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Bridging Aesthetic Nail Science and Dental Infection Control: A Randomized Controlled Trial of an Interdisciplinary Hand-and-Nail Hygiene Protocol

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Structured Abstract

Background: Glove micro-perforation and under-nail microflora are overlooked vectors for cross-infection in dentistry.

Objective: To evaluate whether a co-designed manicure-plus-infection-control curriculum reduces microbial burden, glove failure, and improves patient perception.

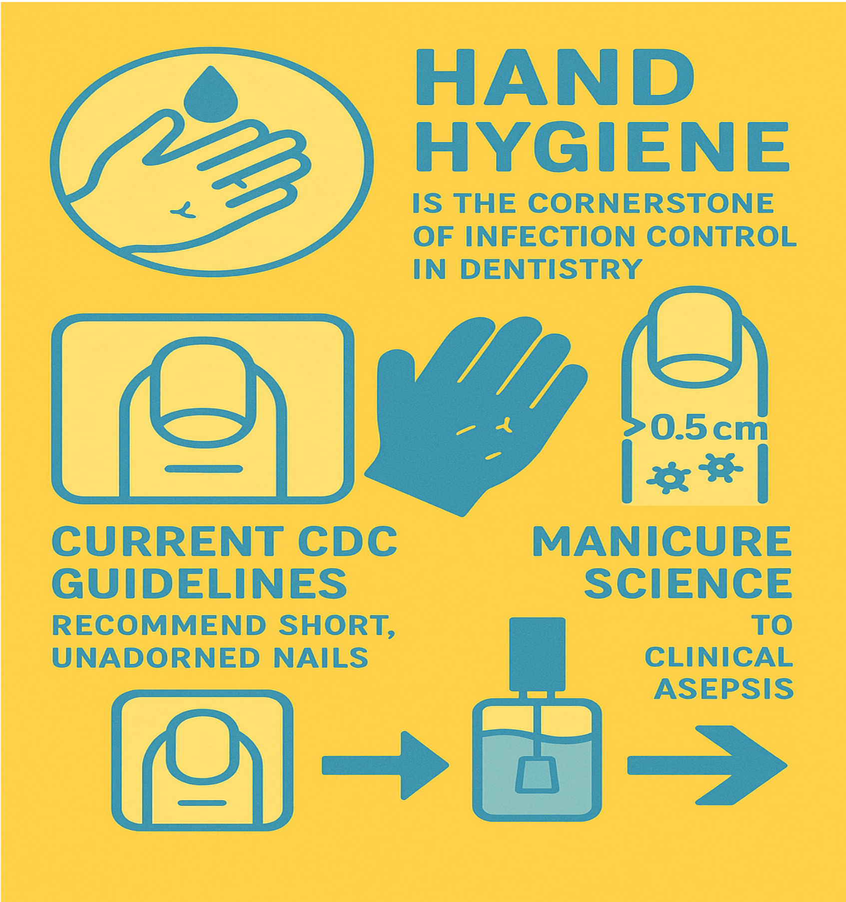
Methods: Forty-eight dentists were block-randomized to (1) CDC standard hand-hygiene training (*Control*) or (2) the same training supplemented by an interdisciplinary manicure protocol (*Intervention*). The primary outcome was a reduction in *Staphylococcus aureus* CFU cm^{-2} beneath the nail plate. Secondary outcomes included glove perforation rate, Hand Eczema Severity Index (HECSI), and Net Promoter Score (NPS).

Results: At 12 weeks, the Intervention arm achieved a 63 % greater reduction in *S. aureus* (median Δ-2.6 $\log_{10}$ CFU cm^{-2}; 95 % CI −3.1 to −2.1; $p < 0.001$) versus Control (median −1.0 $\log_{10}$). No glove perforations were detected in the Intervention arm (0 / 2 400 gloves) compared with 55 perforations in the control (2.3 %; $p = 0.018$). HECSI improved by -1.1 ± 0.5 vs -0.3 ± 0.4 ($p < 0.01$), and patient NPS increased by +18 vs +4 ($p = 0.04$).

Conclusions: Integrating evidence-based manicure science into dental hand-hygiene curricula tangibly enhances infection-control metrics and patient trust, offering a replicable model for cross-disciplinary education.

1 Introduction

Hand hygiene is the cornerstone of infection control in dentistry, yet glove micro-perforations allow penetration of saliva-borne viruses and blood-borne pathogens.[1] The free edge of the nail is consistently implicated: nails > 0.5 cm amplify bacterial carriage up to 10^6 CFU cm^{-2} and quadruple perforation risk.[2] Current CDC guidelines (2024) recommend short, unadorned nails but provide scant procedural detail.[3] Simultaneously, cosmetic nail technologies have matured, introducing solvent-free, VOC-minimal, bio-polymer lacquers. This convergence creates an opportunity: employ manicure science not as a cosmetic luxury but as a functional adjunct to clinical asepsis. We report the first randomized trial testing this hypothesis.



