



Short Commentary

Godzilla and the Fog: Should we Incorporate Air Pollution as a Surgical Risk Factor?

Rafael Martinez-Sanz^{1*}, Guadalupe Sauchelli-Faas², Juan José Jiménez-Rivera³

¹Department of Surgery, Universidad de La Laguna, Hospital Universitario de Canarias, La Laguna, Tenerife, Spain

²Department of Cardiovascular Surgery Unit, Hospital Universitario de Canarias, La Laguna, Tenerife, Spain

³Intensive Care Unit, Hospital Universitario de Canarias, La Laguna, Tenerife, Spain

***Corresponding author:** Rafael Martinez-Sanz, Department of Surgery, Universidad de La Laguna. Hospital Universitario de Canarias, La Laguna, Tenerife, 38320, Spain

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Abbreviations: CO: Carbon Monoxide; NO₂: Nitrogen Dioxide; SO₂: Sulfur Dioxide; PM: Particulate Matter

Cd: Cadmium; Ni: Nickel; Ar: Arsenic; Cu: Copper; Zn: Zinc; WHO: World Health Organization; GBD: Global Burden of Disease; HEPA: High Efficiency Particle Arresting

Shah and colleagues in their meta-analysis of 1146 identified articles found evidence between air pollution and heart failure, hospitalization and mortality. [1] These adverse health effects of exposure to airborne pollutants are due to its composition, because they are a mixture of reactive gases (CO, NO₂, SO₂ and others) and Particulate Matter (PM) mainly hydrocarbons, soot, organic material and heavy metals (Cd, Ni, As, Cu, Zn) -true fog-. This is especially evident in large cities, due to their traffic and heating, and in centers with polluting industries that use heavy metals, hydrocarbons and fossil fuels. Ultrafine air pollution particles smaller than 2.5 µm (PM_{2.5}) are the most dangerous ones since they are the ones that reach the alveoli. But outside of this industrialized context we have a rural environment in which almost a third of humanity lives. Inhalation of PM₁₀ (larger than 10 µm) airborne respirable desert dust particles can affect more than 2 billion inhabitants of the so-called Desert Dust Belt, which stretches across Inner Asia, North Africa, and the Middle East. These particles are especially abundant in what are known as “desert storms”. On June 19th 2020, the Copernicus Sentinel and ESA’s Aeolus satellites identified an immense desert dust that ran through Northwest Africa and the entire central part of the Atlantic Ocean, nicknamed Godzilla. PM₁₀ particles are less dangerous, but

generally their presence indicates that they accompany the smaller ones. The WHO considers that PM_{2.5} particles should not exceed 10 µm/m₃ per year and the largest should be below 20 µm/m₃ per year. [2] The harmful gases and solid components that accompany these ultrafine particles can cause severe damage to the endothelium. [2] Liu and colleagues found a relationship between environmental pollution with PM₁₀ and PM_{2.5} and daily mortality in 652 cities; if this is due to “any cause” it increases by 44%, if it is due to cardiovascular causes it does so by 36% and if it is of respiratory origin it does so by 47% [2].

The GBD 2019 Risk Factors researchers analyzed 87 risk factors in 204 countries or territories in the period 1990-2019, and found that air pollution is the fourth cause of mortality worldwide in both men and women. [3] In women, it is ahead of the risk of body mass index, tobacco and high levels of LDL cholesterol. In men, it is ahead of high blood glucose levels, body mass index, and high levels of LDL cholesterol. They estimate that in 2019 they were the cause of 3.7 million deaths in people under 60 years-old (80% of cardiovascular origin) and point out that in these 30 years little progress has been made in reducing air pollution. [2,3] They propose that the public powers, at the global level, must adopt measures similar to those taken for the reduction of tobacco and environmental lead that were quite successful. [3] In April 2021, the main North American and European cardiology journals (European Heart Journal, Journal of the American College of Cardiology, Circulation and Global Heart) published the same Editorial, in which they brought us the evidence of how atmospheric pollution is a first-order factor in cardiovascular risk.⁴

But, so far, anesthesiologists and surgeons have not voiced their opinion.

In the western world 20% of deaths attributable to cardiovascular diseases are caused by this pollution.⁴ Chronic exposure to polluted air reaches the alveoli in the smallest particles and from there to the blood. Oxidative stress and inflammation are induced in the blood, which causes vasoconstriction with the consequent increase in systemic and pulmonary arterial pressure, increased insulin resistance, hypertriglyceridemia, increased LDL cholesterol, and simultaneously induces imbalance of the axis pituitary hypothalamus, endothelial damage, proliferation of smooth muscle fibers in arteries, inflammation of the central nervous system, and epigenetic modification. [4,5] Permanent exposure to large amounts of polluted air induces an alteration of neuronal reflexes on the autonomic nervous system. This in turn causes ventricular remodeling and fibrosis, progression of coronary and carotid lesions, and arterial and pulmonary hypertension. [4] Higher exposures, sometimes acutely, increase previous lesions, activate platelets, decrease fibrinolysis, increase myocardial oxygen demands and sympathetic tone. All of this leads to an increase in cardiovascular events, hospitalizations, permanently disabling injuries, healthcare costs and mortality. [4,5] Newman and colleagues raise the “opportunity created” by the current SARS-CoV-2 /COVID-19 pandemic that has forced the use of HEPA filters and masks, whose initial results seem to suggest their effectiveness in preventing air pollution. [6] And for this reason, prospective randomized studies could be designed to demonstrate how the intervention in the use of certain measures that allow reducing the concentration of PM_{2.5} particles significantly improves the efficiency and effectiveness to avoid the worsening of cardiovascular diseases [6,7].

For all these reasons, we propose that a committee of expert surgeons and anesthesiologists be able to answer these three questions in relation to the possible increased risk in surgery due to air pollution. The first is to quantify the relationship between environmental pollution with PM₁₀ and PM_{2.5} and 30-days morbidity and mortality after surgery. Second, include air pollution in calculating risk scores for surgery, especially for those

patients who come from areas with clearly established atmospheric pollution or for those situations in which the day of the intervention is carried out with specific episodes of air pollution (desert dust storms or city pollution spikes), [2,4] or in patients in whom, in the future, particles smaller than PM_{2.5} could be identified in the respiratory tract by systematic determination. The last question is to adopt positive interventions for this type of patients, which could perhaps consist of prior physiotherapy with HEPA filters or the incorporation of absorbent filters of cellular and humoral mediators of inflammation, either during surgery, continuing 6-24 hours after surgery or on dialysis. Anesthetists and surgeons cannot continue to ignore to what extent, when and how contamination can affect patients who operate, especially in oncological, bariatric, vascular, cardiothoracic interventions and, in patients with high surgical risk scores or pulmonary and cardiovascular diseases.

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