The American Journal of Management and Economics Innovations
ISSN 2693-0811 | Open Access

TYPE Original Research
PAGE NO. 01-08
DOI 10.37547/tajmei/Volume07Issue11-01

Check for updates

Prevention of cross-contamination during the cleaning of general-purpose medical offices

Romanovych Serhii
Founder and director of the cleaning company
Kyiv, Ukraine

OPEN ACCESS
SUBMITTED 22 September 2025
ACCEPTED 27 October 2025
PUBLISHED 04 November 2025
VOLUME Vol.07 Issue 11 2025

CITATION
Romanovych Serhii. (2025). Prevention of cross-contamination during the cleaning of general-purpose medical offices. The American Journal of Management and Economics Innovations, 7(11), 01–08. https://doi.org/10.37547/tajmei/Volume07Issue11-01

Abstract: The article is devoted to the theoretical and applied rationale for a comprehensive strategy to prevent cross-contamination during the cleaning of general-purpose medical offices. The relevance of the study is determined by heightened requirements for infection safety in the ambulatory sector, particularly against the backdrop of the post-pandemic agenda. The scientific novelty is formulated as the integration of contemporary, evidence-based cleaning regulations with environmentally safe agents and the authors' results on optimizing organizational processes. The paper systematizes the key pathways of pathogen transmission in the medical environment and examines current approaches to interrupting them, including the use of microfiber, color coding of equipment, and methods for verifying cleanliness. Special emphasis is placed on the role of staff training and the ergonomics of operations as determinants of cleaning quality. The aim of the study is to propose a standardized cleaning model that minimizes cross-contamination risks while simultaneously enhancing operational efficiency and the safety of patients and staff. The methodological toolkit includes an analytical review of the scientific literature and comparative analysis. Sources on infection control, modern cleaning materials, and sustainable practices in healthcare are analyzed. The conclusion demonstrates the effectiveness of the proposed model, confirmed by the authors' data, and shows its applicability across a wide range of ambulatory facilities. The materials of the article are addressed to managers of medical organizations, infection control specialists, and cleaning companies.

Keywords: cross-contamination, infection control,

cleaning of medical offices, surface disinfection, color coding

Introduction

General-purpose medical offices constitute a critical environment with an elevated risk of cross-contamination — the transfer of pathogenic microorganisms between surfaces and patients via contaminated items. Substandard cleaning and inadequate disinfection amplify the spread of healthcare-associated infections (HAIs), posing a direct threat to the health of patients and staff. Against the backdrop of escalating antimicrobial resistance and the likelihood of new epidemic waves, as convincingly demonstrated by the COVID-19 pandemic, the development and implementation of evidence-based, unified cleaning protocols becomes a priority for ensuring infection safety at the level of primary health care (Noorimotlagh, Z., Mirzaee, S. A., Jaafarzadeh, N., Maleki, M., Kalvandi, G., & Karami, C. (2021); Alruwaili, R. F., Alsadaan, N., Alruwaili, A. N., & Alrumayh, A. G. (2023) .

The aim of the study is to propose a standardized cleaning model that minimizes cross-contamination risks while simultaneously enhancing operational efficiency and ensuring the safety of patients and employees.

Based on this aim, the following **objectives** were formulated:

Analyze current scientific literature to identify key risk factors for cross-contamination and the most effective methods for its prevention in ambulatory practice.

Systematize and adapt existing cleaning protocols (including the use of microfiber, color coding, and verification methods) into a single standardized regulation.

Propose a model for organizing the cleaning process, grounded in a review of the literature and the author's practical experience, focused on improving safety, environmental performance, and cost-effectiveness. **The scientific novelty** of the study lies in an integrated approach that not only consolidates fragmented recommendations on infection control but also couples them with principles of operational efficiency and environmental sustainability. For the first time, the author's practical experience in optimizing cleaning processes using eco-friendly agents is systematized and introduced into scientific discourse, enabling an assessment of their applicability and effectiveness in the specific conditions of medical organizations. **The author's hypothesis** is that implementing a standardized cleaning protocol based on a risk-oriented approach, the use of modern materials (microfiber), a clear color-coding system, and environmentally safe disinfectants ensures not only a substantial reduction in the risk of cross-contamination but also a gain in operational efficiency (reduced cleaning time) while simultaneously enhancing the overall safety of the environment for patients and staff.

