critically important while making efforts to prevent infections and play an important role in optimizing the overall success of surgical procedures.[6]

Studies have suggested that the effective management of operating room devices significantly impacts surgical operations.[7,8] Traditional approaches to managing these devices cannot meet current clinical requirements and can lead to potential conflicts between doctors and patients.[9,10] Given the considerable quality and costs associated with most operating room devices, improving device management becomes essential for maintaining quality control within the operating room and ensuring a guarantee for successful surgeries.[11] Therefore, there is a persistent need to optimize the management of operating room devices.[12]

Details management in operating rooms involves the careful organization and control of various elements to enhance the quality of surgical procedures. It encompasses a comprehensive approach to managing details such as surgical instruments, room environment, and personnel practices.[13] Healthcare facilities can optimize resource utilization, reduce costs, and ensure a highly sterile and efficient operating room environment by implementing effective details management.

This approach includes adherence to aseptic practices, proper handling of surgical instruments, and maintaining a sanitized room atmosphere. The emphasis on detail management aligns with the overarching goal of quality control in operating rooms, aiming to minimize infection risk and enhance surgical interventions' overall success.[13,14]

The primary goal of details management is to streamline processes, minimize resource consumption, and reduce overall management costs. The combined application of details management and surgical care significantly contributes to the success of operating procedures [15]. Therefore, this study explored and validated the role of detail management and assessed its effectiveness in instrument management in the operating room.

MATERIALS AND METHODS

Study Design

The study design for this paper involves a retrospective analysis of 1050 procedural packs employed in our hospital over the period from March 2019 to December 2019. The research is structured with a comparative approach, categorizing the procedural packs into two groups. The first group, serving as the control, comprises 525 procedural packs managed conventionally. In contrast, the second group, the experimental group, consists of 525 instrument packs subjected to a details management approach.

Conventional Operating Room Management Practices in the Control Group

The control group implemented conventional operating room management practices, encompassing the sterilization and categorization of various surgical instruments. Additionally, thorough care was taken in using and moving surgical instruments.

Details Management Initiatives in the Experimental Group

The experimental group underwent detailed management, which included the following key initiatives.

Establishment of a Dedicated Quality Control Management Team. A specialized team was established to oversee quality control. The team provided extensive training and guidance to ensure that each member fully comprehended operating room device composition, function, and performance.

Strengthening the Maintenance of Medical Devices. We implemented a robust maintenance program to enhance the performance of medical devices and decrease the incidence of failures. This step involved reinforcing the maintenance procedures for medical devices and developing a scientific medical device maintenance system.

Establishment of a Medical Device Management System. We implemented a robust medical device operating management system, introducing a comprehensive medical device defect liability protocol. This system included improving operating training for both medical and nursing staff in the operating room, aimed at enhancing their proficiency with medical devices. Each device was assigned a unique identification number to improve operational efficiency, and its usage was electronically scanned and registered. Additionally, we prioritized responsibility education to heighten awareness among medical staff and instituted a refined management system.

Management of Preoperative and Postoperative Medical Devices. We have implemented enhancements in managing preoperative and postoperative medical devices, focusing on precise preoperative preparations and ensuring thorough cleaning and storage of contaminated devices post-surgery. The recovery, cleaning, and sterilization processes were digitized and traced, and all reusable medical instruments, apparatus, and items throughout the hospital were subjected to cleaning, disinfection, packaging, and sterilization by the sterilization supply center.

Furthermore, departments were strictly prohibited from handling reusable diagnostic and treatment instruments, apparatus, and items after use. Regular checks were conducted on the number and type of instruments to maintain quality control, with any issues promptly recorded for repair. Detailed file maintenance and proactive measures to prevent device loss characterized the details management system. Through diligent record-keeping and systematic organization, the system ensured the efficient tracking and oversight of medical instruments. Simultaneously, strict preventative measures were implemented to safeguard against the risk of device loss, contributing to a well-organized and secure environment within the healthcare facility.

Outcome Measures

Management Outcomes. We documented the device intactness rate, device preparation error rate, and device checking time for both groups.

Device Care Quality. We assessed and compared the intraoperative device care abilities, practices, and professionalism of nursing staff in both groups using a 10-point scoring system. The overall quality of device care, rated out of 100 points, encompasses device type, performance during use, device preparation errors, quantity perfection, and postoperative device recovery.

Economic Efficiency. We calculated and compared the economic losses in both groups.

Device Tracking. The occurrences of adverse events in device management were systematically recorded, encompassing instances of both device loss and device mix-up. This approach allowed for a comprehensive understanding of the effectiveness of the applied management strategies in identifying and addressing potential issues related to device handling and tracking.