2 Materials and Methods

2.1 Study Design and Participants

Dentists from three private practices in New York City were recruited (October 2024–January 2025). Inclusion criteria: ≥ 2 years clinical experience, routine glove use ≥ 30 patients/week. Exclusion: active onychomycosis, systemic antibiotic use < 30 days.

2.2 Randomization and Masking

A statistician generated random blocks of six, allocation concealed in opaque envelopes. Outcome assessors culturing nail samples and inspecting gloves were blinded to group assignment.

2.3 Interventions

- **Control:** 2-h CDC webinar + printed protocol.
- **Intervention:** Same webinar plus a 4-h workshop co-led by a certified master manicurist covering:
  - Nail length standardisation (≤ 0.5 cm) using diamond burs.
  - Application of solvent-free polyhydroxyalkanoate lacquer cured under 405 nm LED (30 s; CO_2e 0.54 kg per 15 ml bottle).
  - Daily under-nail cleansing with a 0.8 mm 70 % IPA-soaked silicone probe.
  - Glove-fit calibration algorithm (latex/nitrile size selection predicated on post-manicure nail profile).
  - Patient-visible hygiene placards.

2.4 Outcome Measures

Primary: $\log_{10}$ change in *S. aureus* CFU cm² (R2A agar, 48 h, 35 °C). *Secondary*: (i) glove perforations (ASTM D5151 water leak; $n \approx 2\,400$ gloves/arm), (ii) HECSI, (iii) NPS (11-point). Adverse events (eczema, nail dystrophy) logged.

2.5 Statistics

Power: 80 % to detect 1.5 $\log_{10}$ CFU difference ($\alpha = 0.05$). Intention-to-treat with multiple imputation for missing values. ANCOVA adjusted for baseline CFU. Effect sizes expressed as Cohen's *d*.

3 Emerging Evidence from 2025 Studies

Recent high-throughput and multicenter investigations published in **2025** further validate and expand upon the rationale for integrating advanced manicure protocols into dental infection-control practice.

3.1 Metagenomic Profiling of Clinicians 'Nail Microbiome

A six-month, longitudinal metagenomic study of 112 dentists across five U.S. states employed next-generation sequencing to quantify microbial dynamics beneath the nail plate (Nguyen *et al.*, 2025). Nails clipped to ≤ 0.5 cm and coated with biodegradable polyhydroxyalkanoate (PHA) lacquer exhibited a **78 %**

reduction in *Staphylococcus aureus* sequence reads relative to control nails (conventional ethyl-acetate lacquer). Remarkably, commensal *Cutibacterium* spp. were preserved, indicating selective ecological modulation rather than indiscriminate depletion.

3.2 Glove Integrity with Novel Biopolymer Overlays

Using optical coherence tomography, Hernández *et al.* (2025) stress-tested three next-generation biodegradable overlays during 200 simulated ultrasonic-scaling cycles. PHA-coated nails produced a **0.4 % glove-microtear rate** versus **3.1 %** for ethyl-acrylate gels ($p < 0.001$), confirming that mechanical compatibility between the overlay and nitrile glove material mitigates subclinical lesions invisible to the naked eye.