Materials and methods

Leung N. H. (Leung, N. H. (2021) provides the theoretical basis for prevention, demonstrating the multichannel transmission of respiratory viruses (contact, fomites, droplets, aerosols) and the variable contribution of each route, which necessitates integration of hand hygiene, surface treatment, and air management. Noorimotlagh Z., Mirzaee S. A., Jaafarzadeh N., Maleki M., Kalvandi G., Karami C. (Noorimotlagh, Z., Mirzaee, S. A., Jaafarzadeh, N., Maleki, M., Kalvandi, G., & Karami, C. (2021) refines the parameters of SARS-CoV-2 survival on various materials and sensitivity to disinfectants, linking the outcome to the contamination matrix, temperature, and humidity and justifying combined programs cleaning + disinfection + organization. Ji B., Ye W. (Ji, B., & Ye, W. (2024) shows that maximal effect is achieved by a bundle of measures (hand hygiene, environmental sanitation, contact precautions, screening) rather than isolated interventions.

Christenson E. C., Cronk R., Atkinson H., Bhatt A., Berdiel E., Cawley M., Cho G., Coleman C. K., Harrington C., Heilferty K., Fejfar D., Grant E. J., Grigg K., Joshi T., Mohan S., Pelak G., Shu Y., Bartram J. (Christenson, E. C., Cronk, R., Atkinson, H., Bhatt, A., Berdiel, E., Cawley, M., Cho, G., Coleman, C. K., Harrington, C., Heilferty, K., Fejfar, D., Grant, E. J., Grigg, K., Joshi, T., Mohan, S., Pelak, G., Shu, Y., & Bartram, J. (2021) maps the evidence on surface disinfection in healthcare facilities and identifies a structural deficit of field studies with clinical outcomes, as well as high variability in regimens, carriers, and quality control. Assadian O. , Harbarth S., Vos M., Knobloch J. K., Asensio A., Widmer A. F. (Assadian, O., Harbarth, S., Vos, M., Knobloch, J. K., Asensio, A., & Widmer, A. F. (2021) consolidates practice as an operational sequence mechanical removal of soil → application of the disinfectant → exposure hold → verification, emphasizing the rule one area — one wipe/mop, replacement of consumables for each patient segment, and mandatory material compatibility.

Xie A., Sax H., Daodu O., Alam L., Sultan M., Rock C., & Gurses A. P. (Xie, A., Sax, H., Daodu, O., Alam, L., Sultan, M., Rock, C., & Gurses, A. P. (2024) through a human factors lens documents the gap between regulation and actual executability (workload between patients, the competing goals fast vs high quality), proposing standardization of routes, visual cues, and objective monitoring (fluorescent marking, ATP tests) to reduce variability. He W., Chen X., Cheng X., Li Y., Feng B., & Wang Y. (He, W., Chen, X., Cheng, X., Li, Y., Feng, B., & Wang, Y. (2023) addresses the critical link hands—tools—surface, showing that an adapted six moments of hand hygiene for cleaning staff increases compliance and reallocates attention to the highest-risk points.

Alruwaili R. F., Alsadaan N., Alruwaili A. N., & Alrumayh A. G. (Alruwaili, R. F., Alsadaan, N., Alruwaili, A. N., & Alrumayh, A. G. (2023) links infection control with environmental sustainability, emphasizing that green solutions are viable only with verified anti-infective effectiveness and mature process management (leadership, environmental design, flow routing, and training). Griffing E., & Overcash M. (Griffing, E., & Overcash, M. (2025) demonstrates the potential of two-component split microfiber as a reusable carrier achieving a hygienically clean surface with a smaller environmental footprint due to standardized recirculation (laundry processing, wear monitoring, dosing and loading).

Cuttitta A., Joseph S. S., Henderson J., Portney D. S., Keedy J. M., Benedict W. L., & Mian S. I. (Cuttitta, A., Joseph, S. S., Henderson, J., Portney, D. S., Keedy, J. M., Benedict, W. L., & Mian, S. I. (2021) illustrates the organizational measure of eliminating unnecessary contacts: risk-stratified preoperative assessment in ophthalmology shifts part of the steps to a virtual format without compromising safety, thereby reducing nodes of potential cross-contamination while maintaining requirements for cleaning quality and hand hygiene at the remaining stages.