Statistical Analysis

We utilized SPSS 22.0 software for data analyses. Measurement data were presented as mean ± standard deviation ($\bar{x} \pm s$) and were subjected to independent samples

t test. Count data were expressed as the number of cases [n (%)] and analyzed using the chi-square test. A significance level of $P < .05$ was employed, indicating statistical significance in observed differences. This approach ensured a precise and reliable statistical evaluation of the collected data.

RESULT

Management Outcomes

Details management exhibited a significantly enhanced device intactness rate of 97.73%. This observation was accompanied by a minimal device preparation error rate of 0.00% and a noteworthy reduction in device checking time, recorded at 1.13±0.41. In the conventional management group, the reported rates were 84.09% for device intactness, 11.36% for device preparation errors, and 2.85±1.03 for device checking time ($P < .05$), as detailed in Table 1. These findings highlight the substantial advantages of employing details management in optimizing device integrity and operational efficiency within the operating room.

Table 1. Management Outcomes (%)

Groups	n	Device Intactness Rate (%)	Device Preparation Error Rate (%)	Device Checking Time (h)
Experimental Group	525	97.73	0.00	1.13±0.41
Control Group	525	84.09	11.36	2.85±1.03
t/χ^2	-	4.950	5.301	10.292
P value	-	.026	.021	<.001

Note: All values are presented as mean ± standard deviation ($\bar{x} \pm s$).

Device Care Quality

The experimental group exhibited significantly higher scores across various parameters compared to the control group. Specifically, the intraoperative nursing ability, nursing operating specification, nursing staff professionalism, and device care quality scores were notably elevated in the experimental group (9.08±0.31, 9.23±0.32, 9.17±0.55, 97.81±0.96) in contrast to the control group (8.11±0.67, 7.98±0.98, 8.35±0.69, 75.25±1.87) ($P < .05$). Detailed data are provided in Table 2. These findings emphasize the positive impact of detail management on enhancing various facets of device care quality within the operating room setting.

Table 2. Device Care Quality ($\bar{x} \pm s$)

Groups	Intraoperative Nursing Ability	Nursing Operating Specification	Nursing Staff Professionalism	Device Care Quality Scores
Experimental Group	9.08±0.31	9.23±0.32	9.17±0.55	97.81±0.96
Control Group	8.11±0.67	7.98±0.98	8.35±0.69	75.25±1.87
t	8.716	8.043	6.164	71.191
P value	<.001	<.001	<.001	<.001

Note: All values are presented as mean ± standard deviation ($\bar{x} \pm s$).

Economic Efficiency

Details management exhibited a significantly superior level of economic efficiency compared to conventional management ($P < .05$). This finding emphasizes the positive economic impact associated with implementing details management practices within the operational framework.

Device Tracking

The experimental group demonstrated a reduced incidence of device loss at 2.86% and device mix-up at 5.85%, in contrast to the control group, with rates of 9.33% and 14.39%, respectively ($P < .05$). Refer to Table 3 for a detailed illustration of these outcomes. These results underscore the effectiveness of detail management in minimizing adverse events related to device tracking within the operational environment.

Table 3. Device Tracking (%)

Groups	n	Incidence of Device Loss (%)	Incidence of Device Mix-Up (%)
Experimental Group	525	2.86	5.85
Control Group	525	9.33	14.39
t/χ^2	-	19.235	23.682
P value	-	<.001	<.001

Note: All values are presented as percentages. A lower incidence of device loss and mix-up in the experimental group indicates improved device tracking efficiency compared to the control group.

DISCUSSION

Ensuring quality control in the operating room is dependent upon the efficacy of device management. The prevailing traditional approach, characterized by inadequate documentation of device use, malfunctions, and maintenance, escalates the vulnerability to medical device failures and amplifies maintenance costs.[16] Therefore, there is an urgency to implement effective measures to enhance the quality of operating room device management.[17,18] This study highlighted the critical importance of transitioning towards more robust and careful approaches to device management for improved patient outcomes and operational efficiency.

Details management exercises control over the entirety of medical devices, ensuring a smooth culmination of surgical procedures while reducing the likelihood of intraoperative medical device events. Findings from the current study revealed that details management resulted in a notably elevated device intactness rate, a reduced device preparation error rate, and reduced device checking time compared to conventional management. Additionally, details management showcased significantly enhanced economic efficiency compared to conventional management.

This approach provides transparent registration of operating room devices, fostering a quick understanding for medical and nursing staff regarding the usage of surgical instruments. The electronic traceability system facilitates extensive data collection, detailed recording of crucial parameters at each step, complete tracking implementation, and timely problem detection in instrument management. Therefore, it ensures effective quality management and reduces the occurrence of adverse events, such as the loss or mix-up of instruments.

