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Comparative Analysis of Air Purification Devices in Dental Laboratories

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ADMINISTRATIVE INFORMATION

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Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 22 April 2024 and was last updated on 22 April 2024.

INTRODUCTION

Review question / Objective 1. Conduct a detailed comparison of HEPA filters, UV-C light systems, and ionizers, focusing on their key features, benefits, and drawbacks in the context of dental laboratory usage.
2. Evaluate factors such as size, portability, noise level, maintenance requirements, and ease of use for each type of device to determine their suitability for dental laboratory environments.
3. Assess the performance metrics of each air purification device, including filtration efficiency, airflow rate, particle removal rate, and effectiveness in eliminating airborne pathogens.
4. Conduct a comprehensive cost analysis of HEPA filters, UV-C light systems, and ionizers, considering both upfront costs (purchase price) and ongoing operational expenses (e.g., energy consumption, filter replacements).

Rationale This narrative review objectives encompass conducting a detailed comparison of HEPA filters, UV-C light systems, and ionizers in dental laboratories, evaluating their key features, suitability, performance metrics, and cost-effectiveness. When selecting air purification devices for dental laboratories, it's essential to prioritize systems that effectively capture particles and eliminate harmful microorganisms while minimizing the production of ozone. By choosing the right combination of filtration technologies, dental laboratories can maintain clean and safe air quality, promoting the well-being of both staff and patients. The purpose of this study is to conduct a comprehensive comparative analysis of various air purification devices commonly utilized in dental laboratories. By evaluating the performance, efficiency, and cost-effectiveness of different air purification technologies, this research aims to provide valuable insights into selecting the most suitable solutions for improving air quality in dental settings.

Condition being studied In dental laboratories, maintaining optimal air quality is paramount due to the presence of various airborne contaminants that pose potential health risks to both dental

professionals and patients. The nature of dental procedures and laboratory activities generates a diverse range of pollutants, including aerosols, volatile organic compounds, and microorganisms. These contaminants can contribute to respiratory issues, allergic reactions, and the spread of infectious diseases if not effectively managed. Recognizing the significance of mitigating airborne pollutants, dental laboratories often deploy air purification devices as a crucial component of their occupational health and safety protocols. These devices are designed to remove or neutralize harmful particles, gases, and microorganisms from the air, thereby creating a safer and healthier working environment for laboratory personnel and ensuring the well-being of patients. Common air purification devices used in dental laboratories include standalone medical-grade air purifiers, dust collection systems with HEPA filtration, and devices equipped with UV radiation production bulbs or plasma technology. These devices are essential for maintaining clean and safe air quality in dental settings by capturing harmful particles, pathogens, and volatile organic compounds that can be present in the air. Standalone air purification systems are effective in capturing bacteria and viruses, while dust collection systems with HEPA filtration help keep the air clean and safe for dental professionals to breathe.
Furthermore, certain apparatus are engineered for the purpose of monitoring and purifying the ambient air within the broader premises where the dental unit is situated, whereas others are equipped with specialized suction extensions intended to access the operational field and the oral cavity of the patient. The efficacy of air purifiers with HEPA 14 filters has been demonstrated in reducing airborne contaminants in dental care facilities, emphasizing the importance of these devices in mitigating the spread of infections and improving indoor air quality.

METHODS

Search strategy To conduct a comprehensive search on the "comparative analysis of air purification devices in dental laboratories", a PubMed search was initiated using Mesh Keywords "Dental Laboratories OR Dental Clinics OR Dentistry OR Dental Clinics / standards OR Dental Offices / standards OR Dental Care OR Air Filters OR Air Microbiology OR Air Pollution, Indoor / prevention & control OR Pandemics / prevention & control OR Temperature." The search was refined by excluding records published between 2020 and 2023, limiting results to freely accessible full texts, filtering out non-relevant article types such as clinical trials and reviews, restricting language to English, and focusing on studies involving human subjects. After applying these filters, the search yielded 9 highly relevant studies meeting the criteria for inclusion in the comparative analysis This strategy ensures the retrieval of recent, accessible, and pertinent research articles essential for evaluating the effectiveness of air purification devices in dental laboratory settings.

Participant or population Laboratories using Air purification filters.

Intervention Not applicable.

Comparator Not applicable.

