Research Square

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Efficacy of a Nanometric Mist Disinfection System in Reducing Bacterial Surface Contamination in Surgical Rooms: A Quasi-Experimental Study in a Tertiary Hospital

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Abstract

Healthcare-associated infections (HAIs) remain a major global patient safety challenge, with operating room surfaces playing an important role in pathogen transmission. Conventional cleaning protocols frequently leave residual microbial contamination, underscoring the need for innovative automated disinfection technologies. This quasi-experimental, pre-post intervention study evaluated the efficacy of an automated nanometric mist disinfection system (Higia Plus®) in reducing bacterial surface contamination in three surgical rooms of a tertiary military hospital in Curitiba, Paraná, Brazil, in June 2026. A total of 48 surface samples were collected using standardized RODAC (Replicate Organism Detection and Counting) contact plates—sixteen sampling points per room—immediately before and after system application. The primary outcome was the percentage reduction in colony-forming units (CFU). Pre-intervention CFU totals were 53 (Room 01), 187 (Room 02), and 97 (Room 03). Post-intervention counts decreased to 1, 4, and 12 CFU, respectively, yielding room-specific efficacies of 98.1%, 97.9%, and 87.6%, and an overall system efficacy of 94.5% (from 337 to 17 CFU across all 48 samples). All three rooms surpassed the predefined efficacy threshold of ≥ 80% CFU reduction. These findings indicate that nanometric mist disinfection is a robust and promising complementary strategy for environmental decontamination in surgical settings, with potential to reduce HAI risk. Future studies should evaluate specific pathogen profiles, clinical outcomes such as surgical site infection rates, and cost-effectiveness.

Introduction

Healthcare-associated infections (HAIs) represent one of the most significant threats to patient safety worldwide, affecting millions of patients each year and imposing substantial economic burdens on health systems (Allegranzi et al. 2011; World Health Organization 2011). The surgical environment is particularly critical, as surface contamination in operating rooms can directly contribute to surgical site infections (SSIs) and other postoperative complications (Mangram et al. 1999; Anderson et al. 2007; Sartelli et al. 2020).

Bacterial contamination of operating room surfaces is a well-documented phenomenon. Environmental surfaces can harbor significant microbial loads even after conventional cleaning protocols, and the persistence of pathogenic microorganisms in the perioperative environment is associated with increased cross-contamination risk and postoperative infectious complications (Bhalla et al. 2004; Datta et al. 2011; Otter et al. 2011a).

Microbiological surface monitoring is an essential component of hospital infection control programs (Donskey 2013). The RODAC (Replicate Organism Detection and Counting) contact plate technique is a standardized and widely validated method for quantifying bacterial surface contamination, offering advantages over swab-based methods in terms of standardization, reproducibility, and ease of execution (Foote et al. 1967; Napolitano et al. 2001; Knobloch et al. 2005; Griffith et al. 2000).

Despite advances in hospital hygiene practices, recent evidence continues to identify concerning levels of residual contamination in surgical environments following conventional cleaning (Donskey 2013; Rutala and Weber 2013). This gap has driven the development of innovative disinfection technologies, including automated systems based on vaporized hydrogen peroxide, ultraviolet irradiation, and aerosolized antimicrobial agents (Otter et al. 2013; Mahida and Boswell 2018; Boyce 2016; Diab-Elschahawi et al. 2011).

Fogging and nebulization-based disinfection systems are a promising approach to environmental decontamination, enabling effective coverage of hard-to-reach surfaces and ensuring uniform distribution of the antimicrobial agent (Holmdahl et al. 2011; Davis 2010). Nanometric mist technologies, generating particles smaller than 10 µm, provide enhanced penetration capacity and superior spatial distribution compared with conventional aerosol systems (Rainina et al. 2017).

In Brazil, effective HAI prevention remains a public health priority, particularly in tertiary-care hospitals serving high-complexity patients (Padoveze and Fortaleza 2014; Oliveira et al. 2010; Agência Nacional de Vigilância Sanitária 2017). Rigorous evaluation of novel disinfection technologies using standardized, transparent methodology is essential to support evidence-based implementation decisions.

This study aimed to evaluate the efficacy of an automated nanometric mist disinfection system (Higia Plus®) in reducing bacterial surface contamination in three surgical rooms of a Brazilian tertiary hospital, using the RODAC contact plate technique for microbiological quantification.

Materials and Methods

Study design

This was a quasi-experimental, pre-post intervention study without a concurrent control group, conducted in accordance with the TREND (Transparent Reporting of Evaluations with Nonrandomized Designs) guidelines for transparent reporting of nonrandomized evaluations (Des Jarlais et al. 2004).

Study setting and period

The study was conducted at the Hospital da Polícia Militar do Paraná (Military Police Hospital of Paraná), a tertiary-care institution located in Curitiba, Paraná, Brazil, in June 2026. Three active surgical rooms (Rooms 01, 02, and 03) from the hospital's surgical suite were selected.

Sampling points

Sixteen surface sampling points were designated in each surgical room, totaling 48 points across the three rooms. Points were selected based on high-contact frequency and epidemiological relevance for pathogen transmission, including: operating table surfaces (head, middle, and foot sections),

workbenches, anesthesia cart buttons, monitoring cables, multiparametric monitors, video tower controls and surfaces, surgical light components (top, adjuster, handle), and electromedical devices (electrocautery unit and syringe pump) (Ledwoch and Maillard 2018; Knobloch et al. 2005).