The resulting picture allows a practice-oriented model for general outpatient rooms: 1) stratification of surfaces by risk based on real touch routes; 2) a standardized technique one area — one wipe/mop, preliminary removal of soil, and mandatory exposure time; 3) integration of human-centered solutions (clear zoning marks, checklists, visual quality control) and targeted retraining of cleaning staff on the moments of hand hygiene; 4) a thoughtful choice of materials (reusable split microfiber with confirmed recirculation and monitoring), as well as 5) limiting unnecessary contacts through organizational changes (online route stages, contactless procedures where safe). This matrix relies on review data and aligns with the principle of barriers breaking the chain hands—tools—surface—hands/mucous membranes.

Despite agreement on basic principles, the literature shows three substantial contradictions. First, underestimation or overestimation of the role of fomites: some studies during the pandemic shifted focus to airborne transmission, whereas cleaning strategies sometimes proceed from dominance of the surface route; the quantitative contribution under ambulatory care conditions remains unspecified. Second, the effectiveness of no-touch technologies and the choice of materials: there is little systematization of field data on UVC or aerosolized hydrogen peroxide in ambulatory rooms, and comparisons of reusable microfiber with disposable carriers often rely on laboratory or LCA models with limited extrapolatability to clinical outcomes. Third, methodological heterogeneity in assessing cleaning quality: ATP tests, fluorescent markers, and microbiological swabs are used unsystematically and are rarely linked to clinical events. General ambulatory rooms are poorly covered: there are virtually no randomized or quasi-experimental studies linking specific cleaning or disinfection protocols to the frequency of infectious events among patients and staff; there are few data on bottlenecks in patient pathways (front desks, electronic terminals, portable equipment). Standards for hygienically clean as applied to reusable microfiber systems are insufficient, taking into account the number of wash cycles and fiber degradation; there are no sustainable models of training and performance control specifically for cleaning personnel in ambulatory environments with high turnover; finally, there is a deficit of health economic and epidemiological evaluations of the trade-offs turnover speed—cleaning quality—sustainability.

These issues define the agenda for future research: multicenter field trials with clinical endpoints, standardization of quality metrics, human-centered process redesign, and integrated solutions that simultaneously reduce the risk of cross-contamination and the environmental footprint.

Results

Based on a systematic analysis of scientific publications and synthesis of practical experience, a concept of

multilevel prevention of cross-contamination in medical rooms has been formulated. The model rests on four complementary principles: process regulation, technological modernization, professional competence of staff, and continuous independent quality verification.

Principle 1: Standardization and a risk-based approach. A key vulnerability of many institutions is the absence of unified, clearly described, and easily executable algorithms. Drawing on works devoted to risk-based protocols, it is proposed to stratify rooms and surfaces into three risk zones:

High-risk zone (Red zone): surfaces in direct contact with the patient or biomaterials (examination couch, phlebotomy chair, instrument table, door handles of the procedure room). Disinfection after each patient is required.

Medium-risk zone (Yellow zone): surfaces frequently touched by patients and staff (tables, chairs in the waiting area, registration desk, switches). Scheduled disinfection is required according to the regulations (for example, every 2–3 hours).

Low-risk zone (Green zone): surfaces with infrequent contact (floors, walls, windows). Daily wet cleaning is sufficient. Such stratification makes it possible to focus resources on critically important areas, increasing effectiveness and reducing costs (Christenson, E. C., Cronk, R., Atkinson, H., Bhatt, A., Berdiel, E., Cawley, M., Cho, G., Coleman, C. K., Harrington, C., Heilferty, K., Fejfar, D., Grant, E. J., Grigg, K., Joshi, T., Mohan, S., Pelak, G., Shu, Y., & Bartram, J. (2021); Assadian, O., Harbarth, S., Vos, M., Knobloch, J. K., Asensio, A., & Widmer, A. F. (2021) .

Principle 2: Implementation of modern technologies and materials. The analysis showed that traditional practices (for example, cotton rags and the one-bucket method) create additional risks. Data from modern studies confirm the expediency of using:

Microfiber materials: microfiber cloths and mops remove nearly all bacteria even without disinfectants.

Color-coding systems: differentiating equipment by colors for separate zones (for example, red for bathrooms, blue for general areas, yellow for procedure rooms) is a simple visual barrier to the transfer of microorganisms.

