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Original Article

Knowledge and Awareness of Instrument Sterilization Protocols among Healthcare Workers in the Operation Theatre

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ABSTRACT

Background: Effective decontamination, cleaning, disinfection, packaging, sterilization, storage, and monitoring of reusable surgical instruments are fundamental components of perioperative infection prevention. Healthcare workers involved in instrument handling require both theoretical knowledge and consistent application of sterilization protocols. Objective: To assess knowledge, awareness, self-reported practices, and factors associated with sterilization knowledge among healthcare workers working in operation theatres. Methods: A cross-sectional analytical study included 76 healthcare workers from two hospitals in Lahore between January and June 2025. A structured questionnaire assessed demographics, sterilization knowledge, hand hygiene, personal protective equipment, instrument handling, sterilization indicators, protocol availability, training, audit, and self-efficacy. Results: Mean age was 41.7±9.6 years and mean professional experience was 9.8±6.3 years. Good or excellent composite knowledge scores were present in 42/76 participants (55.3%, 95% CI 44.1–65.9%). Knowledge of safe handling of contaminated instruments was reported by 72.4%, standard autoclave parameters by 50.0%, Spaulding classification by 28.9%, and biological versus chemical indicators by 39.5%. Knowledge level was associated with education ($p=.015$), designation ($p=.031$), professional experience ($\rho=.29$, $p=.011$), and training attendance ($p=.001$). In multivariable analysis, greater experience and training attendance were associated with higher odds of good/excellent knowledge. Conclusion: Sterilization knowledge was heterogeneous, with particular gaps in instrument classification, sterilization monitoring, formal training, and audit. Structured training, accessible written protocols, and routine quality monitoring may strengthen sterilization practice in operation-theatre settings. Keywords: Sterilization; Surgical Instruments; Operation Theatre; Infection Prevention; Healthcare Workers; Sterilization Indicators; Knowledge.

INTRODUCTION

Reusable surgical instruments pass repeatedly through a reprocessing cycle that includes collection and transport after use, cleaning, inspection, preparation, packaging, sterilization or high-level disinfection

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where appropriate, storage, and redistribution. Failure at any stage can compromise the effectiveness of reprocessing and may expose patients or healthcare workers to infectious hazards. Contemporary sterilization practice consequently depends not only on functioning sterilization equipment but also on personnel who understand the complete instrument-processing pathway and the factors capable of compromising sterility (1-3).

The Spaulding classification remains a foundational framework for determining the level of reprocessing required for reusable medical devices. Critical devices that enter sterile tissue or the vascular system ordinarily require sterilization, whereas semicritical devices require at least high-level disinfection and noncritical devices generally require lower levels of disinfection according to their intended use and contamination risk (4,5). Although device complexity and emerging technologies have created situations that require more nuanced interpretation, correct classification remains central to selecting an appropriate reprocessing method (4).

Cleaning is an essential prerequisite for effective disinfection and sterilization because residual blood, organic material, proteinaceous debris, and biofilm may interfere with subsequent processing. Reprocessing therefore begins at or near the point of use, where prompt treatment of contaminated instruments can limit drying and retention of organic material (6,7). Complex instrument designs, narrow spaces, joints, lumens, and difficult-to-access surfaces may further impair cleaning and facilitate residual contamination or biofilm formation (8,9). Objective assessment of instrument cleanliness can therefore form an important component of reprocessing quality assurance (10).

Sterilization monitoring requires an understanding of physical process parameters together with chemical and biological indicators. These approaches measure different aspects of the sterilization process and should not be treated as interchangeable. Chemical indicators demonstrate exposure to specified processing conditions but do not independently establish microbiological sterility, whereas biological indicators directly challenge sterilization processes using highly resistant microorganisms (1,5,11). Studies of routine steam sterilization have demonstrated that inadequate process performance may remain clinically important when sterilization systems are not appropriately monitored and controlled (12).