Intervention

The intervention consisted of the application of an automated nanometric mist disinfection system (Higia Plus®). The device uses ultrasonic atomization technology to generate particles smaller than 10 µm containing a broad-spectrum antimicrobial agent, which is dispersed homogeneously throughout the room, enabling coverage of all surfaces including hard-to-reach areas. The application protocol followed manufacturer specifications: (1) room preparation with doors and windows closed; (2) strategic positioning of the mist-generating device; (3) system activation with a standardized nebulization cycle; (4) antimicrobial contact period; (5) aeration period before room reopening. The intervention was performed after the day's surgical activities and following conventional terminal cleaning, to evaluate the additional decontamination effect of the nanometric mist technology.

Microbiological sampling

Bacterial surface contamination was quantified using the RODAC (Replicate Organism Detection and Counting) contact plate technique, a standardized and validated method for surface sampling (Foote et al. 1967; Napolitano et al. 2001). RODAC plates consist of Petri dishes containing a convex agar surface that allows direct contact with the sampling site, covering an area of approximately 25 cm^2. The sampling protocol followed standard procedures: (1) aseptic removal of the plate lid; (2) uniform pressure application of the agar surface to the sampling site; (3) plate capping and labeling; (4) immediate transport to the microbiology laboratory. All samples were collected by the same trained technician using strict aseptic technique to prevent cross-contamination between sampling points.

Laboratory processing

After collection, RODAC plates were incubated at 35–37°C for 48 hours. Colony counts were performed manually after incubation, with results expressed as colony-forming units (CFU) per plate.

Outcomes

The primary outcome was the percentage reduction in CFU after intervention, calculated as: Efficacy (%) = [(Pre-CFU − Post-CFU) / Pre-CFU] × 100. Secondary outcomes included absolute pre- and post-intervention CFU counts per sampling point, total CFU per room, and room-specific efficacy. The predefined efficacy threshold was ≥ 80% CFU reduction, based on established criteria in the disinfection literature (Donskey 2013).

Statistical analysis

Descriptive statistics were used, including calculation of total CFU sums, percentage reductions per room, and overall system efficacy across all 48 samples. Points with zero CFU at both time points were recorded as no detectable growth (—) and were excluded from the efficacy calculation.

Ethical considerations

This study was conducted as an environmental technology evaluation without direct patient involvement or clinical data collection. No institutional ethics committee approval was required.

Results

Sample characterization

A total of 48 surface samples were analyzed, evenly distributed across three surgical rooms (16 sampling points per room). All planned samples were collected and processed without losses or exclusions.

Pre-intervention bacterial contamination

Total pre-intervention CFU across all 48 samples was 337 CFU. Room 02 showed the highest baseline microbial burden (187 CFU), followed by Room 03 (97 CFU) and Room 01 (53 CFU). This baseline variability likely reflects differences in procedural volume, equipment complexity, and structural characteristics among the three rooms (Weber et al. 2013; Otter et al. 2011a).

Room 01 (Endoscopy)

Total CFU decreased from 53 (pre-intervention) to 1 (post-intervention), representing 98.1% efficacy (Table 1; Fig. 1). Nine of 16 sampling points showed complete elimination of detectable bacteria. The most contaminated point prior to intervention was the anesthesia cart buttons (13 CFU), which reached zero post-intervention.

Table 1
Pre- and post-intervention CFU counts — Surgical Room 01 (Endoscopy)

Sampling Point	Pre-intervention CFU	Post-intervention CFU	Reduction (%)
Workbench 1	3	0	100.0%
Workbench 2	3	0	100.0%
Operating table — head end	5	0	100.0%
Operating table — middle	0	0	—
Operating table — foot end	11	1	90.9%
Video tower buttons	0	0	—
Walls adjacent to stretcher	0	0	—
Walls adjacent to monitors	0	0	—
Anesthesia cart buttons	13	0	100.0%
Monitoring cables	4	0	100.0%
Multiparametric monitor	7	0	100.0%
Surgical light — top	1	0	100.0%
Surgical light — adjuster	0	0	—
Surgical light — handle	0	0	—
Video tower	0	0	—
Syringe pump	6	0	100.0%
TOTAL / OVERALL EFFICACY	**53**	**1**	**98.1%**

Points with CFU = 0 at both time points: no detectable growth (—).

Room 02

Despite the highest baseline contamination (187 CFU), the system achieved 97.9% efficacy, reducing post-intervention CFU to 4 (Table 2; Figs. 2 and 3). The surgical light top showed the highest pre-intervention count (29 CFU), reaching zero post-intervention. The video tower (87.5% reduction) and electrocautery unit (88.2% reduction) were the only points with residual contamination above 1 CFU. Workbench 1 had a pre-intervention count recorded as > 100 CFU; a conservative value of 100 was used for efficacy calculation.