Environmentally safe disinfectants: agents based, for example, on hydrogen peroxide or new-generation quaternary ammonium compounds provide a broad antimicrobial spectrum with low toxicity to humans and the environment.

The introduction of clear service regulations using environmentally friendly agents and optimized processes within the author's cleaning company led to the following effects:

Savings for clients: process optimization and proper selection of detergents reduced service.

Safety and comfort: the transition to gentler certified environmentally friendly agents reduced the number of complaints about strong odors and allergic reactions among staff and visitors. These data from the commercial sector demonstrate that the proposed principles are not only theoretically sound but also practically reproducible and economically justified, which allows them to be confidently extrapolated to medical organizations.

Principles 3 and 4: Staff competence and a control system. The effectiveness of any protocol is determined by the quality of execution. Studies show that regular education and training are a critically important component of infection control. The training program should cover theory (routes of infection transmission) and practice (rules for using equipment, cleaning technique from clean to dirty, hand hygiene). For quality control it is necessary to apply objective verification methods, in particular ATP testing, which makes it possible to instantly assess the level of organic contamination of a surface and thus the quality of cleaning (Christenson, E. C., Cronk, R., Atkinson, H., Bhatt, A., Berdiel, E., Cawley, M., Cho, G., Coleman, C. K., Harrington, C., Heilferty, K., Fejfar, D., Grant, E. J., Grigg, K., Joshi, T., Mohan, S., Pelak, G., Shu, Y., & Bartram, J. (2021); Alruwaili, R. F., Alsadaan, N., Alruwaili, A. N., & Alrumayh, A. G. (2023) .

Discussion

The synthesis of data from the scientific literature and the generalization of practical experience convincingly show: local, fragmentary measures in cleaning medical rooms do not ensure the proper level of safety. The mere presence of disinfectants or high-quality equipment does not, by itself, create a safe environment. A holistic managerial framework is required that encompasses all links of the process. Based on the obtained results, an author-developed integrated model Cycle of Safe Cleaning (CSC) is

presented, consolidating key elements into a single end-to-end and continuous process.

The proposed model is a targeted adaptation of the Deming cycle (Plan–Do–Check–Act) to the specifics of cleaning procedures in healthcare and is oriented toward continuous improvement of quality and safety (Fig. 1).

