BREEASE – DESIGNED TO ALLEVIATE BREATHING FOR INFANTS AND TODDLERS

In this article, Marie-Christine Klein, PhD, Head of Development & Regulatory Affairs and Christian Weyler, PhD, Project Manager Development & Regulatory Affairs, both at URSATEC, and Dr Fredrik Bokvist, Chief Operational Officer & Co-Founder at VivoLab, discuss the effects of air pollution on health – and how the Breease pacifier could help babies and young children.

Air pollution is one of the most substantial threats to human health caused by our environment. Almost all the global population (99% in 2019) is living in areas that do not meet the air quality guidelines for ambient air set by the WHO. There is a large gap between the improved air quality in high-income countries since the 1990s and negative changes in low- and middle-income countries as a consequence of economic development and increased infrastructure. The facts and figures speak for themselves: air pollution causes 6.7 million premature deaths every year. In 2019, 317,000 deaths of children under five years of age could be attributed to ambient and household air pollution, according to the WHO – again, particularly in middle- and low-income countries.

The underlying mechanisms of how air pollution is threatening human health are multilayered. Deleterious effects on health caused by air pollution are being ascribed to so-called noncommunicable diseases (NCDs). These are diseases that are noninfectious and go hand in hand with the everyday-life adaptations of the modern world in terms of nutrition, ageing and overconsumption of food, alcohol and tobacco. Moreover, the level of education and access to health management measures are factors that contribute to the health threats derived from NCDs. These are mainly cardiovascular, neurological and respiratory diseases. To gain deeper insight into the mechanistic effect of how air pollution acts on different aspects of the human physiology that lead to diseases, it is useful to first take a closer look at what the indicators are for air pollution.

Particulate matter (PM) is an important indicator and measurable parameter for air pollution. It refers to a mixture of different particles of different sizes originating from different sources. Major components are sulfates, nitrates, ammonia, black carbon and mineral dust. PM is categorised by its aerodynamic diameter. The largest particles, between 2.5 and 10 µm – known as PM10 – are ascribed to pollen, sea spray and wind-blown dust from erosion, agricultural spaces and roadway and mining operations.[1] Smaller particles can originate either from primary sources (e.g. combustion of power fuels) or secondary sources (e.g. chemical reaction between gases).[1]

PM has been studied extensively since the WHO issued air quality guidelines in 2005 that accelerated global efforts to protect populations from the risk caused by air pollution. Since then, a lot of evidence has been generated on the negative impact that these inhalable PMs have on the human body. They can penetrate into the deep lungs and reach the bloodstream and, as a consequence, trigger development of cardiovascular,

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cerebrovascular and respiratory pathologies.[1] To complete the picture, not only particles and droplets but also gases such as carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide contribute to air pollution.

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AIR POLLUTION AND NEGATIVE EFFECTS ON HEALTH

Environmental exposure has a huge detrimental effect on human health. Environmental exposure is not solely a phenomenon of outdoor (ambient) pollution. Indoor pollution plays a significant role when discussing the impact of air pollution, which is especially aggravated in households with no access to clean fuel and technologies for cooking. While the proportion is steadily shrinking, a quarter of the global population is still heavily affected by this impact on indoor air pollution. Even if using clean fuel, the importance of indoor air quality should not be underestimated. Nowadays, people in the western world spend as much as 80% of their time indoors – and indoor air is affected by outdoor ventilation, various allergens, smoking, heating and cooking.[2]

One example of intertwined dependencies that are not always obvious is tobacco smoke – an exogenous pollutant to the respiratory tract. First of all, cigarettes themselves may introduce bacteria and fungi that can be pathogenic or alter the physiological microbiome of the respiratory tract. Next, the mucus production in the airways is upregulated, which impairs mucociliary clearance, and low-grade inflammation events occur that have detrimental effects and lead to predisposition to respiratory diseases.

