

# Airborne Microbial Contamination in Dental Practices in Iasi, Romania

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## Abstract

**Aim:** The aim of this study was to assess dental practice airborne microbial contamination during clinical activity in order to evaluate the risk of infection for the patients and dental staff. **Methods:** A total of 90 air samples was collected in 15 dental practices in Iasi, Romania, at the beginning of the working day and after four hours of clinical activity. On each occasion, a set of three culture medium plates was exposed for 15 minutes in two dental office sites. The air samples were tested microbiologically in the Laboratory of Microbiology at the Institute of Public Health, Iasi, Romania. The bacteriological indicators that were used were total number of mesophilic germs (TNMG; CFU/m<sup>3</sup>), *Staphylococcus aureus* (CFU/m<sup>3</sup>) and *Fungi* (CFU/m<sup>3</sup>). The bacteriological results were correlated with the treatment procedures. Collected data were analysed using statistical software ( $P < 0.05$ ). **Results:** The mean value for the TNMG in the air was 129 CFU/m<sup>3</sup> at the beginning of the day and 429.6 CFU/m<sup>3</sup> after four hours of clinical activity. The mean value of TNMG was twice as high in dental practices in which ultrasonic scaling was performed (430.3 CFU/m<sup>3</sup> and 228.3 CFU/m<sup>3</sup>, respectively). For *Fungi* counts, the values were twice as high after clinical activity (230.7 CFU/m<sup>3</sup> and 109.0 CFU/m<sup>3</sup>, respectively). Coagulase-positive *Staphylococcus* was isolated in six (6.6%) of all air samples. **Conclusions:** The results demonstrate higher air contamination after dental treatments as compared to levels for the beginning of the working day. Ultrasonic scaling is one of the most air-contaminant dental treatment procedures. Effective preventive measures and international/national standards are necessary in order to control dental office air contamination and decrease the risk of infection for dental staff and patients.

**Key Words:** Airborne Microbial Contamination, Dental Aerosols, Infection Control, Dental Practice

## Introduction

During dental treatment, staff and patients can be exposed to pathogenic microorganisms including bacteria and viruses such as staphylococci, streptococci, *Mycobacterium tuberculosis*, hepatitis B virus (HBV), hepatitis C virus (HCV), cytomegalovirus, herpes simplex virus (HSV), and human immunodeficiency virus (HIV). These pathogens may be transmitted through direct contact with blood or other oral fluids, indirect contact with contaminated instruments, equipment or environmental surfaces, and mucosal contact with droplets generated by coughing or sneezing or inhalation of airborne microorganisms [1]. In a dental office (practice), contaminated air may contain particles derived

from saliva, blood, dental plaque, calculus, tooth debris or dental filling materials and represents an important potential source of infection [2]. The fine microbial aerosols generated from the high-speed handpiece, ultrasonic scaler or water/air syringe are usually 50 µm or less in diameter and can remain suspended in the air for long periods of time. Studies on air contamination demonstrate that dental drilling procedures create aerosols of saliva and products of drilling, producing particles small enough to penetrate into the respiratory tract and reach the alveoli of the lungs [3-5]. It has been demonstrated that the airborne particles that dental protocols produce are concentrations of relatively small particles (<0.5 µm) together with a lower

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level of concentrations of relatively larger particles ( $>0.5 \mu\text{m}$ ) [6]. Airborne particles larger than 50-100  $\mu\text{m}$  in diameter are defined as spatter droplets and also represent an important source of infection.

The spread and infectious potential of microbial aerosols concentrated within a zone up to 60 cm from a patient's mouth are influenced by several factors, including particle size, quantity and pathogenicity of the invading microorganisms, temperature, humidity and ventilation as well as the immune capacity of the patient [7,8].

The human health effects of the air contaminants vary in severity from mild to life-threatening infections. They can have especially severe consequences for immunosuppressed individuals. A great danger related to dental office air contamination is represented by *Mycobacterium tuberculosis* but also by many viruses originating from the saliva, gingival tissues, the nose, throat and lungs. These include the common cold, influenza, severe acute respiratory syndrome (SARS) and herpetic viruses. The greatest current concern is the pandemic A/H1N1 influenza, which becomes more widespread and may be easily transmitted during dental treatment [9].