Instrument-reprocessing failures may arise from inadequate cleaning, incorrect loading, unsuitable packaging, incomplete drying, inappropriate storage, insufficient monitoring, deviations from manufacturers' instructions, or weaknesses in institutional workflow (2,7,13,14). Immediate-use steam sterilization also requires careful governance because its use should be based on defined clinical circumstances rather than routine compensation for inadequate instrument inventory or workflow deficiencies (15). Evidence examining immediate-use steam sterilization and surgical outcomes further illustrates the importance of evaluating sterilization practices within their specific institutional and procedural context (16). Operation-theatre personnel are particularly important because they interact with surgical instruments before, during, and after operative procedures and often interface directly with sterile-processing services. However, knowledge and implementation of infection-prevention recommendations are not uniformly high across healthcare settings. Multicentre evidence has identified gaps in healthcare workers' knowledge of sterilization and medical-device reuse, while studies involving operating-room nurses and other surgical personnel have demonstrated variable knowledge and implementation of evidence-based infection-prevention recommendations (17-20).

Knowledge alone does not guarantee correct clinical practice. Confidence may coexist with incomplete understanding, and self-reported practice may differ from directly observed performance. Previous work on aseptic technique has demonstrated discordance between professional confidence, training exposure, and conceptual understanding (21), while decontamination studies have associated the availability of processing guidance with better self-reported practice (22). Structured quality-improvement and training approaches within sterile-supply services may improve theoretical knowledge, practical performance, and adherence to standardized procedures (23). Educational qualification, professional experience, written protocols, training opportunities, supervision, resources, and institutional audit may therefore all influence the quality of instrument reprocessing (17,21-23). The present study evaluated sterilization-related knowledge and awareness among operation-theatre healthcare workers and explored professional and institutional factors associated with higher knowledge.

MATERIALS AND METHODS

An analytical cross-sectional study was conducted between January and June 2025 among healthcare workers working in the operation theatres of Shalamar Hospital and Zahida Welfare Hospital in Lahore. Seventy-six healthcare workers were included, with 38 participants recruited from each institution.

Participants were healthcare workers directly or indirectly involved in sterilization, infection-prevention activities, or surgical-instrument handling. Eligible participants were approximately 20–60 years of age and had at least six months of relevant professional experience. Nurses, operation-theatre assistants, sterilization technicians, surgeons, and other relevant theatre personnel were included. Students without direct experience, staff working outside relevant theatre or reprocessing responsibilities, personnel with less than six months of experience, workers unavailable during data collection, and questionnaires with incomplete responses were excluded.

A structured questionnaire containing approximately 43 parameters was used. The instrument assessed demographic and professional characteristics, hand hygiene, personal protective equipment, safe handling of contaminated instruments, sterilization methods, Spaulding classification, biological and chemical indicators, autoclaving, availability of written protocols, audit and supervision, previous training, self-efficacy, satisfaction with institutional training, and hepatitis B vaccination status.

Composite knowledge was scored on a 10-point scale. Scores were classified as poor for 0–4 points, fair for 5–6 points, good for 7–8 points, and excellent for 9–10 points. For analytical purposes, good and excellent categories were combined to define higher knowledge.

Data were analyzed using IBM SPSS Statistics version 26. Continuous variables were summarized using mean±standard deviation and, where supplied, median with interquartile range. Categorical variables were presented as frequencies and percentages. Associations between categorical variables were assessed using chi-square tests. An independent-samples t test was used for sex-based comparison of knowledge scores. Spearman correlation was used to assess the relationship between professional experience and knowledge. Logistic regression evaluated factors associated with good/excellent knowledge. A p value <0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Review Board of Superior University, Lahore, Pakistan.

RESULTS

The mean age of participants was 41.7±9.6 years, with a median age of 42 years. Mean professional experience was 9.8±6.3 years.

Table 1. Demographic and Professional Characteristics

Characteristic	n (%) / Summary
Age, years	41.7±9.6
Median age	42 (IQR 34–49)
Age range	22–60
Experience, years	9.8±6.3
Median experience	9 (IQR 5–14)
Experience range	1–35
Male	42 (55.3%)
Female	34 (44.7%)
Hospital A	38 (50.0%)
Hospital B	38 (50.0%)
Intermediate education	14 (18.4%)
Diploma	28 (36.8%)
Bachelor's degree	20 (26.3%)
Master's degree	8 (10.5%)
Other education	6 (7.9%)
Permanent employment	55 (72.4%)
Contractual employment	21 (27.6%)
OT assistant	22 (28.9%)
Nurse	18 (23.7%)
Technician	12 (15.8%)
Surgeon	10 (13.2%)
Other designation	14 (18.4%)

The strongest individual knowledge domain was safe handling of contaminated instruments, whereas the largest knowledge gaps concerned Spaulding classification and differentiation between biological and chemical indicators.

