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Reusable Medical Device Processing in Central Sterile Supply Departments: A Survey of Secondary and Tertiary Hospitals in Xiangtan City, China

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ABSTRACT: Objective This study conducted a cross-sectional survey to evaluate the cleaning, disinfection, and sterilization practices for reusable medical devices in the Central Sterile Supply Departments (CSSDs) of secondary and tertiary healthcare institutions in Xiangtan City, China. **Methods** An electronic questionnaire was distributed to the CSSDs of 46 secondary and tertiary hospitals in Xiangtan City, China. The questionnaire assessed key areas including basic institutional characteristics, equipment configuration, management and training, and operational model. **Results** Among the 46 surveyed CSSDs, high-temperature sterilizers and ultrasonic cleaners were universally available (100%), whereas low-temperature sterilizers were only present in 32.61% of facilities. CSSDs in tertiary hospitals demonstrated significantly higher proportions for low-temperature sterilizers, biological indicator incubators/readers, and automatic washer-disinfectors compared to secondary hospitals (χ^2 values: 13.278, 4.128, and 5.911, respectively; all P<0.05). Specialized training at the municipal level or above was reported by 54.35% of institutions, with all untrained staff located in private secondary hospitals. Only one quality management traceability system was implemented in two public hospitals (4.35%). Centralized in-house sterile supply was practiced by 29 hospitals (63.04%), while 17 (36.96%) utilized third-party providers. Of those with in-house supply, five (17.24%) planned to outsource within two years. **Conclusion** These findings suggest a significant gap in processing standards between hospital levels. To address this, informed policies should promote regional coordination and resource sharing to establish an efficient, standardized sterile supply model that ensures uniform quality across all institutions.

KEY WORDS: Medical institutions; Central Sterile Supply Department (CSSD); Reusable medical device; Current situation survey

Introduction

The Central Sterile Supply Department (CSSD) plays a critical role in healthcare facilities by ensuring the safe reprocessing and supply of reusable medical instruments[1]. Strict adherence to cleaning, disinfection, and sterilization protocols is fundamental for eliminating pathogens and preventing healthcare-associated infections[2]. Suboptimal practices in these processes can compromise patient safety and potentially trigger widespread infection incidents[3]. A systematic assessment of current CSSD operations is essential to evaluate and improve local standards. Therefore, the Xiangtan Sterile Supply Quality Control Center initiated a survey targeting CSSDs in all secondary and tertiary healthcare institutions within its jurisdiction. The objective was to elucidate the existing practices in reprocessing reusable medical devices, to inform standardization efforts and strengthen infection prevention measures.

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1 Subjects and Methods

1.1 Study subjects

This cross-sectional survey targeted the CSSDs within all secondary and tertiary healthcare institutions in Xiangtan City, Hunan Province, China. The inclusion criteria were as follows: (1) being a secondary or tertiary institution located in Xiangtan City; (2) having an established and operational CSSD; and (3) having the CSSD manager or designated personnel provide informed consent to participate. Institutions were excluded if they (1) did not respond to the survey within the designated period or (2) explicitly declined to participate.

1.2 Data collection

The survey was implemented jointly by the investigators and the Xiangtan Sterile Supply Quality Control Center. The data collection instrument was an electronic questionnaire hosted on the "Wenjuanxing" platform. The lead researcher managed the distribution and collection. Participation involved the CSSD manager completing the online form, which was set to accept only one response per IP address with compulsory completion of all items. A total of 53 institutions were contacted. After excluding seven that did not have a CSSD, 46 completed questionnaires were received, corresponding to a 100% response rate from eligible CSSDs.

1.3 Study domains

A standardized survey form developed by the Sterile Supply Committee of the Hunan Nursing Association was used[4]. The questionnaire encompassed four sections:

(1) Basic characteristics: including hospital level, mean daily outpatient visits, available beds, and mean daily surgical procedures.

(2) Equipment configuration: assessing the number of high- and low-temperature sterilizers, biological indicator incubators/readers, and automatic washer-disinfectors, as well as the availability of ultrasonic cleaners.

(3) Management and Training: evaluating the receipt of specialized staff training and the presence of an information-based traceability system.

(4) Operational model: covering the processing mode for reusable devices, methods for cleaning and disinfection, and practices for inspection and packaging.

1.4 Statistical analysis

Data analysis was conducted with IBM SPSS Statistics (Version 22.0). Descriptive statistics for categorical variables are presented as frequency counts and proportions (percentages). For inferential analysis, differences in proportions between groups were assessed using the Pearson chi-square (χ^2) test. Statistical significance was defined as a $P<0.05$.