Other risks associated with air circulation in dental offices relate to the transmission of allergic and irritating agents such as latex allergens, formaldehyde vapours, ethylene oxide, hexachlorophene and local anaesthetic spray.

According to the Center for Disease Control (CDC) *Guidelines for Infection Control in Dental Health-Care Settings* (2003) [6], preventive measures to control dental office air contamination include universal precautions, which consist of dental staff protective equipment (gown, mask, gloves, eyeglasses), pre-procedural patient mouth-rinsing with antimicrobial products (such as chlorhexidine gluconate [10]), operator isolation (rubber dam), vacuum and electrostatic extraction of aerosols during dental procedures, air circulation methods (ventilation and air conditioning systems), air filtration systems for solid particles and mercury, disinfectants or organic compounds vapours, ultraviolet lamps and microbial controls for instruments and surfaces [11-13].

### Aim

The aim of this study was to assess the level of air microbial contamination in dental practices in Iasi, Romania, in order to quantify the risk of staff and patient exposure to aerosolised microbial

pathogens and motivate the implementation of protective methods.

### Methods

The study was conducted in 15 dental practices in Iasi, Romania. Ninety air samples were collected at two specific times during one working day: in the morning, prior to the treatment session, and after four hours of clinical activity. On each occasion, a set of three culture-solid medium plates (one Petri dish, 90 mm diameter, for 1 m<sup>3</sup> volume of air) was exposed for 15 minutes in two sites in each dental office. The sites were in the active dental operation area close to the dental unit (at a distance of approximately 30 cm) and in a corner of the practice room (approximately 2.5 m from the dental unit). The microbial aerosols were allowed to settle under gravity.

Each set of Petri dishes contained three culture mediums:

- TSA or agar yeast extract for total number of mesophilic germs.
- Agar with 5% sheep blood for *Staphylococcus aureus*.
- Agar Sabouraud used to culture *Fungi*.

The samples were labelled, recorded and transported to a microbiology laboratory in iceboxes at 4°C. The air samples were tested microbiologically in the Laboratory of Microbiology, Department Environmental and Collectivities Medicine at the Institute of Public Health, Iasi, Romania. The bacteriological indicators that were used were total number of mesophilic germs (TNMG; CFU/m<sup>3</sup>), *Staphylococcus aureus* (CFU/m<sup>3</sup>) and *Fungi* (CFU/m<sup>3</sup>). The Petri dishes were incubated at 37°C for 1-2 days for TSA or agar yeast extract and at 25°C for five days for agar Sabouraud. After this period, colonies were counted to assess the number of colony-forming units (CFUs) per plate. Bacterial counts were expressed as CFUs per cubic metre of air sampled. The microbial load for the air unit (10 m<sup>3</sup>), both for TNMG and *Fungi*, was calculated using the Omeliansky formula [14].

During the clinical activity that the dentists performed, treatment depended on patient needs. It included prophylactic procedures (calculus removal using the ultrasonic scaler for 10-20 min) or/and operative dental treatment involving drilling with air-driven, water-cooled handpieces. Rubber dam was not used for adult patients and patients did not perform oral pre-procedural rinses with antiseptic solutions.

The data were analysed using statistical software (Statistical Package for Social Science [SPSS] version 15; SPSS Inc, Chicago, USA) and statistically tested using chi-square. Statistical significance was set at the  $P < 0.05$  level.