The 95% confidence interval for the proportion of participants with good/excellent knowledge was approximately 44.1–65.9%. Institutional and training indicators demonstrated substantial variability. Fewer than half of participants reported confidence or high confidence in sterilization practice, approximately half reported availability of written sterilization protocols, and more than half reported an absence of regular audit or supervision.

Table 2. Selected Sterilization Knowledge and Awareness Responses

Knowledge Domain	Positive/Agreement n (%)	Neutral n (%)	Negative/Disagreement n (%)
Correct hand-hygiene sequence	48 (63.2)	20 (26.3)	8 (10.5)
Correct PPE donning/doffing	41 (53.9)	18 (23.7)	17 (22.4)
Safe handling of contaminated instruments	55 (72.4)	10 (13.2)	11 (14.5)
Knowledge of Spaulding classification	22 (28.9)	24 (31.6)	30 (39.5)
Biological versus chemical indicators	30 (39.5)	20 (26.3)	26 (34.2)
Standard autoclave temperature/cycle	38 (50.0)	22 (28.9)	16 (21.1)
Hepatitis B vaccinated	45 (59.2)	—	31 (40.8)

Table 3. Composite Knowledge Classification

Knowledge Category	Score	n (%)
Poor	0–4	12 (15.8)
Fair	5–6	22 (28.9)
Good	7–8	26 (34.2)
Excellent	9–10	16 (21.1)
Good/Excellent combined	≥7	42 (55.3%)

Table 4. Self-Reported Practice and Institutional Factors

Variable	n (%)
Daily involvement in sterilization	31 (40.8)
Written sterilization protocols available	39 (51.3)
No regular audit/supervision	43 (56.6)
Confident/very confident in sterilization practice	36 (47.4)
Knowledge acquired mainly through observation	26 (34.2)
Knowledge acquired through formal training	22 (28.9)
Dissatisfied with available training	29 (38.2)
Barrier: lack of time	21 (27.6)
Barrier: insufficient training	18 (23.7)
Barrier: lack of resources	12 (15.8)

Knowledge level was significantly associated with educational level and professional designation. Knowledge scores did not differ significantly according to sex. Professional experience was positively correlated with knowledge, while training attendance showed a strong association with awareness category.

Table 5. Bivariate Associations

Analysis	Statistic	p
Knowledge level vs education	χ^2=12.34	.015
Knowledge level vs designation	χ^2=10.58	.031
Knowledge score vs sex	t=1.44	.153
Knowledge score vs professional experience	ρ=.29	.011
Training attendance vs awareness level	χ^2=10.80	.001
Hospital vs Spaulding-classification knowledge	χ^2=1.80	.179

Table 6. Factors Associated With Good/Excellent Knowledge

Predictor	OR	95% CI	p
Experience, per year	1.08	1.01–1.15	.020
Training attendance, yes vs no	2.50	1.10–5.68	.030
Bachelor's or higher vs ≤diploma	1.80	0.90–3.60	.090
Hospital B vs A	0.95	0.50–1.80	.880

Knowledge was also positively associated with self-efficacy (ρ=.45, p<.001) and satisfaction with training (ρ=.30, p=.008). Self-efficacy and training satisfaction were positively correlated (ρ=.35, p=.002). In the multivariable analysis, professional experience and training attendance remained significantly associated with good/excellent knowledge.

DISCUSSION

Only slightly more than half of the participants achieved good or excellent composite knowledge scores. The findings therefore indicate a heterogeneous pattern rather than uniformly poor or uniformly strong sterilization knowledge. Safe handling of contaminated instruments and hand-hygiene principles were comparatively well recognized, whereas fewer than one-third demonstrated knowledge of Spaulding classification and fewer than 40% adequately differentiated biological from chemical sterilization indicators.

The deficiencies observed in instrument classification and process monitoring are important because these concepts guide both selection and verification of appropriate reprocessing procedures. The Spaulding framework remains widely used to relate device-associated infection risk to the required level of decontamination, disinfection, or sterilization (4,5). Similarly, physical, chemical, and biological monitoring provide complementary rather than interchangeable information about a sterilization process (1,11). Evidence from routine healthcare sterilization has demonstrated that inadequate steam-processing cycles can be detected through biological and chemical monitoring, emphasizing that sterilization assurance requires more than simply placing an instrument in an autoclave (12).