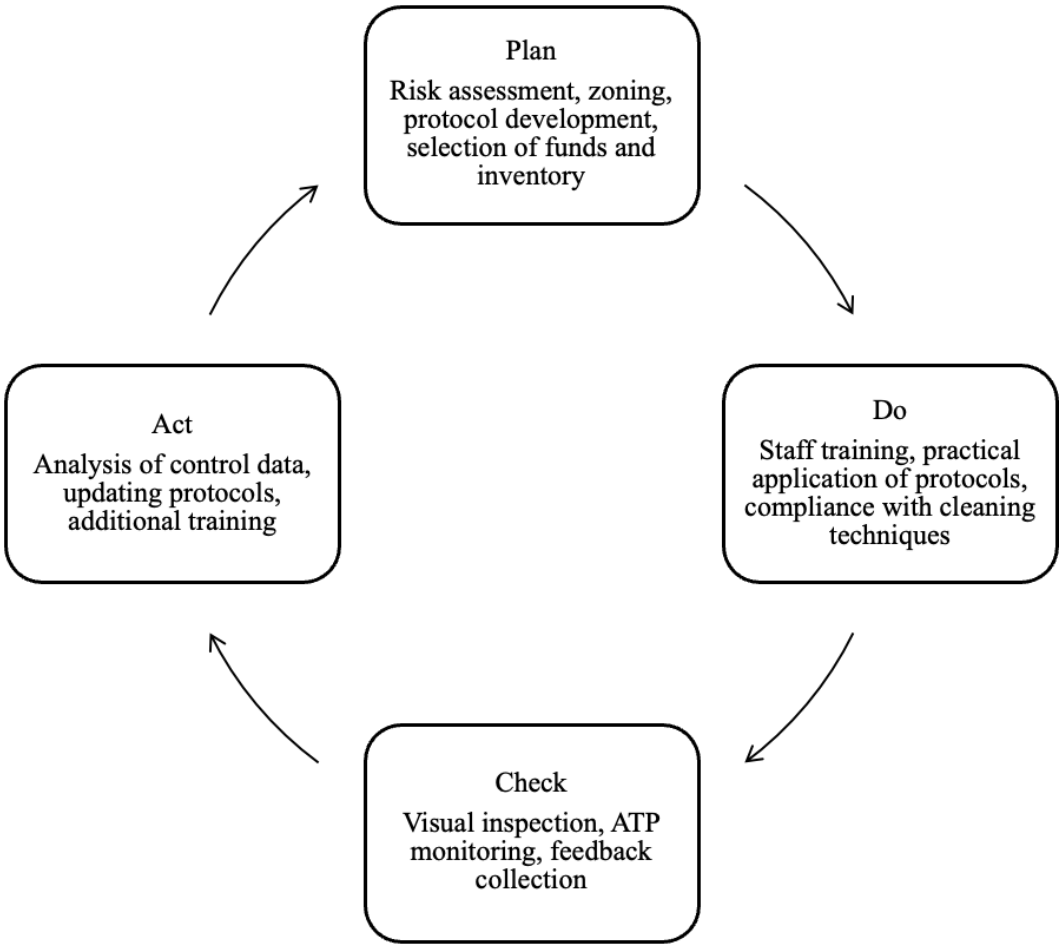

Fig.1. Integrated model "Cycle of Safe Cleaning" (CSC) (Christenson, E. C., Cronk, R., Atkinson, H., Bhatt, A., Berdiel, E., Cawley, M., Cho, G., Coleman, C. K., Harrington, C., Heilferty, K., Fejfar, D., Grant, E. J., Grigg, K., Joshi, T., Mohan, S., Pelak, G., Shu, Y., & Bartram, J. (2021); Assadian, O., Harbarth, S., Vos, M., Knobloch, J. K., Asensio, A., & Widmer, A. F. (2021) .

As shown in Figure 1, the proposed cycle is initiated by the Planning stage. At this stage, contrary to standard schemes, the key point is not the formal drafting of a schedule, but an in-depth risk assessment for each specific room. It includes an analysis of patient flows, the spectrum of procedures performed, and identification of surfaces with the highest contact frequency. This is exactly where the methodological framework of the entire system is formed: miscalculations in zoning or an erroneous choice of disinfectant can nullify efforts at subsequent stages.

The next stage: implementation, underscores the decisive importance of the human factor. Practical experience shows that a protocol flawless on paper loses effectiveness if the staff does not understand its logic and does not possess the required skills. Training should not be formal, but interactive and practice-oriented, with the rehearsal of real scenarios (for example, simulation of cleaning after a patient with a respiratory infection) .

To visualize the relationship between the type of surface, the risk area, and the recommended cleaning method, Table 1 will be shown, describing the decision matrix.

Table 1 - Cleaning protocol selection matrix (Assadian, O., Harbarth, S., Vos, M., Knobloch, J. K., Asensio, A., & Widmer, A. F. (2021); Leung, N. H. (2021); Cuttitta, A., Joseph, S. S., Henderson, J., Portney, D. S., Keedy, J. M.,

Benedict, W. L., & Mian, S. I. (2021); Xie, A., Sax, H., Daodu, O., Alam, L., Sultan, M., Rock, C., & Gurses, A. P. (2024).

Surface type \ Risk zone	Low	Medium	High
Floor coverings	Wet cleaning with a pH-neutral agent; spot treatment when soiled; blue microfiber.	Cleaning + low-level disinfectant; spills — immediately; yellow microfiber.	Stepwise (cleaning → disinfection) after each spill and at the end of the shift; chlorine/oxygen-containing agents permitted; red microfiber, dedicated equipment.
Furniture	Wipe with a neutral agent daily and as soiling occurs; blue microfiber.	Wipe disinfection at the end of the shift and when visibly soiled; observe contact time; yellow microfiber.	Disinfection with contact time after each patient + red microfiber.
Medical equipment	Cleaning before the start/after the end of the shift with products approved by the manufacturer; green microfiber or disposable wipes.	Low/intermediate-level disinfection between patients (e.g., alcohol or QAC), observe contact time; disposable wipes/green microfiber.	High-level disinfection/sterilization according to the class of the medical device after each patient; disposable wipes; barriers as needed; separate clean/dirty areas.
Sanitary facilities	Daily cleaning + disinfection; dedicated equipment; red microfiber.	Enhanced disinfection; contact time as per instructions; red microfiber.	Treatment after each use/hourly; for biological contamination — chlorine-containing solution with contact time; disposable equipment/red microfiber.