### Results

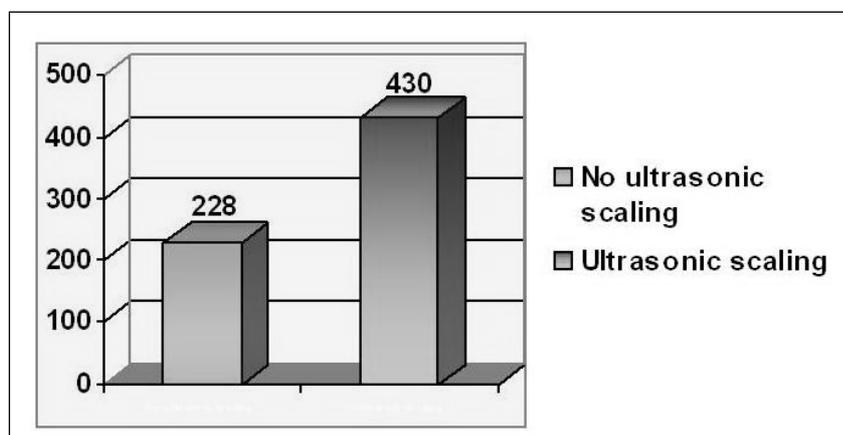
The TNMG in the dental offices showed high variability, ranging from 42 to 273 CFU/m<sup>3</sup> at the beginning of the day and from 105 to 1018 CFU/m<sup>3</sup> after four hours of clinical activity. The mean value for the TNMG in the air was 129 CFU/m<sup>3</sup> at the beginning of the day and 429.6 CFU/m<sup>3</sup> after four hours of clinical activity (Table 1).

Air contamination was evaluated in relation to the protocol of dental calculus removal by the ultra-

sonic scaler. The mean value of TNMG was twice as high in the dental practices in which ultrasonic scaling was performed. (430.3 CFU/m<sup>3</sup> and 228.3 CFU/m<sup>3</sup>, respectively) ( $P = 0.023$ ) (Figure 1).

The average number of patients treated in the dental practices during the four-hour periods between the first and second samples was 9.6. Significantly fewer bacteria ( $P = 0.014$ ) were found in the dental practices in which fewer than eight patients were treated during the four working hours (average value for TNMG: 321.1 CFU/m<sup>3</sup>) as compared to the dental practices that reported more than eight patients being treated (average value for TNMG: 550.7 CFU/m<sup>3</sup>) (Figure 2).

For *Fungi* counts, the values ranged from 21 CFU/m<sup>3</sup> to 29 CFU/m<sup>3</sup> at the beginning of the four-hour period and from 52 CFU/m<sup>3</sup> to 808 CFU/m<sup>3</sup>



**Figure 1.** Total number of mesophilic germs (TNMG) (CFU\*/m<sup>3</sup>) mean value related to ultrasonic scaling.

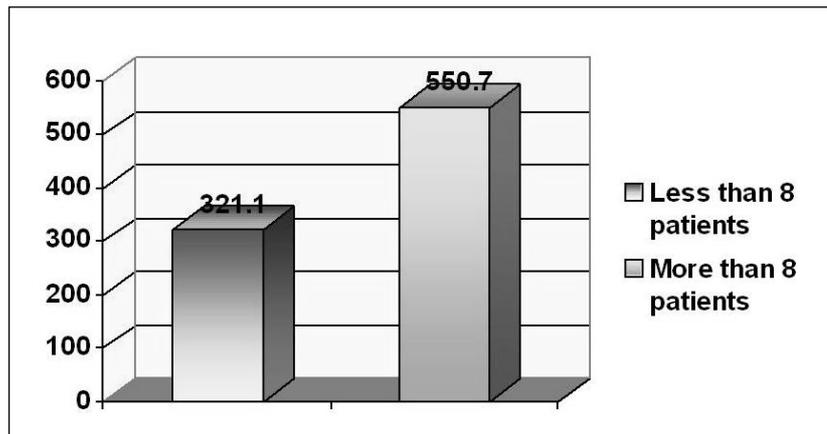
\* CFU: colony-forming units

**Table 1.** Total Number of Mesophilic Germs (TNMG) Values In The Air Of The Dental Practices Before And After Treatment Sessions

Dental Office	TNMG (CFU*/m <sup>3</sup> ) Before treatment sessions	TNMG (CFU*/m <sup>3</sup> ) After treatment sessions
1	79	118
2	94	105
3	42	147
4	42	105
5	147	472
6	157	1018
7	73	462
8	115	157
9	84	178
10	273	147
11	178	556
12	105	273
13	105	157
14	189	504
15	252	556
<b>Mean value</b>	<b>129</b>	<b>429.6</b>

\* CFU: colony-forming units

**Figure 2.** Total number of mesophilic germs (TNMG) (CFU\*/m<sup>3</sup>) mean value related to patient numbers.



\* CFU: colony-forming units

at the end of the four-hour period. ( $P=0.025$ ). The average value was twice as high after clinical activity as compared to before the working sessions (230.7 CFU/m<sup>3</sup> and 109.0 CFU/m<sup>3</sup>, respectively) ( $P=0.014$ ).