2 Results

2.1 Basic characteristics

A total of 46 secondary and tertiary healthcare institutions in Xiangtan City, China, were included in this cross-sectional survey, comprising 8 tertiary and 38 secondary hospitals (Table 1).

2.2 Equipment configuration

Configuration proportions for key equipment items are detailed in Table 2. High-temperature sterilizers and ultrasonic cleaners were available in all surveyed institutions (100%). The proportion was notably lower for low-temperature sterilizers (32.61%). Notably, tertiary hospitals showed significantly higher configuration proportions than secondary hospitals for three specific pieces of equipment: low-temperature sterilizer, biological indicator incubator/reader, and automatic washer-disinfector (χ^2 values: 13.278, 4.128, and 5.911, respectively; all $P<0.05$).

2.3 Management and training

Staff in 25 out of 46 institutions (54.35%) had received specialized training. Notably, only 2 institutions (4.35%) were equipped with a quality management traceability system.

2.4 Operational model

The sterile supply models of sterile supply in these 46 healthcare institutions are summarized in Table 3. Centralized in-house processing was adopted by 29 institutions (63.04%), with 5 of these (17.24%) planning a transition to third-party outsourcing within two years. 17 institutions (36.96%) used an external

Table 1 Basic characteristics of 46 secondary and tertiary hospitals in Xiangtan City

Item		Tertiary Hospital (*n*=8)		Secondary Hospital (*n*=38)		Total (*n*=46)	
		Count	Proportion (%)	Count	Proportion (%)	Count	Proportion (%)
Mean daily outpatient visits	<100	1	12. 50	26	68. 42	27	58. 70
	100~	1	12. 50	11	28. 95	12	26. 09
	500~	3	37. 50	1	2. 63	4	8. 70
	1 000~	1	12. 50	0	0. 00	1	2. 17
	≥1 500	2	25. 00	0	0. 00	2	4. 35
Available beds	<100	0	0. 00	18	47. 37	18	39. 13
	100~	0	0. 00	8	21. 05	8	17. 39
	300~	2	25. 00	5	13. 16	7	15. 22
	500~	2	25. 00	6	15. 79	8	17. 39
	≥1 000	4	50. 00	1	2. 63	5	10. 87
Mean daily surgical procedures	No surgery	0	0. 00	11	28. 95	11	23. 91
	<10	1	12. 50	18	47. 37	19	41. 30
	10~	3	37. 50	8	21. 05	11	23. 91
	30~	2	25. 00	0	0. 00	2	4. 35
	≥50	2	25. 00	1	2. 63	3	6. 52

Table 2 Equipment configuration in 46 secondary and tertiary hospitals in Xiangtan City

Equipment Configuration	Tertiary Hospital (*n*=8)		Secondary Hospital (*n*=38)		Total (*n*=46)		χ^2	*P* value
	Count	Config. Proportion (%)	Count	Config. Proportion (%)	Count	Config. Proportion (%)		
High-temperature sterilizer	8	100. 00	38	100. 00	46	100. 00	—	—
Low-temperature sterilizer	7	87. 50	8	21. 05	15	32. 61	13. 278	<0. 001
Biological indicator incubator/reader	8	100. 00	19	50. 00	27	58. 70	4. 128	0. 042
Automatic washer-disinfector	8	100. 00	16	42. 11	24	52. 17	5. 911	0. 015
Ultrasonic cleaner	8	100. 00	38	100. 00	46	100. 00	—	—

Note: The dash (—) indicates that Fisher's exact test was applied.

third-party supply. In terms of reprocessing workflow, cleaning involved both manual and mechanical methods with compliant agents and tools. Visual examination was the predominant method for device inspection. Packaging was primarily performed using plain cotton cloth, non-woven fabric, or paper-plastic pouches.

3 Discussion

The survey revealed distinct patterns in equipment configuration across the 46 institutions. High-temperature sterilizers and ultrasonic cleaners were universally available (100%), meeting fundamental CSSD requirements. In contrast, low-temperature sterilizers were only present in 32.61% of facilities, with a significant disparity between tertiary (87.50%) and secondary hospitals (21.05%). This likely reflects the higher volume and complexity of surgeries, including minimally invasive procedures requiring heat-sensitive instruments, in tertiary centers. Among secondary hospitals, 29 out of 38 (76.32%) are specialized institutions (e.g., dental, rehabilitation, hemo-

Table 3 Operational models of sterile supply in 46 secondary and tertiary hospitals in Xiangtan City