Only half of participants demonstrated knowledge of standard autoclave parameters. An isolated questionnaire item on temperature or cycle conditions cannot comprehensively measure sterilization competence because required parameters depend on the sterilizer, device characteristics, packaging, load configuration, and manufacturers' instructions (3,5). Nevertheless, limited knowledge of fundamental steam-sterilization principles is relevant when personnel participate in instrument processing or evaluate whether sterilization has been performed appropriately. Contemporary reprocessing literature emphasizes that cleaning, inspection, preparation, packaging, sterilization, monitoring, storage, and handling function as an integrated system rather than independent technical steps (1-3,7).

The importance of the cleaning stage also deserves emphasis. Residual contamination may compromise subsequent reprocessing, particularly when instruments have complex surfaces, narrow spaces, joints, or other difficult-to-clean components (8,9). Objective cleanliness-monitoring approaches have therefore been investigated as quality-control tools in sterile-supply departments (10). Point-of-use treatment may further reduce the opportunity for organic contamination to dry onto instruments before formal decontamination begins (6). These considerations indicate that staff knowledge should extend beyond autoclave operation to the complete instrument-processing pathway.

Institutional support appeared incomplete in the present study: only approximately half of participants reported access to written sterilization protocols, while 56.6% reported an absence of regular audit or supervision. These findings are clinically relevant because direct assessments of reprocessing systems have demonstrated that compliance with recommended processing practices may be substantially lower than expected from self-report alone (13). Similar evidence from healthcare-worker surveys indicates that knowledge can vary by professional category, employment characteristics, and previous infection-control training (17). Studies of decontamination practice have additionally found better practice where instrument-processing guidance was available in the workplace (22).

The distinction between knowledge and implementation is also evident in perioperative infection-prevention research. Operating-room nurses may report high awareness of evidence-based recommendations while institutional implementation remains inconsistent across individual practices (18). More recent evidence from surgical personnel has similarly identified gaps between knowledge of surgical-site infection prevention and actual adherence, with continuing education proposed as one component of improvement (19). Other nursing studies have demonstrated that education, professional experience, and specific training can be associated with differences in infection-prevention knowledge (20). These findings are consistent with the present observation that educational level, designation, professional experience, and training attendance were related to sterilization knowledge.

Professional experience demonstrated a modest positive correlation with knowledge, and each additional year of experience was associated with slightly greater odds of good/excellent knowledge in the multivariable model. Training attendance showed a stronger association, with trained participants having approximately 2.5-fold greater odds of higher knowledge. A multicentre sterilization survey similarly reported positive associations between previous infection-control training and correct responses to selected sterilization-related questions (17). However, the present cross-sectional design cannot establish that training or experience caused better knowledge. Personnel who participate in

training may differ from non-participants in motivation, professional role, baseline education, institutional support, or exposure to infection-prevention activities.

The relationship between confidence and competence also requires careful interpretation. Knowledge and self-efficacy were moderately correlated in the present study, yet confidence should not be considered equivalent to verified procedural competence. Previous research on aseptic technique found high self-reported confidence despite incomplete understanding of fundamental concepts and long intervals since formal training or reassessment (21). This reinforces the importance of combining educational interventions with competency assessment and direct observation rather than relying solely on staff confidence or questionnaire responses.

Routine audit may provide an additional mechanism for translating knowledge into reliable practice. Direct observational audits, sterilizer-cycle records, biological-indicator monitoring, chemical indicators, traceability systems, and instrument-cleanliness assessments can evaluate dimensions of practice that knowledge questionnaires cannot capture (10-13). Structured management interventions within central sterile supply departments have been associated with improvements in cleaning qualification, theoretical knowledge, practical performance, standard implementation, and hand-hygiene implementation (23). Quality improvement should therefore combine education with process monitoring, feedback, and institutional accountability.

The reported barriers further demonstrate that reprocessing performance is multidimensional. Participants identified lack of time, insufficient training, and resource limitations, while only 28.9% reported acquiring their knowledge primarily through formal training. Broader studies of reprocessing have shown that equipment availability, workflow, infrastructure, standardized procedures, staff roles, and institutional systems can influence compliance with recommended practices (13,14). Consequently, improvement should not be limited to individual education. Institutions also require adequate supplies, clear written procedures, sufficient instrument inventory, appropriate staff allocation, supervision, accessible training, functional sterilization equipment, and systems for routine quality assurance.