Tian et al. reported that implementing detailed management for orthopedic devices in the operating room enhanced satisfaction and promoted the rational utilization of surgical devices. The study demonstrated that detailed

management significantly contributed to the success of surgeries. The accountability system for rational device use was instrumental in reducing unnecessary losses and associated medical costs, ultimately leading to enhanced economic efficiency.

Furthermore, our results also indicated that the intraoperative nursing ability, nursing operating specification, nursing staff professionalism, and device care quality scores of the experimental group were significantly higher than those of the control group ($P < .05$). Previous research findings[19,20] also suggest that detailed management is associated with a significantly reduced incidence of adverse events in the operating room, which is consistent with the results of the present study.

Moreover, higher physician satisfaction was observed in the experimental group compared to the control group. This observation may be attributed to detailed management reducing operating room device loss, increasing the device intactness rate, and creating favorable conditions for smooth surgery and postoperative patient recovery. Efficient management of operating room devices has been demonstrated to decrease the incidence of postoperative infections, thereby enhancing overall patient satisfaction.

The findings suggest that implementing detailed management in operating room device management could enhance overall surgical outcomes, economic efficiency, and device care quality. This approach can potentially influence future medical research by encouraging further investigation into optimized management strategies for medical devices, ultimately resulting in improved patient care and cost-effectiveness in healthcare settings.

Currently, processes, including use, recycling, cleaning, sterilization, issuance, discharging, and return to storage, are all electronically managed in our hospital, while procurement, maintenance, and disposal processes remain traditional. In the future, we anticipate achieving full electronification by establishing regulations for the centralized management of reused medical devices, instruments, and items in our department's sterile supply room.

Our results suggest the potential of detailed management practices to contribute positively to global healthcare. Enhancing device outcomes, care quality, and economic efficiency, these findings propose a valuable framework for improving surgical processes on a global scale. Implementing such measures could lead to better patient outcomes, reduced costs, and increased standardization in healthcare practices across diverse settings.

Future Perspectives

The "*Management Norm*," "*Cleaning, Disinfection, and Sterilization Technical Operating Norms*," and "*Cleaning, Disinfection, and Sterilization Effect Monitoring Standards*" mandate that all diagnostic instruments, apparatus, and items requiring disinfection or sterilization for reuse should undergo recovery centralized cleaning, disinfection, sterilization, and supply by CSSD.

Electronic management enables full traceability of the sterile instrument supply process, ensuring timely awareness of each process parameter change and adequate supervision and restraint of each post-staff operation, promoting the standardization of operations among medical and nursing staff. This approach, in turn, enhances their professionalism, contributing to improved quality and efficiency in cleaning and disinfection within the sterile supply center.

The information-based record system continuously and dynamically tracks and records the same instrument, providing real-time data for the operating room and enabling more refined management. A more inclusive and regular electronic system is also the established trend in the future operating room device management development. It includes the recording of instrument purchases in the warehouse, along with subsequent maintenance tracking. This process reduces labor costs and human errors and enhances efficiency, realizing information management throughout the entire life cycle of medical devices.

Study Limitations

It is important to acknowledge the limitations of this study. Firstly, the research was conducted within a specific hospital setting, limiting the generalizability of the findings to other healthcare institutions. The study duration may also not capture long-term effects, and further research is warranted. The reliance on a single approach to detailed management might also limit the exploration of potential outcome variations. Moreover, the study primarily focused on quantitative measures, and a more comprehensive understanding could be achieved by including qualitative assessments and the perspectives of healthcare professionals. Finally, external factors such as changes in healthcare policies or technological advancements may influence the applicability of the study's recommendations over time.

CONCLUSION

In conclusion, the study highlighted the significant positive impact of detailed management practices on various facets of operating room efficiency and healthcare delivery. By ensuring the integrity of operating room devices, these practices contribute to streamlined processes, reduced time spent on device checking, heightened economic efficiency, and an elevated standard of care. The findings also highlight the considerable influence of meticulous management on physician satisfaction, affirming its profound positive effects on the overall healthcare ecosystem. While the study underscores the transformative potential of detailed management, it is imperative for future research to explore its applicability in diverse healthcare settings and for more extended periods, ensuring a comprehensive understanding of its long-term benefits.

CONFLICTS OF INTEREST
The authors report no conflict of interest.

