Bulletin de veille émissions d'aérosols par l'appareil respiratoire humain N° 17 – Février 2025

Objectifs : veille scientifique sur les émissions d'aérosols (gaz et particules) par l'appareil respiratoire humain (nez/bouche).

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Kakeshpour T, Louis JM, Walter PJ, Bax A.

Chemical Analysis of Deep-Lung Fluid Derived from Exhaled Breath Particles.

Analytical Chemistry. 2025;97(7):4128-36.

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Breath particles generated deep within the lung provide noninvasive access to sampling nonvolatiles in peripheral airway lining fluid. However, background contamination, their variable production among subjects, together with a huge unknown dilution when using the common breath condensate method for collection has limited their use for quantitative biomarker analysis. Instead, we first capture and dry the particles in a flexible chamber followed by accurate optical particle characterization during their collection for chemical analysis. By decoupling breathing and aerosol sampling airflows, this sequential approach not only accommodates all types of breathing routines but also enables the use of a variety of aerosol samplers for downstream biomarker analysis. Using 23Na NMR, we measured 0.66 M Na in dry particles collected on a filter, which suggests that dehydration reduces their volume by a factor of ∼5.5 based on known Na levels in lung fluid. 1H NMR revealed 0.36 and 0.68 M phosphocholine lipids in dried particles collected from two volunteers, presumably enriched to these levels relative to literature values derived from bronchoalveolar lavage fluid due to the film-bursting mechanism that underlies breath particle generation. Decoupling of breath collection and aerosol capture enabled the design of an impactor sampler with 72% efficiency. This impactor minimizes reagent and handling-related contamination associated with traditional filters by collecting dry particles directly in a microreactor for subsequent derivatization and quantification by mass spectrometry. The method is demonstrated by quantifying subnanogram amounts of urea from breath particles, corresponding to lung fluid urea concentrations consistent with literature blood plasma values.

Saccente-Kennedy B, Archer J, Symons HE, Watson NA, Orton CM, Browne WJ, et al.

Quantification of Respirable Aerosol Particles from Speech and Language Therapy Exercises.

J Voice. 2025;39(1):43-56.

Introduction. Voice assessment and treatment involve the manipulation of all the subsystems of voice production, and may lead to production of respirable aerosol particles that pose a greater risk of potential viral transmission via inhalation of respirable pathogens (eg, SARS-CoV-2) than quiet breathing or conversational speech. Objective. To characterise the production of respirable aerosol particles during a selection of voice assessment therapy tasks. Methods. We recruited 23 healthy adult participants (12 males, 11 females), 11 of whom were speech-language pathologists specialising in voice disorders. We used an aerodynamic and an optical particle sizer to measure the number concentration and particle size distributions of respirable aerosols generated during a variety of voice assessment and therapy tasks. The measurements were carried out in a laminar flow operating theatre, with a near-zero background aerosol concentration, allowing us to quantify the number concentration and size distributions of respirable aerosol particles produced from assessment/therapy tasks studied. Results. Aerosol number concentrations generated while performing assessment/therapy tasks were log-normally distributed among individuals with no significant differences between professionals (speech-language pathologists) and non-professionals or between males and females. Activities produced up to 32 times the aerosol number concentration of breathing and 24 times that of speech at 70-80 dBA. In terms of aerosol mass, activities produced up to 163 times the mass concentration of breathing and up to 36 times the mass concentration of speech. Voicing was a significant factor in aerosol production; aerosol number/mass concentrations generated during the voiced activities were 1.1-5 times higher than their unvoiced counterpart activities. Additionally, voiced activities produced bigger respirable aerosol particles than their unvoiced variants except the trills. Humming generated higher aerosol concentrations than sustained /a/, fricatives, speaking (70-80 dBA), and breathing. Oscillatory semi-occluded vocal tract exercises (SOVTEs) generated higher aerosol number/mass concentrations than the activities without oscillation. Water resistance therapy (WRT) generated the most aerosol of all activities, >> 10 times higher than speaking at 70-80 dBA and >30 times higher than breathing. Conclusions. All activities generated more aerosol than breathing, although a sizeable minority were no different to speaking. Larger number concentrations and larger particle sizes appear to be generated by activities with higher suspected airflows, with the greatest involving intraoral pressure oscillation and/or an oscillating oral articulation (WRT or trilling).

Tuhkuri Matvejeff A, Saari S, Oksanen LM, Heikkilä P, Silvonen V, Hakala J, et al.

Effects of Spoken Phones and Patient Characteristics on Respiratory Aerosol Emission.

Journal of voice : official journal of the Voice Foundation. 2025.

OBJECTIVES: This study investigates how the production of three different phones ([a], [o], [r]), as well as breathing, coughing, and individual characteristics, influences respiratory particle emission. DESIGN: Experimental study. METHODS: Particle size distribution and sound pressure levels (SPL) were measured in 41 infection-free participants under controlled conditions. The measurement instruments, condensation particle counter (3775, TSI Inc.), and aerodynamic particle sizer (APS 3321, TSI Inc.), covered the size range of 0.004-10 µm. Exhaled flow rates were calculated from CO(2) concentrations measured with LI-840A NDIR gas analyzer (LI-COR Environmental). RESULTS: Production of [o] generated more particles than production of [a] across all size fractions. The alveolar trill [r] generated more small particles than did the vowels. SPL had a consistent positive effect on particle generation but did not fully explain the differences. Exhaled flow rates showed no statistical differences between the *phones. Higher age was associated with elevated particle emission in breathing. Higher exhaled flow rate and higher body mass index (BMI) were associated with higher particle emission in coughing. No systematic connection between peak expiratory flow (PEF) or sex and particle emission was observed. CONCLUSIONS: Understanding respiratory aerosol generation, in different situations and individuals, is critical for advancing knowledge of airborne transmission of diseases. Our findings corroborate prior evidence of an association between SPL and particle emission in voiced activities. Particle production also varies systematically across different phones, irrespective of SPL. The predominance of small particles in the phonation of [r] suggests the production of satellite particles from the tongue vibration. The higher particle generation in the phonation of [o] compared with [a] suggests the oral opening may contribute to the number of emitted particles. None of the individual characteristics-age, sex, BMI, or PEF-was a systematic predictor of particle production across all respiratory activities.*