Immediate-use steam sterilization represents another area in which institutional policy and workflow are important. Contemporary reviews emphasize that contaminated surgical instruments and rapid-cycle processing require carefully controlled procedures and should not substitute for appropriate inventory or standard reprocessing pathways (15). Observational evidence examining immediate-use steam sterilization and orthopaedic surgical-site infection demonstrates that its relationship with clinical outcomes must be interpreted within the context of indications, protocol adherence, and institutional processes rather than by assuming that all rapid sterilization practices carry identical risk (16). These principles further support protocol-driven rather than ad hoc sterilization practices. Taken together, the findings indicate that sterilization safety requires both knowledgeable personnel and reliable institutional systems. The present study identified specific educational deficits in Spaulding classification, sterilization monitoring, and autoclave principles, while also demonstrating limited formal training and audit exposure. Strengthening competency-based education, written reprocessing protocols, periodic reassessment, and direct quality monitoring may therefore provide a more comprehensive approach than knowledge training alone (17,21-23).

CONCLUSION

Sterilization-related knowledge among operation-theatre healthcare workers was heterogeneous. Good or excellent composite knowledge was present in approximately 55% of participants, while the largest knowledge gaps concerned Spaulding classification, biological and chemical indicators, and selected autoclave principles. Professional experience and training attendance were associated with higher knowledge. The findings support structured training, accessible written reprocessing protocols, routine audit, competency assessment, and stronger institutional sterilization-quality systems.

LIMITATIONS

The study was cross-sectional and therefore cannot establish causal relationships between training, professional experience, and knowledge. The sample was relatively small and was drawn from only two institutions, limiting generalizability to other operation-theatre and sterile-processing settings. Much of the information was based on self-report, which may be affected by recall and social-desirability bias. Direct observation of sterilization procedures was not performed, and questionnaire reliability and full psychometric validation were not available. Institution-level sterilizer performance, actual biological-indicator results, traceability records, and surgical-site infection outcomes were also not measured.

Consequently, the findings primarily characterize knowledge and self-reported institutional conditions rather than directly verified sterilization competence or sterilizer effectiveness.