Table 2
Pre- and post-intervention CFU counts — Surgical Room 02

Sampling Point	Pre-intervention CFU	Post-intervention CFU	Reduction (%)
Workbench 1	> 100	0	100.0%
Workbench 2	8	0	100.0%
Operating table — head end	2	0	100.0%
Operating table — middle	2	1	50.0%
Operating table — foot end	6	0	100.0%
Video tower buttons	3	0	100.0%
Walls adjacent to stretcher	0	0	—
Walls adjacent to monitors	0	0	—
Anesthesia cart buttons	3	0	100.0%
Monitoring cables	3	0	100.0%
Multiparametric monitor	0	0	—
Surgical light — top	29	0	100.0%
Surgical light — adjuster	2	0	100.0%
Surgical light — handle	4	0	100.0%
Video tower	8	1	87.5%
Electrocautery unit	17	2	88.2%
TOTAL / OVERALL EFFICACY	**187***	**4**	**97.9%**

* Workbench 1 pre-intervention count recorded as > 100 CFU; value of 100 used for efficacy calculation. Points with CFU = 0 at both time points: no detectable growth (—).

Room 03

CFU counts were reduced from 97 to 12, yielding 87.6% efficacy (Table 3; Fig. 4). The electrocautery unit showed the highest pre-intervention contamination (45 CFU; 91.1% reduction post-intervention). An atypical finding was observed at the anesthesia cart buttons, where no colonies were detected pre-intervention but 5 CFU were found post-intervention, possibly reflecting a sampling artifact or minor recontamination during the aeration period. Excluding this point, room efficacy would exceed 93%.

Table 3
Pre- and post-intervention CFU counts — Surgical Room 03

Sampling Point	Pre-intervention CFU	Post-intervention CFU	Reduction (%)
Workbench 1	8	0	100.0%
Workbench 2	5	0	100.0%
Operating table — head end	8	1	87.5%
Operating table — middle	3	0	100.0%
Operating table — foot end	1	0	100.0%
Video tower buttons	1	0	100.0%
Walls adjacent to stretcher	0	0	—
Walls adjacent to monitors	0	0	—
Anesthesia cart buttons†	0	5	↑ atypical
Monitoring cables	5	1	80.0%
Multiparametric monitor	0	0	—
Surgical light — top	6	0	100.0%
Surgical light — adjuster	0	0	—
Surgical light — handle	3	0	100.0%
Video tower	12	1	91.7%
Electrocautery unit	45	4	91.1%
TOTAL / OVERALL EFFICACY	**97**	**12**	**87.6%**

† Atypical result: no growth pre-intervention, 5 CFU post-intervention (possible RODAC plate contact artifact or recontamination during aeration). Points with CFU = 0 at both time points: no detectable growth (—).

Overall system efficacy

Across all 48 samples in the three surgical rooms, total CFU fell from 337 (pre-intervention) to 17 (post-intervention), yielding an overall system efficacy of 94.5% (Table 4). All three rooms exceeded the predefined ≥ 80% CFU reduction threshold, demonstrating consistent and robust performance of the Higia Plus® system across different surgical environments.

Table 4
Summary of room-specific and overall system efficacy

Surgical Room	Pre-intervention CFU	Post-intervention CFU	Efficacy (%)
Room 01 — Endoscopy	53	1	98.1%
Room 02	187*	4	97.9%
Room 03	97	12	87.6%
OVERALL	**337**	**17**	**94.5%**

* Includes Workbench 1 (> 100 CFU), computed as 100 for efficacy calculation.

Photographic Documentation of RODAC Plate Results

Representative RODAC plate pairs illustrating the pre- and post-intervention microbial load are presented below. Figures 1 and 2–3 correspond to Surgical Rooms 01 and 02, respectively; Fig. 4 corresponds to Surgical Room 03.

Discussion

This study demonstrated high efficacy of the Higia Plus® nanometric mist disinfection system across three surgical rooms of a tertiary military hospital, achieving an overall CFU reduction of 94.5% and room-specific values between 87.6% and 98.1%. All results exceeded the predefined ≥ 80% efficacy threshold, consistent with published evidence on automated disinfection technologies (Otter et al. 2013; Boyce 2016; Triggiano et al. 2021).

The residual bacterial contamination detected on surgical room surfaces prior to intervention—despite conventional terminal cleaning—underscores a recognized limitation of manual cleaning protocols (Donskey 2013; Otter et al. 2011a). Surface contamination in operating rooms contributes to HAI risk, including SSIs, which remain among the most frequent and clinically impactful postoperative complications (Mangram et al. 1999; Anderson et al. 2007; Berríos-Torres et al. 2017).

The RODAC contact plate method used in this study is an established gold standard for surface microbiology, providing better standardization and reproducibility compared with swab techniques, and enabling objective, comparable quantification of bacterial burden before and after intervention (Foote et al. 1967; Napolitano et al. 2001; Griffith et al. 2000).

The overall efficacy of 94.5% is consistent with comparable studies. Triggiano et al. (2021) reported > 90% bacterial reduction using a combined hydrogen peroxide and ethanol aerosol fogging system in hospital settings. Khandelwal et al. (2015) demonstrated 99.9% pathogen reduction in intensive care units with hydrogen peroxide mist. Davis (2010) documented significant contamination reductions in operating rooms treated with a disinfectant fogger evaluated alongside RODAC plate sampling. Holmdahl et al. (2011) compared hydrogen peroxide vapor and aerosol room decontamination systems

and reported efficacies between 85% and 99% depending on the microorganism and surface type evaluated.

