A mobile ALI system for outdoor usage - toxicity testing of airborne particles and gases in a road tunnel and subway

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Air Liquid Interface (ALI) exposure systems are used to test the toxicity of airborne particles and gases (Latvala *et al*, 2017). In the nPETS project (EU-project; Nanoparticle emissions from the transport sector: health and policy impacts), we developed mobile ALI systems for outdoor usage. That enabled us to test the toxicity of real-world aerosols, such as transportation emissions.

Particulate and gaseous emissions from different modes of transport cause several effects on human health. The project aimed to test the toxicity of the nanoparticle and fine particle emissions from cars, trains, ships and airplanes. Very few studies have used ALI systems at outdoor locations before, and several obstacles had to be overcome to perform the studies successfully.

Generally, ALI systems have the advantage of testing the toxicity of airborne particles directly from a source, i.e., unchanged particles that have the same size, shape, and chemical composition as particles inhaled by humans can be tested. Our system also enable the deposition of nanoparticles, separate examination of particles and gases, and online assessment of the particle dose onto the cells.

The ALI system developed in the nPETS project allowed: 1) Size selection of nanoparticles, and their toxicity testing, and 2) Concentration of outdoor aerosols, making it possible to do toxicity testing of low-concentration real-world aerosols. We also explored the use of two different cell models, representing macrophages and alveolar lung cells. The parameters of the ALI system were optimized for best cell survival prior to usage (aerosol flow, temperature, humidity, voltage), and particle deposition and toxicity testing were validated (Juárez-Facio *et al,* 2024).

In this study, the toxicity of airborne particles was tested in a road tunnel (Introna *et al*, 2024), the subway, and in a car brake laboratory in Stockholm, Sweden. Cells were exposed for 2 hours, and cytotoxicity and inflammatory response (IL-1β, IL-8, and IL-6, see Fig. 2) of the lung cells were tested after 24 h incubation.

We expect mobile ALI systems to become a widely used tool for future assessments of the effects of real-world aerosols on human health.

Our study made an important contribution to the development of such ALI systems, as we successfully demonstrated the use of an ALI system outdoors. The toxicity of different particle sizes, and the gas phase could be assessed for different transportation modes. Furthermore, a concentrator enabled toxicity testing of airborne particles at low outdoor concentrations.

Figure 1. A mobile ALI exposure system was used to test the toxicity of emissions from the Söderleds road tunnel in Stockholm.

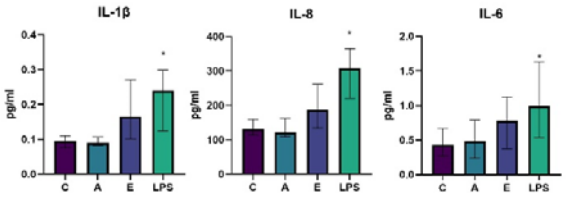

Figure 2. Cytokine release (road tunnel). C = neg. control, A = road tunnel air without particles, E = exposure to road tunnel emissions, LPS = pos. control.

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Latvala, S., Vare, D., Karlsson, H.L. and Elihn, K. (2017) *J. Appl. Tox.* doi: 10.1002/jat.3510

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