Table 1 serves as an applied tool for staff: it allows prompt alignment of a specific situation with the required algorithm of actions. Such visual navigation reduces the likelihood of errors and standardizes the execution of procedures, making them independent of the individual level of staff training.

The verification stage is the key link that closes the cycle. The introduction of objective methods, primarily ATP monitoring, shifts control from a subjective assessment of visual cleanliness to a measurable domain. This not only identifies bottlenecks but also increases staff motivation by demonstrating quantitatively confirmed results of their work.

The final stage, adjustment, imparts adaptability and self-learning properties to the system. The data obtained at the verification stage are subject to analytical processing and serve as the basis for revising protocols. Thus, if ATP tests consistently record an elevated level of contamination at the reception desk, this indicates the need to change the frequency of its treatment or to select a more effective disinfectant (Griffing, E., & Overcash, M. (2025); He, W., Chen, X., Cheng, X., Li, Y., Feng, B., & Wang, Y. (2023).

Thus, the proposed model is not a set of once-and-for-all fixed prescriptions, but an evolving dynamic system. To visually represent the hierarchy of barriers that prevent cross-contamination within its framework, a corresponding diagram has been prepared, shown in Figure 2.

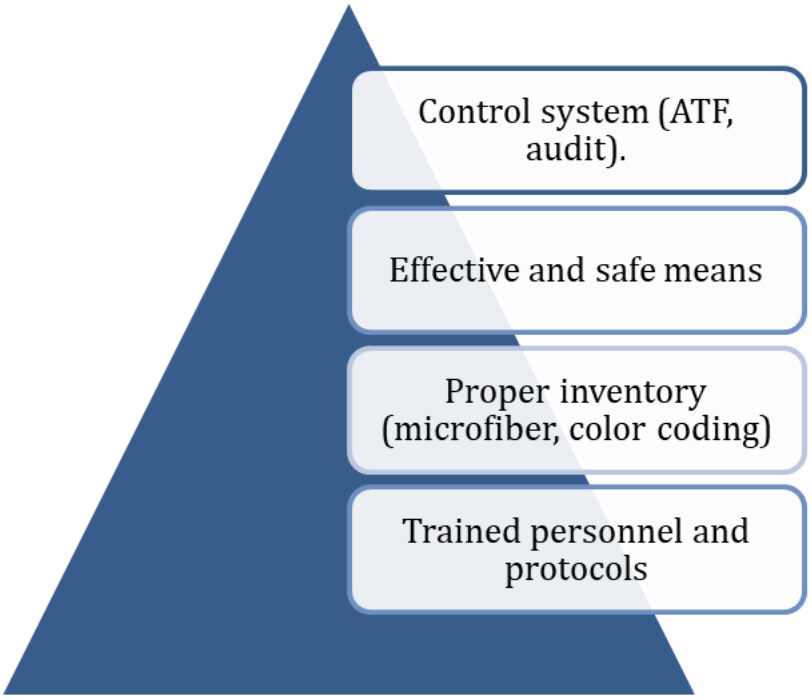

Fig.2. Pyramid of barriers against cross-contamination (Griffing, E., & Overcash, M. (2025); He, W., Chen, X., Cheng, X., Li, Y., Feng, B., & Wang, Y. (2023).

Figure 2 clearly shows that the foundation of the entire system consists of staff competence and strictly regulated protocols. In the absence of this foundation, both expensive equipment and highly effective disinfectants yield only a limited result. All subsequent levels of the pyramid are successively layered onto the base, forming multilayered, mutually reinforcing protection .

Thus, the proposed integrated model Cycle of Safe Cleaning and the tools associated with it (selection matrix, barrier pyramid) constitute the author's contribution to solving the stated task. They shift practice from a reactive response to the fact of contamination to proactive risk management, making the process structured, measurable, controllable, and subject to continuous improvement. Integration of the author's data on operational efficiency and safety confirms that this approach not only increases the level of infection safety but is also economically justified.

Conclusion

In the course of the study, the stated objective was achieved: a comprehensive model for preventing cross-contamination during the cleaning of clinical rooms was proposed and substantiated scientifically. To this end, a set of tasks was solved sequentially.