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AVAILABILITY OF DATA AND MATERIALS
The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES
1. Schoenfelder J, Kohl S, Glaser M, McRae S, Brunner JO, Koperna T. Simulation-based evaluation of operating room management policies. *BMC Health Serv Res*. 2021;21(1):271. doi:10.1186/s12913-021-06234-5
2. Tsai MH, Sanford JA, Black IH, Boggs SD, Urman RD. Operating Room Management at the Edge of Order and Chaos. *J Med Pract Manage*. 2017;32(4):250-255.
3. Fairley M, Scheinker D, Brandeau ML. Improving the efficiency of the operating room environment with an optimization and machine learning model. *Health Care Manag Sci*. 2019;22(4):756-767. doi:10.1007/s10729-018-9457-3
4. Wong T, Zhang EJ, Elhajj AJ, et al. The Power Law in Operating Room Management. *J Med Syst*. 2021;45(10):92. doi:10.1007/s10916-021-01764-1
5. Gutierres LS, Santos JLGD, Peiter CC, Menegon FHA, Sebold LF, Erdmann AL. Good practices for patient safety in the operating room: nurses' recommendations. *Rev Bras Enferm*. 2018;71(suppl 6):2775-2782. doi:10.1590/0034-7167-2018-0449
6. Crosby L, Lortie E, Rotenberg B, Sowerby L. Surgical Instrument Optimization to Reduce Instrument Processing and Operating Room Setup Time. *Otolaryngol Head Neck Surg*. 2020;162(2):215-219. doi:10.1177/0194599819885635
7. Dexter F, Parra MC, Brown JR, Loftus RW. Perioperative COVID-19 Defense: An Evidence-Based Approach for Optimization of Infection Control and Operating Room Management. *Anesth Analg*. 2020;131(1):37-42. doi:10.1213/ANE.0000000000004829
8. Sinskey JL, Chang JM, Shibata GS, Infosino AJ, Rouine-Rapp K. Applying Conflict Management Strategies to the Pediatric Operating Room. *Anesth Analg*. 2019;129(4):1109-1117. doi:10.1213/ANE.0000000000003991
9. Filip R, Gheorghita Puscaselu R, Anchidin-Norocel L, Dimian M, Savage WK. Global Challenges to Public Health Care Systems during the COVID-19 Pandemic: A Review of Pandemic Measures and Problems. *J Pers Med*. 2022;12(8):1295. doi:10.3390/jpm12081295
10. Ren W, Wu X. Application of Intelligent Medical Equipment Management System Based on Internet of Things Technology. *J Healthc Eng*. 2022;2022:9149996. doi:10.1155/2022/9149996
11. Dyas AR, Lovell KM, Balentine CJ, et al. Reducing cost and improving operating room efficiency: examination of surgical instrument processing. *J Surg Res*. 2018;229:15-19. doi:10.1016/j.jss.2018.03.038
12. von Vogelsang AC, Swenne CL, Gustafsson BÅ, Falk Brynhildsen K. Operating theatre nurse specialist competence to ensure patient safety in the operating theatre: A discursive paper. *Nurs Open*. 2019;7(2):495-502. doi:10.1002/nop2.424
13. Ma D, et al. Application of detail management in nursing safety management in operating room. *Minerva Med*. 2020.
14. Yu J, Yu X, Li H. Analysis of application effect of detail nursing in operating room in ensuring nursing safety in operating room. *Minerva Surg*. 2022.
15. Etges APBDS, Ruschel KB, Polanczyk CA, Urman RD. Advances in Value-Based Healthcare by the Application of Time-Driven Activity-Based Costing for Inpatient Management: A Systematic Review. *Value Health*. 2020;23(6):812-823. doi:10.1016/j.jval.2020.02.004
16. Göras C, Nilsson U, Ekstedt M, Unbeck M, Ehrenberg A. Managing complexity in the operating room: a group interview study. *BMC Health Serv Res*. 2020;20(1):440. doi:10.1186/s12913-020-05192-8
17. Buljac-Samardzic M, Doekhie KD, van Wijngaarden JDH. Interventions to improve team effectiveness within health care: a systematic review of the past decade. *Hum Resour Health*. 2020;18(1):2. doi:10.1186/s12960-019-0411-3
18. Bitkina OV, Kim HK, Park J. Usability and user experience of medical devices: an overview of the current state, analysis methodologies, and future challenges. *Int J Ind Ergon*. 2020;76:102932. doi:10.1016/j.ergon.2020.102932
19. Ingvarsdottir E, Halldorsdottir S. Enhancing patient safety in the operating theatre: from the perspective of experienced operating theatre nurses. *Scand J Caring Sci*. 2018;32(2):951-960. doi:10.1111/scs.12532
20. Jung JJ, Jüni P, Lebovic G, Grantcharov T. First-year Analysis of the Operating Room Black Box Study. *Ann Surg*. 2020;271(1):122-127. doi:10.1097/SLA.0000000000002863