Title: Airborne Contaminants in Dentistry: A Comprehensive Review of Microbial, Chemical, and Environmental Emissions During Clinical Procedures

Principal Investigator (PI) name: Dr. Nazeeba Siddika, Assistant Professor of Epidemiology.

Co-PI: Dr. Ehsanul Hoque Apu, Assistant Professor of Biomedical Sciences.

Other Investigator: Dr. Sorin Teich, Dean of Bitonte College of Dentistry.

Location: Bitonte College of Dentistry, NEOMED

Abstract of project – Aerosol generation in dental settings has long been recognized as a central concern for occupational and patient safety. Dental procedures involving high-speed handpieces, ultrasonic scalers, air–water syringes, and air-polishing devices produce complex mixtures of airborne contaminants, including microbial bioaerosols, chemical emissions, and particulate pollutants. These aerosols consist of droplets and particles of varying sizes that can remain suspended in the air, disperse throughout the operatory, and be inhaled by dental personnel or patients.

The COVID-19 pandemic amplified global attention to dental aerosols, highlighting the potential role of airborne transmission in clinical environments. Although numerous studies have investigated aerosol generation during specific dental procedures, findings remain highly variable due to methodological inconsistencies, differences in measurement technologies, and heterogeneity across clinical environments. Furthermore, recent investigations indicate that aerosols generated in dentistry may contain not only microorganisms from the patient's oral cavity but also particles derived from dental materials, waterline systems, cleaning agents, and environmental dust. These components contribute to a complex exposure mixture with uncertain health implications.

Many investigations address only microbial contamination or aerosol quantity, neglecting the chemical and particulate components that also contribute to exposure. Despite the substantial interest in aerosol-related risks, a comprehensive understanding of the sources, composition, and behavior of aerosols and pollutants generated during dental procedures is still lacking. This gap hinders the development of evidence-based guidelines to optimize ventilation, personal protective equipment (PPE), material selection, and procedural workflows. A rigorous synthesis of the available evidence is therefore needed to support future occupational safety recommendations and infection-control policies.

The goals and objectives for the research project; what aspect of the overall research will be the focus of the student's research experience?

The primary aim of this research proposal is to conduct a comprehensive review of the available evidence on microbial, chemical, and particulate pollutants generated during dental procedures, with an emphasis on identifying their sources, composition, and potential health implications.

The specific aims are to:

1. Synthesize existing literature on aerosol production during dental procedures, focusing on microbial, chemical, and particulate emission profiles.
2. Identify and categorize the sources of these contaminants, including patient-derived, procedure-specific, equipment-based, and environmental origins.
3. Evaluate reported exposure levels, including particle size distributions, microbial loads, and chemical concentrations across different dental procedures and settings.

The student will gain the ability to understand the purpose and value of conducting a comprehensive review in research and how to summarize the evidence.

What is the specific research question being addressed by the research project?

What is the current evidence on the quantity, size distribution, and composition of aerosols generated during common dental procedures, and what are their primary sources?

The significance of the overall research

This comprehensive review will provide a much-needed synthesis of the diverse evidence related to aerosolized contaminants in dental settings. By integrating data on microbial, chemical, and particulate emissions, the study will offer a holistic understanding of dental aerosol composition, sources and its determinants. The findings will:

- Support the development of evidence-based infection-control policies, particularly in the wake of emerging respiratory diseases for both healthcare provider and the patient.
- Inform occupational health guidelines by clarifying the risks faced by dental personnel and identifying high-emission procedures.
- Guide improvements in clinic ventilation, procedural workflows, and equipment selection, ultimately enhancing indoor air quality.

  By providing a robust scientific foundation, this review will contribute meaningfully to the advancement of safer, more resilient, and better-informed dental clinical environments.

The research methods that will be used/learned by the student during the fellowship to address the question/problem being asked.

The students will learn how to formulate a clear and focused research question. They will learn to identify appropriate search terms, perform literature searches, and extract relevant and essential information from selected articles. The students will also develop skills in organizing and recording extracted data, synthesizing the available evidence, identifying gaps in the current literature, and proposing informed recommendations for future research directions.

The proposed methods of data analysis: Not applicable

A statement of how the anticipated findings from the fellow contribute to the success of the overall research being investigated.

The fellow's review will directly support the broader research program by providing a consolidated, methodologically rigorous foundation upon which future experimental investigations and risk-mitigation strategies can be built. Their work will help illuminate gaps in current knowledge, highlight underexplored exposure pathways, and inform the development of evidence-based recommendations for ventilation optimization, PPE design, operatory workflows, material selection, and infection-control policies. Ultimately, the fellow's findings will strengthen the scientific rationale guiding the project and enhance its impact on dental public health and occupational safety.