Inter-room variability in efficacy (87.6%–98.1%) likely reflects differences in baseline contamination levels, room volume and layout, equipment complexity, and airflow patterns. Despite having the highest baseline contamination (187 CFU), Room 02 achieved 97.9% efficacy, demonstrating robust system performance under high-burden conditions. Room 03 showed the lowest efficacy (87.6%), potentially attributable to its structural or ventilation characteristics or to the greater complexity and volume of electromedical equipment present. The atypical result at the Room 03 anesthesia cart buttons (0 → 5 CFU post-intervention) is most likely a sampling artifact or minor recontamination event during aeration, rather than a true intervention failure (Ledwoch and Maillard 2018).

Automated no-touch disinfection technologies are increasingly recognized as valuable complements to manual cleaning in high-risk areas such as operating rooms and intensive care units (Otter et al. 2013; Boyce 2016; Mahida and Boswell 2018). Nanometric mist systems offer theoretical advantages including homogeneous surface coverage, elimination of operator-dependent technique variability, penetration into complex equipment interstices, and reduced reliance on manual labor (Rainina et al. 2017). These characteristics make the technology particularly suitable for complementing terminal cleaning protocols in environments with complex equipment configurations, as is typical of surgical rooms.

The Brazilian healthcare context deserves specific consideration. HAI rates in Brazilian hospitals, particularly in the public and tertiary-care sectors, remain elevated, and the implementation of evidence-based decontamination strategies is a recognized national priority (Padoveze and Fortaleza 2014; Oliveira et al. 2010; Agência Nacional de Vigilância Sanitária 2017). The results reported here support the potential utility of nanometric mist disinfection as a component of comprehensive HAI prevention programs in Brazilian tertiary hospitals.

Limitations

This study has several limitations. First, the quasi-experimental design without a concurrent control group precludes definitive causal inference. Second, the single-center, single-period evaluation limits generalizability to other settings and conditions. Third, microbiological analysis was restricted to total CFU counts without pathogen identification or antimicrobial resistance profiling; future studies should incorporate species-level identification and characterization of clinically relevant pathogens. Fourth, no clinical outcome measures (e.g., SSI rates, postoperative infection incidence) were assessed; prospective studies with patient follow-up are needed to establish the clinical impact of the technology. Fifth, factors that may have contributed to inter-room variability—including room volume, ventilation characteristics, and equipment configuration—were not formally measured or controlled.

Conclusions

The Higia Plus® nanometric mist disinfection system demonstrated high and consistent efficacy in reducing bacterial surface contamination in surgical rooms, surpassing the predefined ≥ 80% CFU reduction threshold in all three evaluated rooms. With an overall efficacy of 94.5% across 48 RODAC plate samples, the technology represents a promising complementary strategy for environmental decontamination in surgical settings. Future research incorporating pathogen-specific analysis, randomized or controlled designs, clinical endpoint evaluation, and cost-effectiveness analyses will be essential to consolidate evidence for routine implementation in hospital infection control programs.

Declarations

Funding

This study received no external funding.

Competing Interests

The authors declare that they have no competing interests.

Author Contributions

B.B.: conceptualization, methodology, data collection, data analysis, writing – original draft, review and editing. All authors read and approved the final manuscript.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Approval

This study was conducted as an environmental technology evaluation without direct patient involvement or clinical data collection. Accordingly, no institutional ethics committee approval was required, as no human or animal subjects were involved.

References

1. Agência Nacional de Vigilância Sanitária (2017) Medidas de prevenção de infecção relacionada à assistência à saúde. Anvisa, Brasília
2. Allegranzi B, Bagheri Nejad S, Combescure C et al (2011) Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet 377:228–241. https://doi.org/10.1016/S0140-6736(10)61458-4
3. Anderson DJ, Sexton DJ, Kanafani ZA et al (2007) Severe surgical site infection in community hospitals: epidemiology, key procedures, and the changing prevalence of methicillin-resistant

Staphylococcus aureus. Infect Control Hosp Epidemiol 28:1047–1053. https://doi.org/10.1086/519864

4. Berríos-Torres SI, Umscheid CA, Bratzler DW et al (2017) Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. JAMA Surg 152:784–791. https://doi.org/10.1001/jamasurg.2017.0904
5. Bhalla A, Pultz NJ, Gries DM et al (2004) Acquisition of nosocomial pathogens on hands after contact with environmental surfaces near hospitalized patients. Infect Control Hosp Epidemiol 25:164–167. https://doi.org/10.1086/502369
6. Boyce JM (2016) Modern technologies for improving cleaning and disinfection of environmental surfaces in hospitals. Antimicrob Resist Infect Control 5:10. https://doi.org/10.1186/s13756-016-0111-x
7. Datta R, Platt R, Yokoe DS, Huang SS (2011) Environmental cleaning intervention and risk of acquiring multidrug-resistant organisms from prior room occupants. Arch Intern Med 171:491–494. https://doi.org/10.1001/archinternmed.2010.597
8. Davis CR (2010) An evaluation of RODAC plate sampling and a new disinfection fogger system in hospital clean rooms. Ann R Coll Surg Engl 92:511–515. https://doi.org/10.1308/003588410X12699663904336
9. Des Jarlais DC, Lyles C, Crepaz N, TREND Group (2004) Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: the TREND statement. Am J Public Health 94:361–366. https://doi.org/10.2105/AJPH.94.3.361
10. Diab-Elschahawi M, Berger J, Blacky A et al (2011) Impact of different-sized ultraviolet devices on bactericidal efficacy of ultraviolet C room decontamination in a clinical setting. Am J Infect Control 39:e107–e112. https://doi.org/10.1016/j.ajic.2011.01.018
11. Donskey CJ (2013) Does improving surface cleaning and disinfection reduce health care-associated infections? Am J Infect Control 41:S12–S19. https://doi.org/10.1016/j.ajic.2012.12.010
12. Foote PA, Snyder BL, Spitznagel EL (1967) RODAC plate sampling in hospital environments: methodology and applications. Appl Microbiol 15:1009–1014
13. Griffith CJ, Cooper RA, Gilmore J et al (2000) An evaluation of hospital cleaning regimes and standards. J Hosp Infect 45:19–28. https://doi.org/10.1053/jhin.1999.0705
14. Holmdahl T, Lanbeck P, Wullt M, Walder MH (2011) A head-to-head comparison of hydrogen peroxide vapor and aerosol room decontamination systems. Infect Control Hosp Epidemiol 32:831–836. https://doi.org/10.1086/661104
15. Jalali M, Khodavaisy S, Rezaei S et al (2020) Dry mist antimicrobial disinfection and microbial load reduction in hospital wards. J Infect Dev Ctries 14:848–853. https://doi.org/10.3855/jidc.12262
16. Khandelwal N, Handa A, Yadav S et al (2015) Efficacy of hydrogen peroxide nebulization in ICU decontamination. J Clin Diagn Res 9:DC01–DC04. https://doi.org/10.7860/JCDR/2015/13814.6892
17. Knobloch JK, Horstkotte MA, Rohde H, Mack D (2005) Evaluation of different methods for detection of microorganisms on environmental surfaces. J Clin Microbiol 43:2860–2865.