Coagulase-positive *Staphylococcus aureus* was isolated in 6.6% of all samples.

### Discussion

Most dental treatment procedures have the potential for creating contaminated aerosols and splatter. The results of this study confirm high levels of microbial air contamination during dental treatment, which represent an important source of health-care associated infections. The potential diseases include not only tuberculosis, common cold, influenza, herpetic viruses infection, and SARS but also bloodborne infections such as hepatitis B and C or HIV infection, because blood is very often found in the aerosols produced by an ultrasonic scaler or other high-speed equipment [15,16].

In the current study, the level of dental office air contamination was higher than that found in previous studies. A study published in 1995 reported a level of contamination of 216 CFU/m<sup>3</sup> for ultrasonic scaling treatments and 75 CFU/m<sup>3</sup> for operative treatments [17] and a more recent study [8] found 120-280 CFU/m<sup>3</sup> in the air in dental surgeries.

The high level found in the current study may be related to the fact that in our investigation, patients were not treated under rubber dam during treatment. The efficacy of rubber dam in controlling atmospheric bacterial contamination during dental procedures has been reported as leading to a 98.8% bacterial reduction at a distance of one metre from a patient's mouth [18].

Pre-procedural oral rinses were not performed at the beginning of dental treatment and this fact

may also be related to the high level of bacterial contamination in the current study. Previous research demonstrated that rinsing with an antiseptic mouthwash produced a 94.1% reduction in recoverable CFUs compared to the non-rinsed controls [8].

The ultrasonic scaling was obviously associated with increased air contamination levels confirming the results reported by several other studies showing that this procedure is one of the greatest producer of airborne contaminants in dentistry [19,20]. Two recent studies have highlighted the spread of infection through the air resulting from the most intensive aerosol and splatter emission that occur from an ultrasonic scaler tip and the bur on a high-speed handpiece [21,22]. A study published in 2000 reported that the microbial aerosol peak concentrations in dental treatment rooms were associated with scaling procedures (47% of procedures giving rise to a peak) and to a lesser extent by cavity preparation (11%) [16].

The level of bacterial contamination of the air after four hours of dental procedures was 3.3 times higher than before the treatment. This result is in agreement with those from previous studies [23,24], which demonstrated that air microbiological contamination at the end of the day will be higher, that many different species of bacteria may be present in a dental office, and that the contamination may become worse if using a high-speed handpiece or ultrasonic scaler.

The coagulase-positive *Staphylococcus*, which was present in 6.6% of the samples, can cause a wide variety of diseases in humans through either toxin production or invasion. Of great significance is the species *S. aureus*, an important pathogen agent that causes, wound and human skin infections, and nosocomial infections.

Our investigations also demonstrated the presence of *Fungi* in the dental office air samples, con-

firming a finding from a previous study of a *Fungi* concentration of  $4 \times 10^1$  CFU/m<sup>3</sup> to  $34 \times 10^1$  CFU/m<sup>3</sup>) [25]. This fungal contamination is involved in respiratory irritations and infections and allergic reactions.

The results of the present study must be used for increasing awareness and quantifying the risk of staff and patient exposure to aerosolised microbial pathogens in the general dental office, which must be controlled by efficient preventive measures. These include protective clothing and equipment for the staff, pre-procedural patient oral rinses, high-volume evacuators, ventilation and air filtration [26,27].

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## Conclusions

Dental aerosols represent an environmental hazard due to their high contamination with microorganisms and blood.

The high air pollution of dental operation areas in the 15 dental offices in Iasi, Romania, suggests that there is a need for considerable improvement in the prevention of this problem in these offices.

Such improvement can be stimulated by international/national standards and effective preventive measures to protect dental staff and patients from the airborne pathogens transmission.