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Continuous Hydroxyl Radical Air Disinfection and Infection Outcomes in a Geriatric Long-Term Care Department: A Prospective Cohort Study

Airborne transmission is an important driver of health care–associated infections in long-term care facilities (LTCFs), yet remains underaddressed in day-to-day prevention.[1] Continuously active air disinfection—using UV-C–driven hydroxyl radical generation—offers a practical approach that operates safely in occupied spaces and complements standard measures[2-8] We evaluated the real-world effectiveness of such a system in reducing infectious outcomes among frail older adults in an LTCF.

We conducted a prospective controlled cohort study in 2 adjacent LTCF units at a single center in a metropolitan area. The units provide identical levels of care with comparable staffing and environment. In January 2023, 3 ceiling-mounted hydroxyl radical generators (medical-grade UV-C–driven system) were installed in the intervention unit and operated continuously; the control unit continued routine care without added air disinfection. The resident population comprised medically complex older adults requiring continuous nursing care (mean age 82 years; 64% women). Baseline clinical and demographic characteristics differed modestly between units. Data were extracted from the electronic medical record for 2 consecutive years: 2022 (preintervention) and 2023 (intervention).

The primary outcome was the incidence of clinically suspected infectious disease symptoms (fever, new respiratory symptoms, acute gastrointestinal symptoms, urinary symptoms, cellulitis/erysipelas, or acute cognitive/functional decline suspected to be infectious). These outcomes reflect clinically suspected infections documented in routine nursing and physician notes and were abstracted from the electronic medical record using predefined criteria applied consistently across both units. Secondary outcomes were all-cause hospitalizations and all-cause mortality; hospitalizations were stratified by infectious vs noninfectious indications.

The analysis included 242 resident-years (122 in the control unit; 120 in the intervention unit). Residents could contribute data in 1 or both study years depending on length of stay, and multiple infection events per resident were permitted. Primary comparisons assessed the change in infection incidence from 2022 to 2023 within each unit and the between-unit difference in these changes, operationalized as a time (2022 vs 2023) × unit (intervention vs control) interaction. Mixed-effects regression models tested the time × unit interaction using 5000 bootstrap resamples. When rate distributions deviated from normality, rates were log-transformed. Adjusted models accounted for baseline differences in resident characteristics. For hospitalizations and mortality, rates were compared across years and units using Fisher's exact tests, and a logistic regression model including time, unit, and a time × unit interaction term was used to assess whether changes over time differed between units. The protocol received institutional review board approval with a waiver of individual informed consent, given unit-level implementation and analysis of aggregated deidentified data.

In 2022 (preintervention), infection incidence did not differ between units. In 2023 (intervention period), infection incidence in the intervention unit was lower than its 2022 baseline ($P = .02$) and lower than the contemporaneous control unit ($P = .01$). Figure 1 depicts annual infection incidence (events per resident-year): rates decreased in the intervention unit from approximately 1.88 per resident-year in 2022 to 0.98 per resident year in 2023, whereas rates in the control unit remained stable (1.61 in 2022 vs 1.57 in 2023). Overall infections declined in the intervention unit from 51.6 to 26.8 per 10,000 resident-days between 2022 and 2023, whereas rates in the control unit remained stable (44.1 to 43.1 per 10,000 resident-days). Adjusted models showed a significant time × unit interaction ($\beta = -0.55$; 95% CI, -0.85 to 0.25; $P < .001$), indicating a larger decline over time in the intervention unit after adjustment for measured baseline differences. Reductions were most evident in chest and viral infections in the intervention unit. Hospitalizations were similar across units and years, overall and by indication. Infectious admissions were 10 of 16 (2022) and 11 of 22 (2023) in the intervention unit, and 7 of 11 (2022) and 11 of 19 (2023) in the control unit. Mortality trends diverged: in the control unit, mortality increased from 6.8% to 19.0% ($P = .031$), whereas in the intervention unit mortality changed from 21.4% to 23.4% ($P = .665$). A logistic regression model including time, unit, and a time × unit interaction, adjusting for baseline resident characteristics (age, sex, comorbidity, and functional status), demonstrated that the interaction was not statistically significant ($P = .159$).