Study designs to be included Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) criteria.

Eligibility criteria Studies published in English.

Information sources Comprehensive search on the "comparative analysis of air purification devices in dental laboratories", a PubMed search was initiated using Mesh Keywords "Dental Laboratories OR Dental Clinics OR Dentistry OR Dental Clinics / standards OR Dental Offices / standards OR Dental Care OR Air Filters OR Air Microbiology OR Air Pollution, Indoor / prevention & control OR Pandemics / prevention & control OR Temperature." The search was refined by excluding records published between 2020 and 2023, limiting results to freely accessible full texts, filtering out non-relevant article types such as clinical trials and reviews, restricting language to English, and focusing on studies involving human subjects.

Main outcome(s) In conclusion, the comparative analysis of air purification devices in dental laboratories underscores the importance of understanding the trade-offs between HEPA filters, UV-C systems, and air ionizers. Each device offers unique benefits and drawbacks, emphasizing the need for informed decision-making tailored to specific needs and priorities within dental settings.

Data management This systematic review was conducted by the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) standards and submitted to PROSPERO with number ID: CRD-487956.

Quality assessment / Risk of bias analysis The evaluation of the risk of bias for the selected studies was carried out independently. In case of disagreement, the third author was consulted. A consensus was reached through discussion. Risk

of bias rated as “low,” “high” or “medium” and plotted traffic light plot using RStudio software version R 4.3.1.

Figure 1A shows the traffic light plot for reviews articles. ROBIS tool was employed to evaluate the risk of bias in six systematic reviews. While most reviews demonstrated moderate methodological quality, Hammond et al. 2021 stood out with better rigor in study selection and data collection, achieving a medium risk of bias rating. Conversely, reviews such as Scarano et al. 2020 and Dexter et al. 2020 had more comprehensive issues, yet all studies maintained some methodological strengths worth noting.

Figure 1B shows the traffic light plot for RCT. Capparè et al. 2022's randomized controlled trial, assessed using Cochrane's Risk of Bias Tool, showed low risks in key areas such as random sequence generation, allocation concealment, and blinding, reflecting a well-structured study design. The trial, however, faced medium risks related to incomplete outcome data and selective reporting, which are areas for improvement but didn't significantly detract from the overall robustness of the study.

Figure 1C shows the traffic light plot for observational studies. Boccia et al. 2023 and Zhao et al. 2021, reviewed through the STROBE framework, revealed high risks of bias but also displayed certain strengths like data measurement and discussion of limitations, particularly in the Boccia study. Although both studies encountered methodological challenges, their approaches in certain areas like funding utilization and statistical methods indicated potential for foundational reliability. Such insights underscore the need for careful interpretation but acknowledge the foundational efforts in research methodology.

Strategy of data synthesis The study selection process involved a systematic search and filtering of literature from PubMed®/MEDLINE, using keyword search terms like "Dental Laboratories," "Dental Clinics OR Dentistry," "Dental Clinics / standards," "Dental Offices / standards," "Dental Care," "Air Filters," "Air Microbiology," "Air Pollution, Indoor / prevention & control," "Pandemics / prevention & control," and "Temperature." Initial search yielded 1,254,577 articles, which was then refined to focus on articles published between 2020 and 2023, narrowing the results down to 261,210. Further filtration for free full-text access resulted in 145,992 articles. The search was subsequently refined to specific article types including Clinical Trials, Observational Studies, Randomized Controlled Trials, Reviews, and Systematic Reviews, reducing the number to 14,246. A language filter for articles in English was applied, resulting in 14,045 articles, and subsequent refinement based on species relevance brought this number down to 8,099 articles. The final step in the process identified only 9 studies as highly relevant, demonstrating stringent criteria for relevance and quality in the context of recent dental practices and air quality standards.

Subgroup analysis The data was compiled from a variety of articles:

- Author(s), year of publication, country, study design.
- Total number of patients/datasets.
- Training/validation datasets
- Test datasets.

Sensitivity analysis Not applicable.

Language restriction Only articles in English.

Country(ies) involved Saudi Arabia.

Keywords Air purification devices; Dental laboratoires; Air quality; Comparative analysis; Filtration systems and Infection control.

Dissemination plans All the Data will be shared after publication of the article.

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