https://doi.org/10.1128/JCM.43.6.2860-2865.2005

18. Ledwoch K, Maillard JY (2018) Are we really measuring what matters in hospital environmental surface decontamination studies? J Hosp Infect 100:e81–e91. https://doi.org/10.1016/j.jhin.2018.01.024
19. Mahida N, Boswell T (2018) Non-touch disinfection technologies: a review of clinical evidence. J Infect Prev 19:20–28. https://doi.org/10.1177/1757177417720004
20. Mangram AJ, Horan TC, Pearson ML et al (1999) Guideline for prevention of surgical site infection, 1999. Infect Control Hosp Epidemiol 20:250–278. https://doi.org/10.1086/501620
21. Napolitano MG, Naclerio A, Deeg A, Burke D (2001) Usefulness of RODAC plates for evaluation of bacteriological contamination of surfaces in operating theaters. J Hosp Infect 48:120–125. https://doi.org/10.1053/jhin.2001.0943
22. Oliveira AC, Kovner CT, Silva RS (2010) Nosocomial infection in an intensive care unit in a Brazilian university hospital. Rev Lat Am Enfermagem 18:233–239. https://doi.org/10.1590/S0104-11692010000200014
23. Otter JA, Yezli S, French GL (2011a) The role played by contaminated surfaces in the transmission of nosocomial pathogens. Infect Control Hosp Epidemiol 32:687–699. https://doi.org/10.1086/660363
24. Otter JA, Yezli S, Perl TM et al (2013) Is there a role for 'no-touch' automated room disinfection systems in infection prevention and control? J Hosp Infect 83:1–13. https://doi.org/10.1016/j.jhin.2012.11.002
25. Padoveze MC, Fortaleza CMCB (2014) Healthcare-associated infections: challenges for public health in Brazil. Rev Saude Publica 48:995–1001. https://doi.org/10.1590/S0034-8910.2014048004616
26. Rainina E, Berzina I, Naidenov V, Shestakovskaya I (2017) Evaluation of micro-aerosol technology for hospital surface decontamination. J Hosp Infect 97:224–230. https://doi.org/10.1016/j.jhin.2017.07.018
27. Rutala WA, Weber DJ (2013) Disinfectants used for environmental disinfection and new room decontamination technology. Am J Infect Control 41:S36–S41. https://doi.org/10.1016/j.ajic.2012.11.006
28. Sartelli M, Pagani L, Iannazzo S et al (2020) A proposal for a comprehensive approach to infections across the surgical pathway. World J Emerg Surg 15:13. https://doi.org/10.1186/s13017-020-00295-3
29. Triggiano F, Pace MC, Dambrosio M et al (2021) Fogging with combined hydrogen peroxide and ethanol solution in hospital settings: laboratory and in-hospital evaluation. Int J Environ Res Public Health 18:8888. https://doi.org/10.3390/ijerph18178888
30. Weber DJ, Anderson D, Rutala WA (2013) The role of the surface environment in healthcare-associated infections. Curr Opin Infect Dis 26:338–344. https://doi.org/10.1097/QCO.0b013e3283630f04

31. World Health Organization (2011) Report on the burden of endemic health care-associated infection worldwide. WHO, Geneva