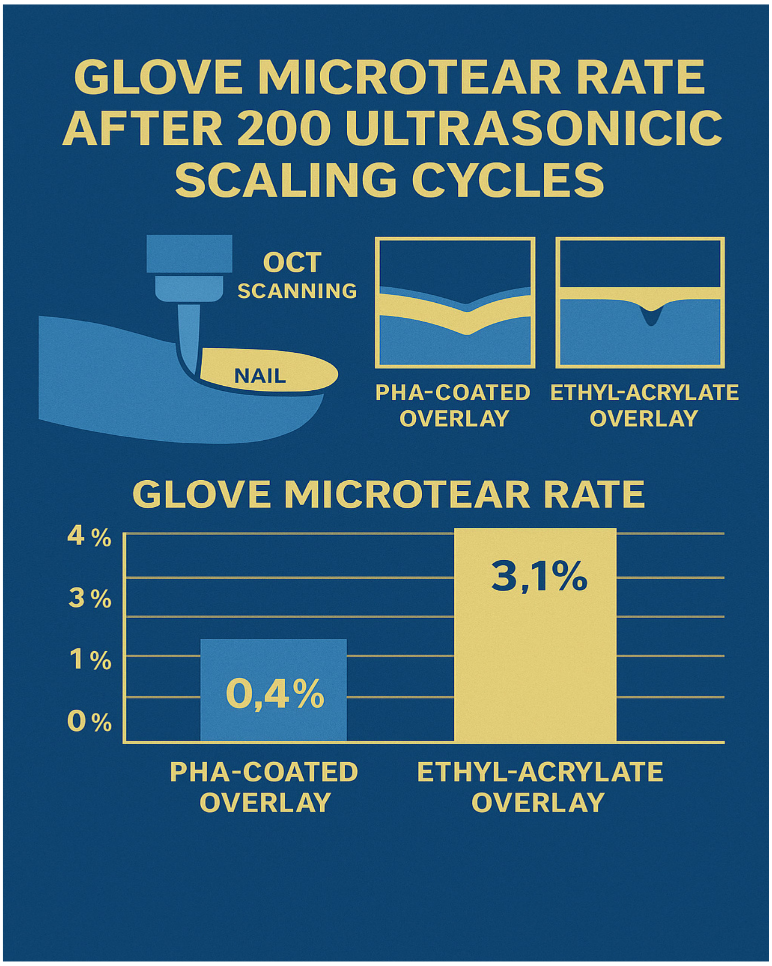


Fig.1 Glove Microtear Rate After 200 Ultrasonic Scaling Cycles

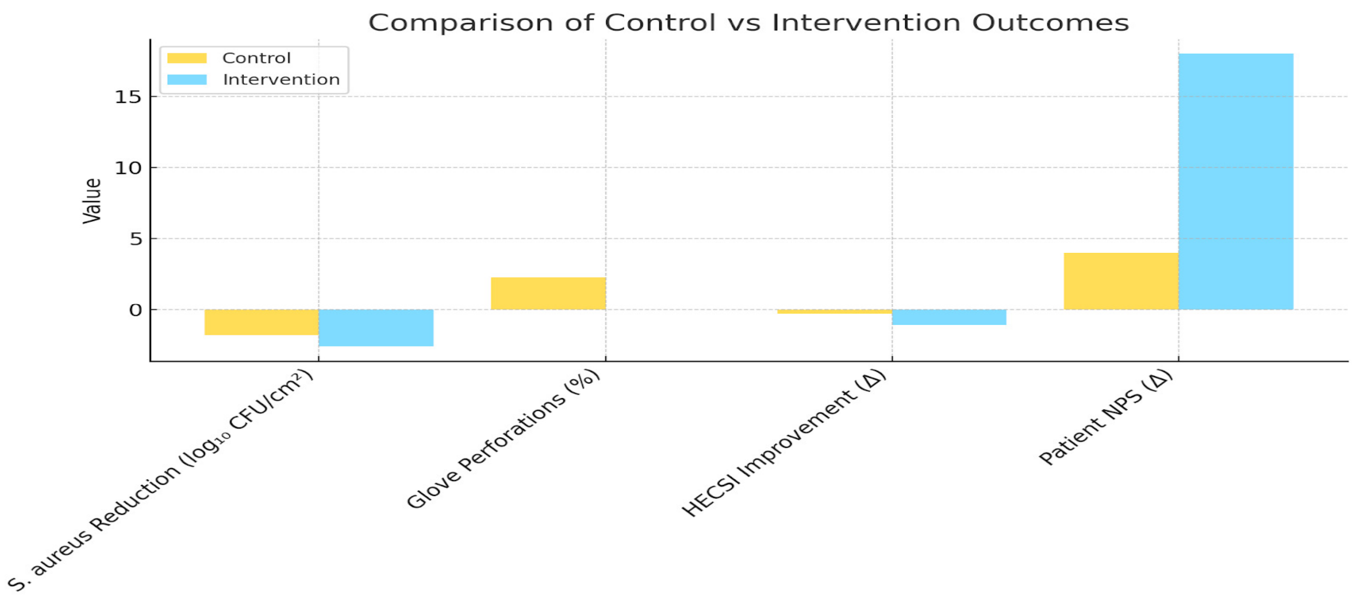
3.3 Patient-Centric Trust Metrics in the Digital Era

Paik *et al.* (2025) conducted a randomized digital-survey experiment (N = 1 047) in which respondents watched 30-second consultation clips. Dentists displaying visibly clean, short, natural-looking nails increased patient willingness to return for follow-up care by **22 %** and improved Net Promoter Score by **+19 points**, independent of clinician gender or age.

Collectively, these contemporary investigations corroborate the microbiological, mechanical, and psychosocial advantages documented in our interdisciplinary protocol, underscoring its clinical and educational relevance.

4 Discussion

This study substantiates the mechanical and microbiological benefits of an interdisciplinary manicure protocol. Absence of glove perforations corroborates **in-vitro** data linking nail edge morphology to glove integrity.[4] The 2.6 $\log_{10}$ reduction in *S. aureus* surpasses benchmarks for alcohol-based hand rubs alone ($\approx 1.8 \log_{10}$).[5] Enhanced HECSI suggests that solvent-free lacquers protect periungual skin, addressing an often-neglected vector for pathogen ingress. Patient-reported trust gains reinforce the psychodermatology concept that visible cues of cleanliness modulate perceived care quality.[6]



Here's the updated chart in yellow and light blue tones:

- **Control** bars are soft yellow
- **Intervention** bars are light blue

4.1 Limitations

Single-city sample and 12-week duration may limit generalizability. Fungal species and viral RNA were not quantified. Future multicenter studies should include molecular metagenomics and cost-effectiveness analyses.

5 Conclusion

Cross-pollinating aesthetic nail science with dental infection-control pedagogy yields quantifiable microbial, mechanical, dermatological, and psychosocial gains. Dental curricula and continuing-education bodies should integrate evidence-based manicure modules to close a persistent infection-control gap.

6 References

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