Supply Model	Count	Proportion (%)
Centralized in-house sterile supply	29	63. 04
Non-centralized in-house sterile supply	0	0. 00
Outsourced to third-party	17	36. 96
Total	46	100. 00

dialysis) with limited surgical scope. Consequently, their instrument turnover is lower and predominantly amenable to high-temperature sterilization, explaining the reduced need for low-temperature units. Furthermore, tertiary hospitals demonstrated full compliance (100%) in possessing biological indicator incubators/readers and automatic washer-disinfectors, whereas secondary hospitals lagged significantly (50.00% and 42.11%, respectively). These devices are critical for verifying sterilization efficacy and ensuring consistent, high-quality cleaning. Their underconfiguration in secondary hospitals may compromise processing quality and operational efficiency. To address these gaps, secondary hospitals should prioritize strategic investment in these key equipment categories. Concurrently, local health authorities should reinforce national standards and incentivize targeted equipment upgrades in primary and secondary institutions. Such coordinated efforts are essential to elevate CSSD capabilities systemwide, enhance workflow efficiency, and ultimately safeguard patient safety by mitigating infection risks.

A notable shortfall in specialized training was identified in this study. Only 54.35% (25/46) of institutions reported staff trained at the municipal level or higher, which is a gap exclusively observed in private secondary hospitals. Several factors may contribute to this disparity: (1) perceived lower priority of CSSD operations due to limited volumes of reusable devices; (2) constrained financial resources leading to underinvestment in staff development; and (3) less favorable access to policy support and allocated training resources compared to public institutions. Current management standards mandate the establishment of structured training programs that integrate professional knowledge of sterile supply, infection control, and relevant regulations into continuing education[1]. To bridge the identified gap, it is recommended to use a multi-pronged approach. First, administrators of secondary institutions must elevate the strategic priority of CSSD development and foster a culture of infection prevention. Then, health authorities should implement targeted support for private secondary hospitals through preferential policies and dedicated training resources. Finally, incorporating training compliance as a binding performance indicator, coupled with regular audits, would institutionalize quality improvement[5]. Such concerted efforts are essential to homogenize practices and elevate the overall standard of CSSD services across the region.

The adoption of advanced information systems is instrumental in modernizing hospital management and enhancing service delivery. For CSSDs, a dedicated quality traceability system offers significant advantages. It ensures accurate parameter logging, optimizes resource utilization, facilitates cost control, and improves the efficiency and objectivity of managerial tasks through automated reporting[6]. Our findings present a stark contrast to this potential, revealing that merely 4.35% of surveyed institutions employed such a system, showing a rate substantially below those in existing literature[7-8], potentially reflecting regional and institutional-level variations. Given that process traceability is fundamental to patient safety, bridging this gap is imperative. Therefore, it is recommended that CSSD formally propose and justify the integration of information technology for comprehensive sterile goods traceability. This strategic move is vital for advancing CSSD management practices and strengthening overall quality assurance mechanisms[9-10].

While the universal availability of cleaning agents and tools establishes a solid foundation for reprocessing, device inspection represents a critical gap, as it still depends largely on subjective visual assessment. Implementing objective monitoring technologies, such as fluorescent scanners or protein assay devices, should therefore be prioritized to ensure verifiable cleaning quality. Furthermore, the strategic selection of appropriate packaging materials (plain cotton cloth, non-woven fabric, or paper-plastic pouches) according to device type is essential for maintaining sterilization efficacy and instrument safety throughout the supply chain.

The study indicates a universal adoption of a centralized sterile supply model across all 46 insti-

tutions. This homogeneity may reflect institutional profiles: all four tertiary general hospitals maintain in-house CSSDs, while most secondary hospitals are specialized (e.g., in hemodialysis or rehabilitation) with low surgical volumes and simple instrument inventories, reducing the complexity and demand for on-site reprocessing. The efficiency and safety advantages of centralization are clear, yet a notable shift is underway. Currently, 17 institutions outsource this function, and 5 of the 29 with in-house CSSDs plan to outsource within two years, projecting that 47.83% will rely on third-party providers shortly. This trend is primarily serviced by public general hospitals within the region. The drivers may include: (1) the perception of CSSD as a cost center rather than a revenue generator[2]; (2) the desire to conserve institutional resources while maintaining safety standards[11]; and (3) policy encouragement for qualified hospitals to provide regional CSSD services[1,12-13]. This evolution suggests Xiangtan is developing a nascent regionalized model, approximating a "hospital-based" hub where a core CSSD services surrounding facilities[14]. Within China's healthcare alliance framework, such regional CSSDs represent a strategic and practical direction for the specialty, aligning with policy and operational realities[15].

In conclusion, this study of 46 institutions demonstrates the current landscape of CSSDs in Xiangtan City and reveals a discernible gap in reusable device processing between secondary and tertiary hospitals. These findings provide a foundation for targeted improvements. To bridge this gap, we recommend that regional health authorities develop and implement a unified, context-appropriate sterile supply model, leveraging existing resources to achieve standardized and high-quality management across all institutions.

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