



DECEMBER 11-12, 2025  
۲۱ و ۲۰ آذر ماه ۱۴۰۴



دومین کنگره  
پلازما پزشکی ایران

The 2<sup>nd</sup> Congress on Plasma Medicine

دبیرخانه دائمی کنگره  
پلازما پزشکی ایران  
www.plasmamedsym.ir



# Unprecedented Eradication of Biofilms on Flexible Endoscopes Using Cold Atmospheric Plasma-Aerosol

Mohammad Mahdi Ajalli

Department of Medicine, Zanjan University of Medical Sciences, Zanjan, Iran

## OPEN ACCESS

### Citation:

Ajalli MM. Unprecedented Eradication of Biofilms on Flexible Endoscopes Using Cold Atmospheric Plasma-Aerosol. *Iran Biomed J. Supplementary* (2026): 50.



This article is licensed under a Creative Commons Attribution-NonDerivatives 4.0 International License.

**Keywords:** Biofilm inactivation, Cold atmospheric plasma, Endoscope sterilization, Low-temperature disinfection, Reactive species

## ABSTRACT

**Introduction:** Sterilization of medical equipment is critical to prevent healthcare-associated infections, yet conventional methods often fail against resilient biofilms on heat-sensitive devices. However, effective low-temperature alternatives that eradicate biofilms without damaging materials remain elusive. In this study, we demonstrate the unprecedented efficacy of cold atmospheric plasma-aerosol (CAP-A) in sterilizing biofilm-contaminated endoscopes.

**Materials and Methods:** We exposed *Pseudomonas aeruginosa* and *Staphylococcus aureus* biofilms on flexible endoscopes to CAP-A generated from a helium-oxygen mixture at room temperature. Treatment durations ranged from 5 to 15 minutes, followed by viability assessments via colony-forming unit counts and confocal microscopy.

**Results and Discussion:** CAP-A treatment reduced biofilm viability by over 6 log units (99.9999% inactivation) within 10 minutes, compared to less than 2 log units for hydrogen peroxide vapor ( $n = 12$ ;  $p < 0.001$ ). Reactive oxygen and nitrogen species penetrated biofilms up to 50  $\mu\text{m}$  deep, resolving structures at 1  $\mu\text{m}$  resolution via microscopy. No material degradation occurred, with surface integrity preserved (>99% similarity to controls). Against multi-species biofilms, inactivation reached 7 log units, establishing superior performance over prevailing low-temperature methods.

**Conclusion:** The approach suggested in our study establishes CAP-A as a transformative sterilization technique for thermolabile medical devices, paving the way for reduced infection rates in clinical settings.

**Corresponding Author:** Mohammad Mahdi Ajalli

Department of Medicine, Zanjan University of Medical Sciences, Zanjan, Iran; E-mail: Zums.mma@gmail.com



Iranian Biomedical Journal Supplementary (February 2026): 50