This pathomechanism is also thought to hold true for asthma and bronchiectasis. Therefore, it is not surprising that exposure to air pollution is a major contributor to the pathogenesis of chronic obstructive pulmonary disease (COPD) worldwide. Indeed, most recent estimates suggest that 50% of the total attributable risk of COPD may be related to air pollution.[3] What is more, the detrimental effects on health are not limited to respiratory-tract-associated pathologies. Cardiovascular diseases in ageing, diabetes, reproductive outcomes and several neurocognitive end points have also been associated with air pollution.[1]

AIR POLLUTION IN A PAEDIATRIC SETTING

Looking at the literature on air pollution and its effects on human health, it becomes evident that children are more susceptible to the health effects of air pollution than adults. There are various reasons for this. Children have an immature immune and respiratory system, breathe more rapidly and they inhale a larger air volume per kilogram of body weight compared with adults, which explains their vulnerability to air pollution. Moreover, they are closer to the ground, which means pollutants that reach peak concentrations closer to the ground are more likely to have an effect. And susceptibility to polluted air starts even earlier – when pregnant women are exposed to polluted air, premature-birth and low-weight babies become more likely.

A broad data basis is evidence for the connection between air pollution exposure and adverse effects on children's lung growth and lung function, sometimes in an irreversible manner.[4] Even when only taking a closer look at the PM2.5 fraction (particles smaller than 2.5 µm) of air pollutants, a broad variety of phenotypes are reported. Among these are higher prevalences of cognitive decline and behavioural issues, such as attention deficit hyperactivity disorder (ADHD), and a variety of chronic respiratory conditions, including bronchitis and the development of asthma and COPD. Particularly robust in various studies is the connection of childhood asthma with both passive smoking and exposure to traffic-related pollution.[2]

PM2.5 MANAGEMENT

Managing air pollution and reducing exposure, not only but particularly for vulnerable patient groups, is key and a driver for guidelines such as the aforementioned air quality guidelines from the WHO. It is clear that managing air pollution on a population level requires high-level policy adaptations through implementation of adequate legislation, as has proved successful in the past. Transitioning away from burning coal in many regions of Europe and the US, for example, has resulted in declining outdoor air pollution from PM. In a similar vein, there is evidence that long-term reductions in PM2.5 improve life expectancy and overall health.[5]

Nevertheless, a different trend concerning the load of air pollution was observed between 1988 and 2016 as a result of increasing wildfires in the US and Canada.[4] This example shows that new impacts derived from climate change require new strategies in the future. That is why air pollution as a public health threat is addressed in the UN Sustainable Development Goals.

Since whole populations can only be reached by improvements in air pollution in a systematic manner, it is necessary to also consider measures that may improve exposure on an individual level with beneficial effects. Substantial evidence is available that high-efficiency particulate air filter purifiers reduce indoor PM2.5 concentrations and improve subclinical cardiopulmonary health indicators.[6] Even small reductions of the PM2.5 fraction have a significant effect on the health outcome and predisposition for various pathologies. These examples show that one reasonable measure for individual efforts against air pollution is focusing on PM2.5 reduction for the paediatric patient group.

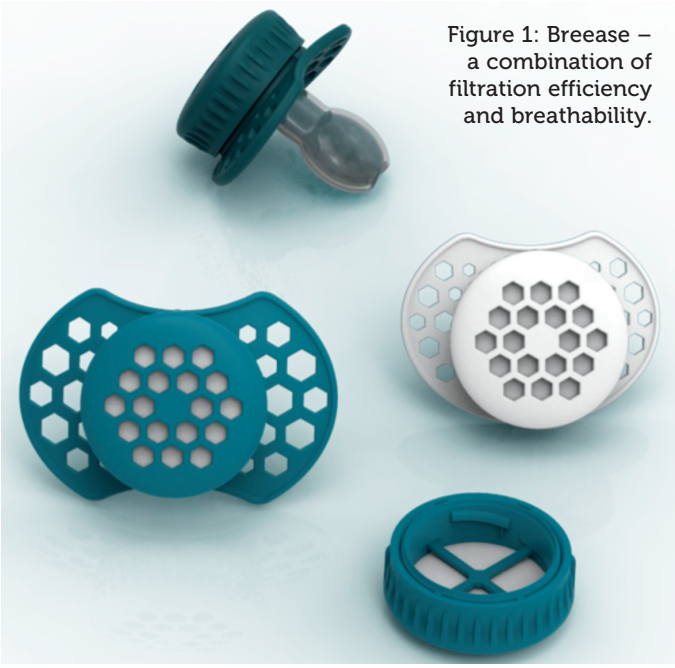

Figure 1: Breease – a combination of filtration efficiency and breathability.