Figures

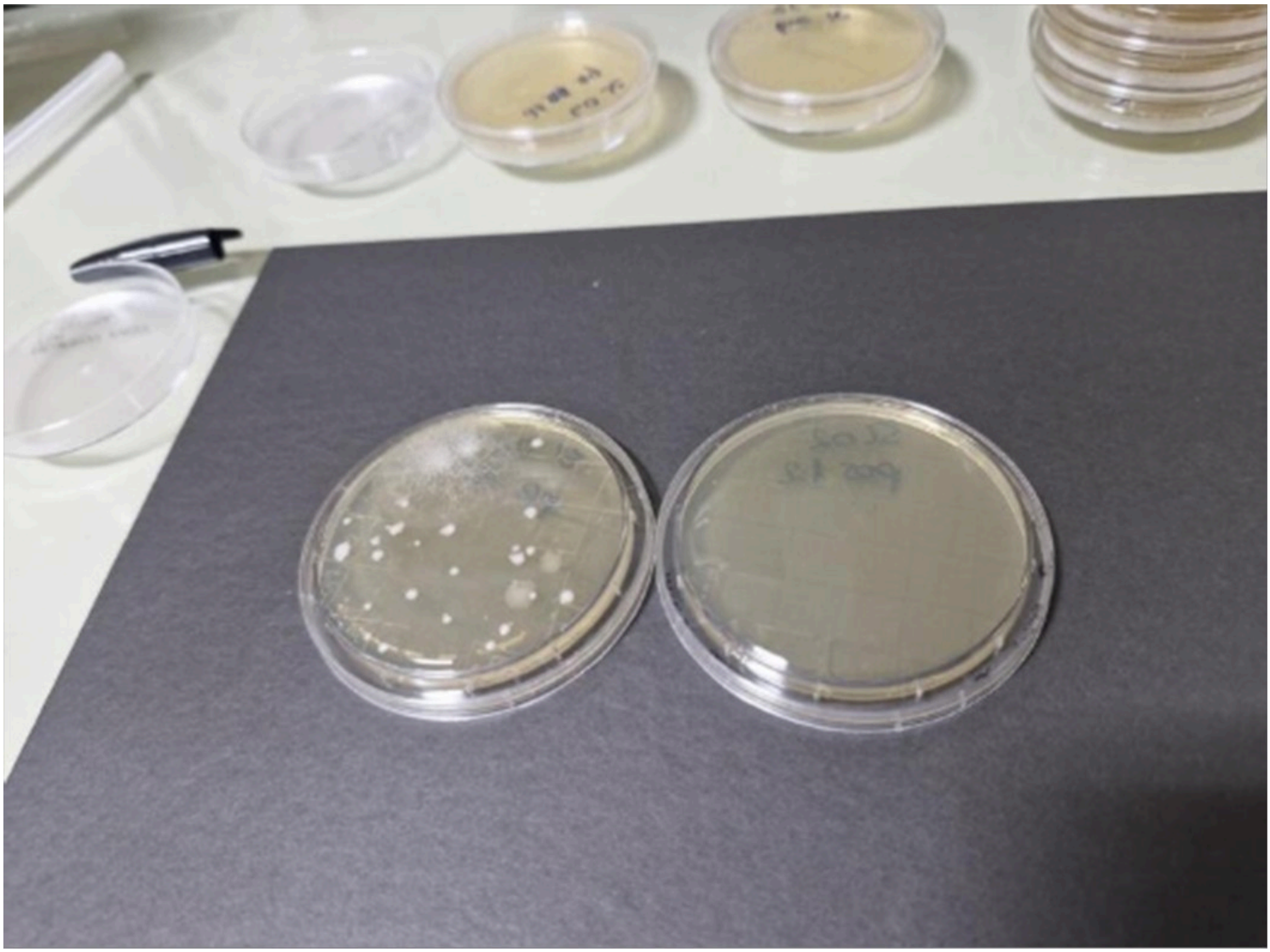


Figure 1

Representative RODAC contact plate pair from Surgical Room 01 (Endoscopy). Left: pre-intervention plate showing multiple bacterial colonies. Right: post-intervention plate following nanometric mist application, demonstrating complete absence of microbial growth (0 CFU).

