

Observation of aerosol generation by human subjects during cardiopulmonary exercise testing using a high-powered laser technique: A pilot project

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Authors: Christopher Varga^a, Keith Kwiatkowski^a, Michael Pedro^a, Herman Groepenhoff^a, Edward Rose^a, Callum Gray^b, Kai Pinkerton^a, Michael McBride^c, Stephen Paridon^c.

Objectives

Aerosols produced by humans may transmit pathogens [1] such as Covid-19 [2]. Aerosol production has typically been studied with the human subject at rest, limiting applicability of results to the real world [3]. There is little data about aerosols produced during exercise. This study sought to determine aerosol production during cardiopulmonary exercise testing (CPET) are lacking.

Study methods

A pulsed Nd:YAG laser (Quantel, Bozeman, MT) was used to illuminate a specific region in front of two healthy exercising subjects during CPET. The subjects exercised to fatigue. CPET was performed using two different cycle-based CPET systems: Vyntus™ CPX Metabolic Cart and Vmax™ Metabolic Cart (Vyair Medical GmbH, Germany). CPET with breath-by-breath aerosol particle counting was performed. A high-resolution camera synchronized with the laser pulses captured images for particle counting (net exhaled particle (NEP) counts) at intervals during each test, including at rest, submaximal exercise, peak exercise, and active recovery. Image acquisition was synchronized with the laser pulses. Particle-image velocimetry (PIV) was used to measure particle velocities.

Results

For both CPET carts and both subjects, the NEP per milliliter (ml) reached a minimum value at peak exercise and subsequently increased into recovery; see figure below. NEP per ml was higher at resting breathing than at peak exercise. On a per minute basis, NEP production initially rose with exercise but declined in late and peak exercise, then rebounded in early recovery to values approximately equal to those measured during resting breathing.

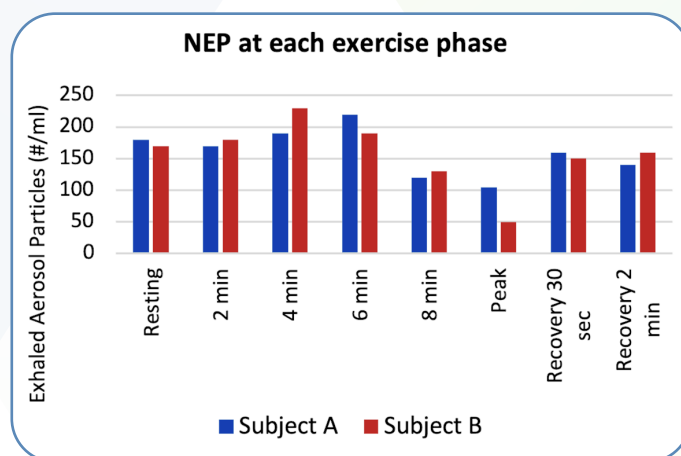


Figure 1. Net exhaled particle (NEP) at each exercise phase.

^a Vyair Medical, Mettawa, IL.

^b LaVision, Inc., Ypsilanti, MI.

^c Division of Cardiology, The Children's Hospital of Philadelphia; The University of Pennsylvania Perlmán School of Medicine

What is CPET?

Cardiopulmonary exercise testing (CPET) provides assessment of pulmonary and cardiovascular system functionality by measuring the response of these systems to both submaximal and peak effort during exercise. Often using either a cycle ergometer or a treadmill, the subject breathes into the CPET device which measures oxygen consumption and carbon dioxide production, along with highly accurate standard spirometric function such as minute ventilation and tidal volume. CPET and numerous other medical procedures that produce aerosols and are deemed non-emergent had been postponed or suspended during the recent pandemic.



Figure 2. Vyntus™ CPX.

Take home message

- Human activities produce aerosols that may cause infection.
- In these two subjects, the number of aerosols produced decreased at peak exercise, then returned to baseline during recovery.
- This data suggests that exercise testing does not generate more aerosolized particles than resting respiration.

References

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For more details on the content of the study, please refer to the original article here.

Full reference: Varga CM, Kwiatkowski KJ, Pedro MJ, Groepenhoff H, Rose EA, Gray C, Pinkerton KD, McBride MG, Paridon SM. Observation of aerosol generation by human subjects during cardiopulmonary exercise testing using a high-powered laser technique: a pilot project. *Journal of Medical and Biological Engineering.* 2022 Feb;42(1):1-0.

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Jaeger Medical GmbH
Leibnizstrasse 7
97204 Hoechberg
Germany

Jaeger Medical America, Inc.
14050 Rebecca St, Bldg 4
Moreno Valley, CA 92553
USA

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