The Swedish company VivoLab followed that line of evidence and developed a low-airflow-resistance children's pacifier called Breease, which incorporates a pollution filter. This device could potentially be part of the efforts to reduce children's exposure to harmful airborne particles (Figure 1). The pacifier facilitates air filtration by breathing through the device. It is designed to have a lower resistance of airflow through the pacifier than through the nose. Breathing patterns reveal that most infants breathe through their mouth and nose and are not strong nose breathers.[7] In the case of a congested nose, babies will resort to 100% mouth breathing, which is facilitated by the Breease pacifier.

"Breease contains a high-capacity PM2.5 filter that can be disassembled from the pacifier itself and exchanged on a regular basis with a new filtration unit."

Breease contains a high-capacity PM2.5 filter that can be disassembled from the pacifier itself and exchanged on a regular basis with a new filtration unit. The filter is an electrostatic filter media traditionally used in critical care applications, such as medical ventilators, spirometry and respirators. Breease and miniBreease fulfil the European soothers standard EN 1400 in all applicable parts. In order to adjust to the anatomical situations of newborns and small children, the body and teat of Breease comes in two different sizes, with miniBreease intended to be used from 0 to 9 months and Breease from 9 to 36 months. This invention could be a beneficial hands-on solution for this very vulnerable patient group.

As discussed above, exposure settings can vary and, particularly when it come to indoor pollution environments, underestimated. The significance of individual, easy, hands-on measures to lower the effects of exposure for children becomes obvious.

OUTLOOK

Having in mind that one solution could be the answer for different challenges, VivoLab and URSATEC are working on a product combination for supportive treatment of respiratory tract infections and the symptoms of dry air settings for children. The idea is to combine the moisturising salt solutions of a non-pressurised, user-friendly and soft-mist-generating pocket inhaler (Softbreezer) and the pacifier Breease (Figure 2). The liquid in the Softbreezer is dispersed into droplets by mechanically pressing the liquid through a microchip with pores, producing a very consistent droplet size distribution and delivery rate. The metered dose inhaler thereby generates a soft mist that is easily inhalable during normal tidal breathing. By adapting the Softbreezer to the Breease pacifier, the known usability profile of the pacifier can be of great advantage and engage children in moisturising therapy without the need for a treatment scenario they are not familiar with.

"The idea is to combine the moisturising salt solutions of a non-pressurised, user-friendly and soft-mist-generating pocket inhaler (Softbreezer) and the pacifier Breease."

Figure 2: One step further – a combination of Breease and the Softbreezer for moisturising children's airways.

SUMMARY

Even though concepts of air pollution reduction are developed, and a specific resolution was endorsed by 194 WHO member states in 2015[1] to ease the load on a population level, there is still a huge gap between high- and middle-to-low-income countries. Moreover, climate change has added a new layer of severity to ambient and household pollution – for example, in the form of wildfires or the prevalence of pollen grains and fungal spores – which impacts respiratory health. The desire for individual measures to protect the most vulnerable groups in particular is growing. As such, emphasis should be put on cost-effective and simple protective measures for individual intervention.

ABOUT THE COMPANIES

URSATEC was founded in 1993 to accomplish one mission: the establishment of preservative-free applications, based on its proprietary packaging systems in different application areas, primarily the nasal, dermal, buccal and otological fields. Having sold almost 2 billion units within the last 25 years, URSATEC systems are widely established. URSATEC is consistently expanding its business and offers full development service, dosage systems, primary packaging materials and filling services for over the counter and Rx applications to the healthcare industry.

VivoLab, founded in 2018 by Swedish doctors, is a medtech start-up focused on improving children's health through innovative, affordable solutions. With multiple patents for its groundbreaking products, VivoLab is at the forefront of paediatric healthcare technology. Its mission is to provide accessible, high-quality medical care for children globally, ensuring that economic barriers do not limit access to life-saving treatments. Based in the AstraZeneca BioVentureHub in Mölndal, Sweden, VivoLab thrives in a collaborative environment, working with experts to develop cutting-edge technologies that make a real difference to the lives of children and their families.

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Marie-Christine Klein, PhD, is a biologist by training and joined URSATEC in 2019. She leads the development and regulatory affairs team that is focusing on innovative developments in combination with the URSATEC application technology.

Christian Weyler, PhD, joined URSATEC at the beginning of 2024, with a PhD in Chemistry. As part of the Development & Regulatory Affairs team, he brings experience in project management to realise customer projects dealing with challenges during all phases of developments.

Fredrik Bokvist, PhD, Chief Operational Officer & Co-Founder at VivoLab, is an intensive-care physician who loves gadgets and technical development.

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