Scottish Government Health Directorates Chief Scientist Office

CHIEF SCIENTIST OFFICE

FOCUS ON RESEARCH

The effect of nanoparticles on in-vitro airway epithelial cell function in children and adults with and without asthma

Researchers

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Aim

Three hundred million people suffer from asthma worldwide representing a major public health concern due to its prevalence, associated ill health, and high societal and healthcare costs. Nanoparticles are very small sub-microscopic particles that are present naturally in the atmosphere (e.g. volcanic activity), but exposure from anthropogenic sources is increasing, Nanomaterial use has exponentially increased with the Project on Emerging Nanotechnologies documenting a global increase from 54 products in 2005 to 1317 in 2010, mainly in cosmetics, clothing, personal care, sunscreen and electronics. Another important source of nanoparticles is from motor vehicle emissions, particularly in urban environments. Human lungs with their intimate air interface are potentially vulnerable to nanoparticles and given the well-established increased susceptibility of asthmatic airways to environmental insult, the lungs of adults and children with asthma are likely to be particularly vulnerable. This study investigated the effect of nanoparticles on the cells (bronchial airway epithelial cells) that line the airways (breathing tubes) in terms of their effects on their function and whether any effects are greater in cells from children and adults with asthma compared with cells from healthy control subjects.

Project Outline/Methodology

Airway epithelial cells were taken from adults and children with or without asthma undergoing day-case surgery or elective bronchoscopy. These cells were cultured (grown) in the laboratory. Nanoparticles originating from vehicle emissions (cerium, a diesel additive or zinc from catalytic converters) will be added at doses representative of 'real-life' were added to the cultured airway cells and the effect on their function and production of inflammatory mediator's important in asthma measured.

Key Results

We found that the nanoparticles zinc oxide and cerium dioxide that are present in vehicle emissions altered the profile of mediators secreted from airway cells cultured from children with asthma compared with cells from healthy control subjects. High concentrations of zinc oxide was toxic to bronchial AEC while lower non-cytotoxic concentrations of this nanoparticle and cerium dioxide had significant effects on the secretory profile of bronchial AEC.

Conclusions

Our findings show that zinc oxide and cerium dioxide nanoparticles have the potential to have profound effects on AEC function with zinc oxide having the potential for toxic effects that could damage epithelial integrity and function. Children with asthma appear to be more sensitive to the effects of these nanoparticles when compared with adults with asthma.

What does this study add to the field?

Nanoparticles have clear potential to contribute to the clinical course and comorbidity of asthma, particularly in children with this condition.

Implications for Practice or Policy

The UK Government has prioritised the quantification of risks associated with nanoparticles. Potential adverse effects on the lungs caused by nanoparticles are a cause for concern particularly in asthma. This study has provided important information on their potential adverse effects thereby informing risk assessments in collaboration with relevant stakeholders from the motor vehicle industry and government.

Where to next?

The development, use of and exposure to nanotechnology is certain to increase. A key goal therefore health impact will be the development of nanotechnologies that do not adversely affect health.

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