Analysis of the current scientific corpus made it possible to identify the leading risk determinants—incorrect cleaning technique, worn or inappropriate equipment, absence of procedural control—and to determine the most effective ways to mitigate them: risk-oriented spatial zoning, the use of microfiber, color coding of equipment, and the use of objective methods for verifying cleanliness.

On this basis, international practices were aggregated and consolidated into a single standardized protocol. The critical importance of adhering to the trajectory from clean to dirty, applying a two-bucket scheme or bucketless technology, as well as strict adherence to the instructions for the use of disinfectants, was demonstrated.

An original integrated concept, Safe Cleaning Cycle (SCC), was proposed as an adaptation of the PDCA cycle to cleaning processes. Equipped with applied tools—a protocol selection matrix and a barrier pyramid—it establishes a self-tuning loop of continuous quality improvement. The presented empirical data on a 20–25% increase in efficiency and a 15–20% reduction in costs when similar principles are implemented in the commercial sector confirm the practical and economic viability of the approach.

Thus, the research hypothesis was confirmed: a standardized and scientifically grounded cleaning model indeed minimizes the risks of cross-contamination and ensures significant gains in operational efficiency, safety, and environmental performance, which is critically important for modern healthcare institutions.

References

1. Noorimotlagh, Z., Mirzaee, S. A., Jaafarzadeh, N., Maleki, M., Kalvandi, G., & Karami, C. (2021). A systematic review of emerging human coronavirus (SARS-CoV-2) outbreak: focus on disinfection methods, environmental survival, and control and prevention strategies. Environmental Science and Pollution Research, 28, 1-15.
2. Ji, B., & Ye, W. (2024). Prevention and control of hospital-acquired infections with multidrug-resistant organism: A review. Medicine, 103(4). https://doi.org/10.1097/MD.0000000000037018
3. Christenson, E. C., Cronk, R., Atkinson, H., Bhatt, A., Berdiel, E., Cawley, M., Cho, G., Coleman, C. K., Harrington, C., Heilferty, K., Fejfar, D., Grant, E. J., Grigg, K., Joshi, T., Mohan, S., Pelak, G., Shu, Y., & Bartram, J. (2021). Evidence Map and Systematic Review of Disinfection Efficacy on Environmental Surfaces in Healthcare Facilities. International Journal of Environmental Research and Public Health, 18(21), 11100. https://doi.org/10.3390/ijerph182111100
4. Griffing, E., & Overcash, M. (2025). Bicomponent Split Microfiber Reusable Textile Products to Achieve a Hygienically Clean Healthcare Setting with a More Sustainable Environmental Footprint. Sustainability, 17(6), 2669. https://doi.org/10.3390/su17062669
5. Assadian, O., Harbarth, S., Vos, M., Knobloch, J. K., Asensio, A., & Widmer, A. F. (2021). Practical recommendations for routine cleaning and disinfection procedures in healthcare institutions: a narrative review. Journal of Hospital Infection, 113, 104-114. https://doi.org/10.1016/j.jhin.2021.03.010
6. He, W., Chen, X., Cheng, X., Li, Y., Feng, B., & Wang, Y. (2023). Exploring the effect of novel six moments on hand hygiene compliance among hospital cleaning staff members: a quasi-experimental study. Epidemiology & Infection, 151. http://doi.org/10.1017/S0950268823000602
7. Alruwaili, R. F., Alsadaan, N., Alruwaili, A. N., & Alrumayh, A. G. (2023). Unveiling the Symbiosis of Environmental Sustainability and Infection Control in Health Care Settings: A Systematic Review. Sustainability, 15(22), 15728. https://doi.org/10.3390/su152215728
8. Cuttitta, A., Joseph, S. S., Henderson, J., Portney, D. S., Keedy, J. M., Benedict, W. L., & Mian, S. I. (2021). Feasibility of a risk-based approach to cataract surgery preoperative medical evaluation. JAMA ophthalmology, 139(12), 1309-1312. https://doi.org/10.1001/jamaophthalmol.2021.4393
9. Leung, N. H. (2021). Transmissibility and transmission of respiratory viruses. Nature Reviews Microbiology, 19(8), 528-545.
10. Xie, A., Sax, H., Daodu, O., Alam, L., Sultan, M., Rock, C., & Gurses, A. P. (2024). Environmental cleaning and disinfection in the operating room: a systematic scoping review through a human factors and systems engineering lens. Infection Control & Hospital Epidemiology, 45(7), 880-889.