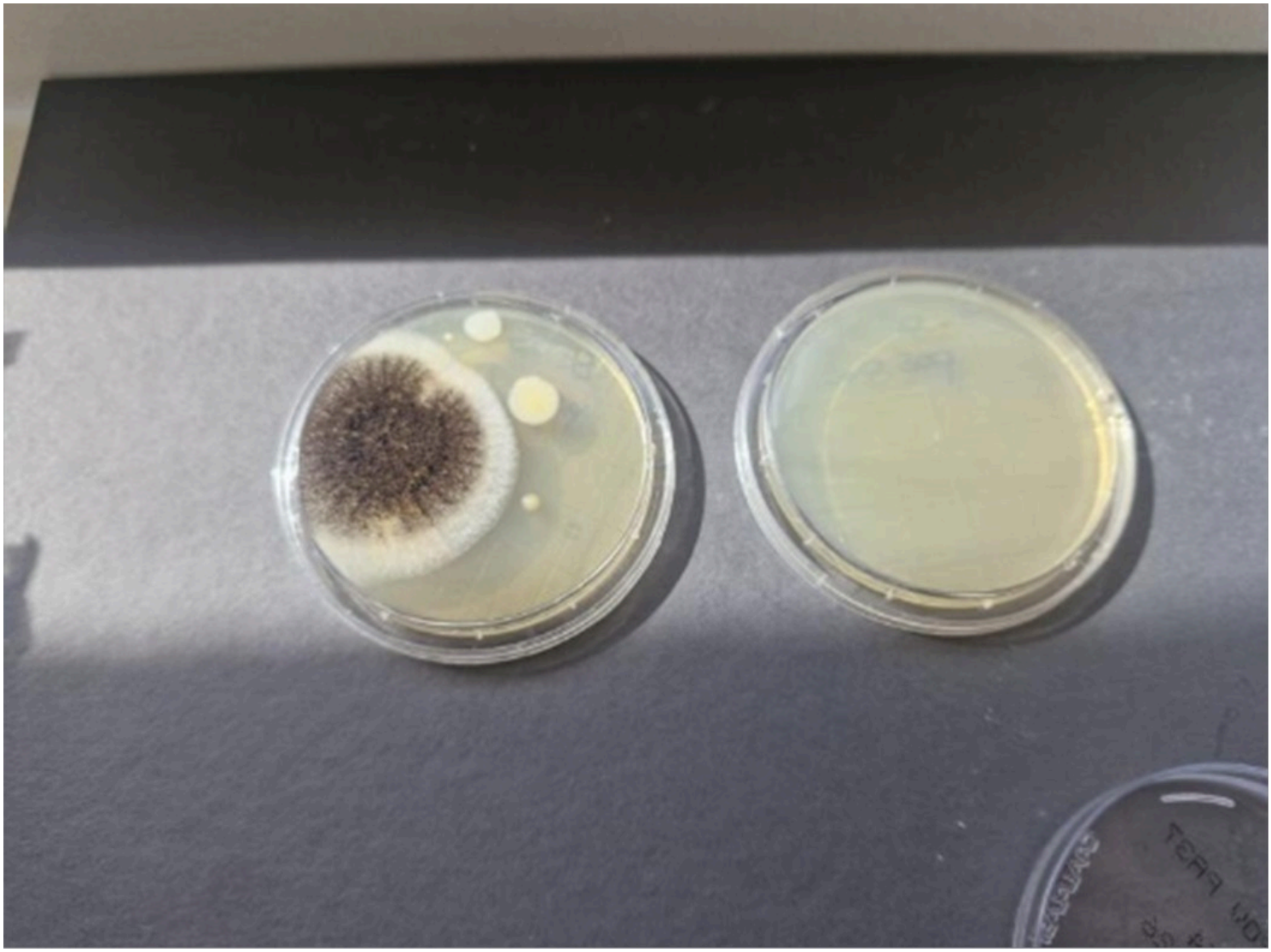


Figure 2

RODAC contact plate pair from Surgical Room 02. Left: pre-intervention plate with extensive dark filamentous fungal growth and satellite bacterial colonies (>100 CFU at this sampling point). Right: post-intervention plate with complete absence of detectable microbial growth.