We therefore demonstrated that continuously active hydroxyl radical air disinfection was corelated with a marked decline in suspected respiratory and viral infectious disease symptoms. Although the time × unit interaction for mortality was not statistically significant, mortality trends differed descriptively between units; as mortality was a secondary, exploratory outcome and the study was not designed or sized to detect mortality differences, these findings are hypothesis generating and warrant confirmation in larger, adequately powered studies. Our findings align with prior reports that advanced air treatment can reduce

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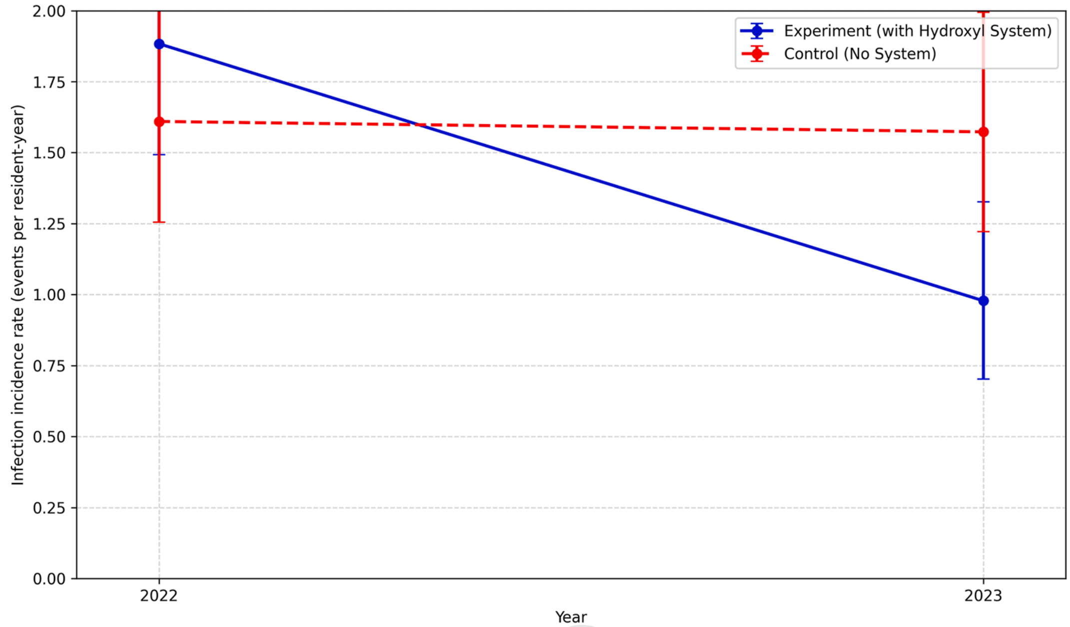

Fig. 1. Mean annual infection incidence rate by unit and study year (2022–2023). Mean infection rate represents an incidence rate expressed as infection events per resident-year. Rates are shown for the intervention unit (hydroxyl radical air disinfection) and the control unit in the preintervention year (2022) and the intervention year (2023). Error bars represent 95% CIs. Blue line: intervention unit (with hydroxyl system); red line: control unit (no system). Infection incidence declined significantly in the intervention group but remained unchanged in the control group.

airborne pathogen burden and respiratory infections in nursing homes and other congregate care environments,[1,9] consistent with recent evidence from long-term care settings using germicidal UV light.[10] At the same time, intervention evidence in LTCFs remains mixed: a randomized trial of in-room portable HEPA air purifiers in residential aged care did not demonstrate a significant reduction in acute respiratory infection incidence, suggesting that effectiveness may depend on the specific technology and implementation context.[11] Together, these data underscore the value of continuous, unattended environmental controls that do not require staff compliance or room vacancy. Given the complexity of airflow in clinical spaces[5] and the absence of environmental, airflow, or HVAC measurements, we cannot draw mechanistic conclusions regarding ventilation in this setting.

Study limitations include a single-center implementation, unit-level intervention, and possible residual confounding despite adjustment. Outcome definitions relied on electronic medical record–documented clinical criteria; therefore, misclassification and clinician-to-clinician variability in documentation are possible and hospitalization decisions may be influenced by nonclinical factors. Nonetheless, the concurrent control, year-over-year design, and adjusted mixed modeling provide real-world evidence relevant to LTCFs. Continuous air disinfection may complement infection-prevention bundles and mitigate respiratory infectious burden during seasonal surges. Because the technology is designed for use in occupied rooms, it may be operationally feasible for high-risk, resource-constrained long-term care environments.[2-8]

Disclosure

This study was supported by Hydroxyl Israel Ltd and Pyure USA Ltd. Installation of the air disinfection devices was funded by the company that distributes the technology locally and by the U.S. manufacturer. Y.M. is affiliated with the local distributing company, and I.G. serves as an independent scientific advisor to that company. The other authors report no conflicts of interest. The funder had no role in the study design, data collection, statistical analysis, interpretation, or manuscript preparation.

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