REFERENCES

1. Rutala WA, Weber DJ. Disinfection, sterilization and antisepsis: principles, practices, current issues, new research and new technologies. Am J Infect Control. 2023;51(11S). doi:10.1016/j.ajic.2023.03.013.
2. George RE, Bay CC, Shaffrey EC, Wirth PJ, Rao VK. A day in the life of a surgical instrument: the cycle of sterilization. Ann Surg Open. 2024;5(1). doi:10.1097/AS9.0000000000000381.
3. Land V, Dickerson S, Goldman A, Shirley ED. The surgical instrument sterilization process: what every surgeon should know. JBJS Rev. 2023;11(11).00131. doi:10.2106/JBJS.RVW.23.00131.
4. Rowan NJ, Kremer T, McDonnell G. A review of Spaulding's classification system for effective cleaning, disinfection and sterilization of reusable medical devices: viewed through a modern-day lens that will inform and enable future sustainability. Sci Total Environ. 2023;878:162976. doi:10.1016/j.scitotenv.2023.162976.
5. Link T. Guideline implementation: sterilization. AORN J. 2019;109(6):772-782. doi:10.1002/aorn.12668.
6. Eberhardt GL, Atwood BI, Smith JD. Point of use treatment for medical devices: from bedside to battlefield. Mil Med. 2024;189(9-10). doi:10.1093/milmed/usad499.
7. Walsh LJ. Current challenges in environmental decontamination and instrument reprocessing. Int Dent J. 2024;74(Suppl 2). doi:10.1016/j.identj.2024.08.016.
8. Lopes LKO, Costa DM, Tipple AFV, Watanabe E, Castillo RB, Hu H, et al. Complex design of surgical instruments as barrier for cleaning effectiveness, favouring biofilm formation. J Hosp Infect. 2019;103(1). doi:10.1016/j.jhin.2018.11.001.
9. Costa DM, Lopes LKO, Vickery K, Watanabe E, Vasconcelos LSNOL, de Paula MC, et al. Reprocessing safety issues associated with complex-design orthopaedic loaned surgical instruments and implants. Injury. 2018;49(11):2005-2012. doi:10.1016/j.injury.2018.09.006.
10. Li Y, Lu Y, Cai R, Hu G, Lu L. Monitoring the cleanliness of reusable surgical instruments in central sterile supply department by adenosine triphosphate method. J AOAC Int. 2022;105(3):844-847. doi:10.1093/jaoacint/qsab102.
11. Laranjeira PR, de Souza RQ, Bronzatti JAG, Graziano KU. Steam sterilization chemical indicators are not adequate for monitoring real steam sterilization cycles. PDA J Pharm Sci Technol. 2020;74(4):435-438. doi:10.5731/pdajpst.2019.09886.
12. Panta G, Richardson AK, Shaw IC, Chambers S, Coope PA. Effectiveness of steam sterilization of reusable medical devices in primary and secondary care public hospitals in Nepal and factors associated with ineffective sterilization: a nation-wide cross-sectional study. PLoS One. 2019;14(11). doi:10.1371/journal.pone.0225595.
13. Panta G, Richardson AK, Shaw IC, Coope PA. Compliance of primary and secondary care public hospitals with standard practices for reprocessing and steam sterilization of reusable medical devices in Nepal: findings from nation-wide multicenter clustered audits. BMC Health Serv Res. 2020;20(1):923. doi:10.1186/s12913-020-05788-0.
14. Tipple AFV, Costa DM, Lopes LKO, Veloso TR, Pereira LA, Hu H, et al. Reprocessing of loaned surgical instruments/implants in Australia and Brazil: a survey of those at the coalface. Infect Dis Health. 2022;27(1):23-30. doi:10.1016/j.idh.2021.09.003.
15. Rutala WA, Weber DJ. Risk of disease transmission to patients from "contaminated" surgical instruments and immediate use steam sterilization. Am J Infect Control. 2023;51(11S). doi:10.1016/j.ajic.2023.01.019.
16. Tantillo TJ, Stapleton EJ, Frane N, Gorlin M, Schilling ME, Armellino D, et al. The association of immediate-use steam sterilization with the incidence of orthopaedic surgical site infections: a propensity score-matched cohort study. J Bone Joint Surg Am. 2022;104(11):988-994. doi:10.2106/JBJS.21.01275.
17. Panta G, Richardson AK, Shaw IC, Coope PA. Healthcare workers' knowledge and attitudes towards sterilization and reuse of medical devices in primary and secondary care public hospitals in Nepal: a multi-centre cross-sectional survey. PLoS One. 2022;17(8). doi:10.1371/journal.pone.0272248.
18. Aktaş FO, Damar HT. Determining operating room nurses' knowledge and use of evidence-based recommendations on preventing surgical site infections. J Perianesth Nurs. 2022;37(3):404-410. doi:10.1016/j.jopan.2021.08.012.

19. Nepravishta E, Topi S, Toçi E, Nepravishta E, Kapaj A. A survey on surgical site infections prevention guidelines knowledge and implementation level of trauma centre healthcare professionals. Br J Hosp Med (Lond). 2024;85(11):1-19. doi:10.12968/hmed.2024.0333.
20. Balodimou SA, Papageorgiou EG, Dokoutsidou EE, Papageorgiou DE, Kaba EP, Kelesi MN. Greek nurses' knowledge on the prevention of surgical site infection: an investigation. J Wound Care. 2018;27(12):876-884. doi:10.12968/jowc.2018.27.12.876.
21. Gould DJ, Chudleigh J, Purssell E, Hawker C, Gaze S, James D, et al. Survey to explore understanding of the principles of aseptic technique: qualitative content analysis with descriptive analysis of confidence and training. Am J Infect Control. 2018;46(4):393-396. doi:10.1016/j.ajic.2017.10.008.
22. Sahiledengle B. Decontamination of patient equipment: nurses' self-reported decontamination practice in hospitals of southeast Ethiopia. BMC Res Notes. 2019;12(1):392. doi:10.1186/s13104-019-4427-5.
23. Yang L, Xun Q, Xu J, Hua D. Application of the defect management improvement mode under Joint Commission International standard to improve the instrument cleaning and disinfection effect and management quality in the central sterile supply department: a randomized trial. Ann Transl Med. 2022;10(3):137. doi:10.21037/atm-21-6610.