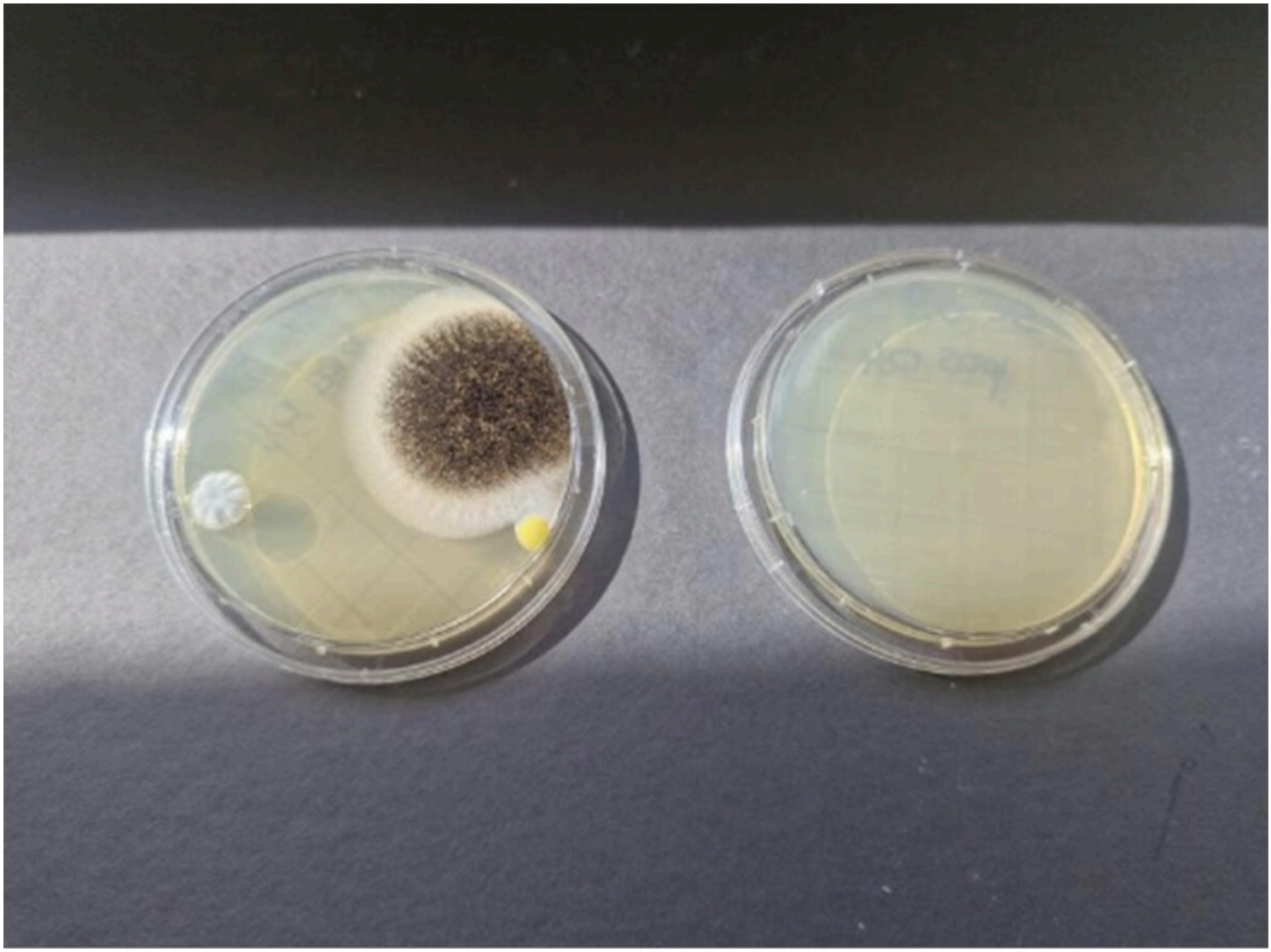


Figure 3

RODAC contact plate pair from Surgical Room 02. Left: pre-intervention plate showing exuberant filamentous fungal growth with dark conidia compatible with Aspergillus sp., accompanied by yeast and bacterial colonies. Right: post-intervention plate with no detectable microbial growth following nanometric mist application.

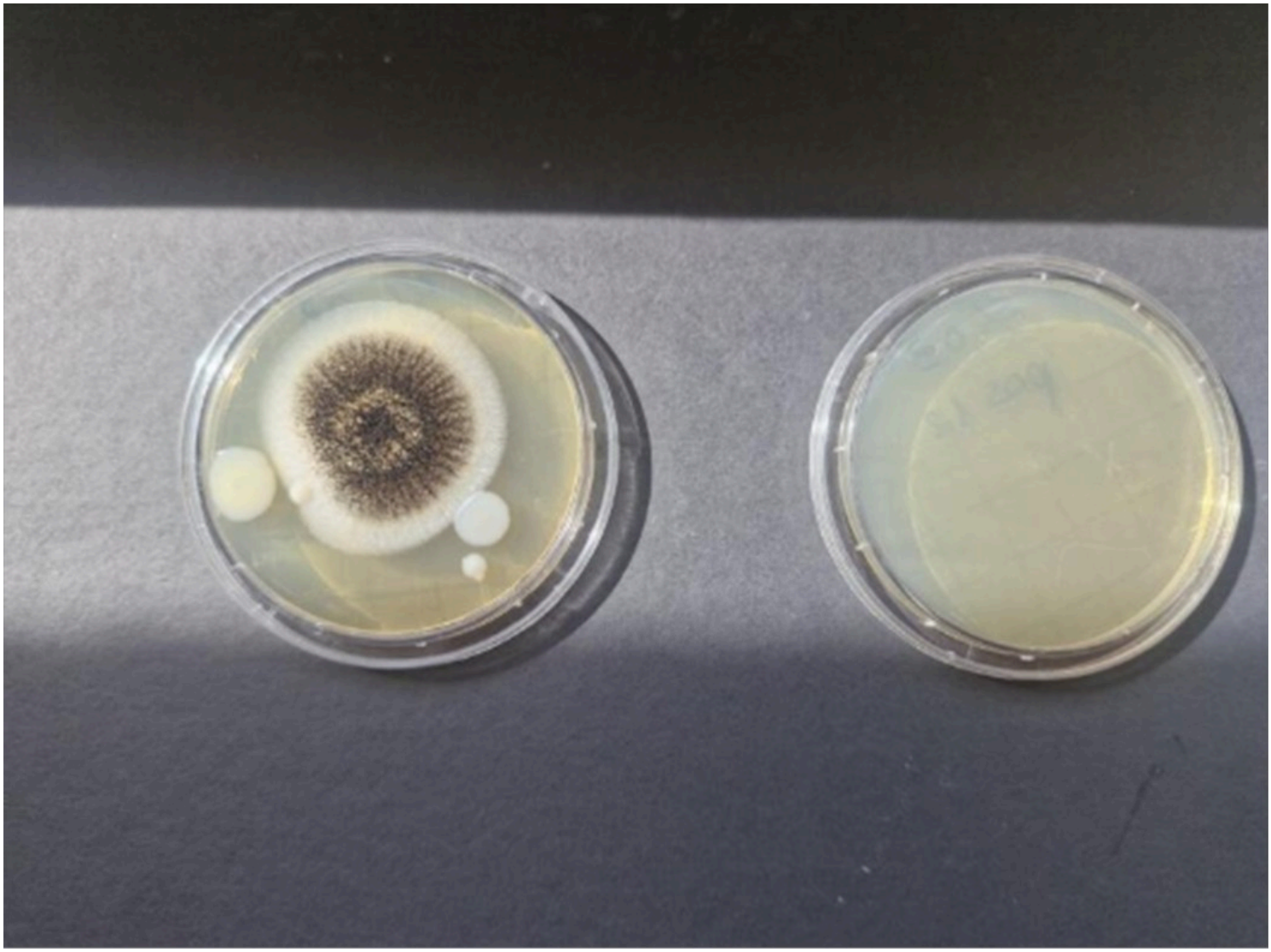


Figure 4

RODAC contact plate pair from Surgical Room 03. Left: pre-intervention plate showing pigmented filamentous fungal growth with satellite bacterial colonies. Right: post-intervention plate after nanometric mist application, with complete absence of detectable microbial growth.