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Cold Atmospheric Plasma as a Preoperative Modality for Infection Control: A Systematic Review

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ABSTRACT

Introduction: Surgical site infections remain a major concern in the perioperative period, and the rising prevalence of antimicrobial resistance highlights the need for non-antibiotic methods. One such method is cold atmospheric plasma (CAP), which has the potential to reduce microbial load and lower the risk of infections. This review evaluated preclinical and experimental evidence on CAP for preoperative infection control.

Materials and Methods: A systematic search was performed in PubMed, Scopus, Web of Science, Embase, and IEEE Xplore for studies published up to 2025. The inclusion criteria for studies were: (1) preclinical in vivo or in vitro studies, (2) studies quantifying microbial load, biofilm reduction, or tissue antiseptics, and (3) controlled experimental designs. Studies were excluded if they were reviews, clinical trials, unrelated to preoperative applications, or lacked quantified outcomes.

Results and Discussion: A total of 27 studies involving over 1,100 biological samples and 312 animals met the inclusion criteria. Most studies evaluated the antimicrobial effects of CAP against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and multidrug-resistant organisms. Among the 19 studies, CAP application reduced in a reduction of microbial load by 2.1-4.8 log₁₀ colony-forming unit (95% CI: 1.9-5.0) compared to the control groups, with plasma-treated groups showing favorable results. Thirteen studies examined biofilm disruption and reported an average biofilm reduction of 48%-79% (95% CI: 41%-83%). In seven in vivo animal models, significant decreases in wound contamination were observed, and the CAP-treated groups had a 36% lower infection rate than those receiving standard antiseptics measures alone, indicating improved postoperative tissue integrity.

Conclusion: Our findings shows that CAP is effective in reducing microbial load, disrupting biofilms and lowering the risk of infections. However, for clinical application, it is essential to establish standardized parameters, conduct safety evaluations, and perform trials to confirm its efficacy in infection control.



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