


UNDERSTANDING THE DISEASE



Climate change, global warming, and intensive care

Thomas Bein^{1*} , Christian Karagiannidis² and Michael Quintel³

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In the last five decades, human activities have resulted in the release of increasing quantities of carbon dioxide and other greenhouse gases, thus contributing to global climate change by additional heating of the atmosphere. The world has warmed up by approximately 0.85 °C. In particular, the last decade has been the warmest since 1850 [1], and the frequency and intensity of natural disasters (such as earthquakes, devastating storms, forest fires, prolonged heat waves, droughts, and floods) have increased manifold. Between 1998 and 2017, climate-related and geophysical disasters killed 1.3 million people and left a further 4.4 billion injured, homeless, displaced, or in need of emergency assistance [2]. Climate change scenarios include a change in the spread of infectious diseases with warming and changes in outbreaks associated with extreme weather events after floods or as a result of water heating. Furthermore, warmer climates provide more favourable conditions for the survival and completion of the life cycle of the vector that transmits pathogens [3]. Natural disasters and extreme events lead to traumatic deaths and injuries, mental illnesses, and infections, while global warming per se promotes heat-associated illnesses (cardiovascular strain, pulmonary diseases, exsiccosis, mental disorder [4]).

The *World Health Organisation* (WHO) expects approximately 250,000 additional deaths per year between 2030 and 2050 from extreme heat, natural disasters, and changing patterns of infections, mostly in people at risk (people living in coastal regions or mega cities, children, the elderly, people with multiple and/or severe

comorbidities, and—last but not least—people living in regions with weak healthcare infrastructures) [5].

The impact of global warming on diseases requiring intensive care has been extrapolated from some existing data regarding a change in the spread of infectious diseases [6], an (further) alteration of the function of the respiratory system—especially in patients suffering from chronic lung diseases—an expected increase in kidney diseases, an expansion of cognitive disorders due to heat waves, particularly in the elderly, and some adverse effects on the cardiovascular system. An overview of health-related changes requiring intensive care is given in Fig. 1.

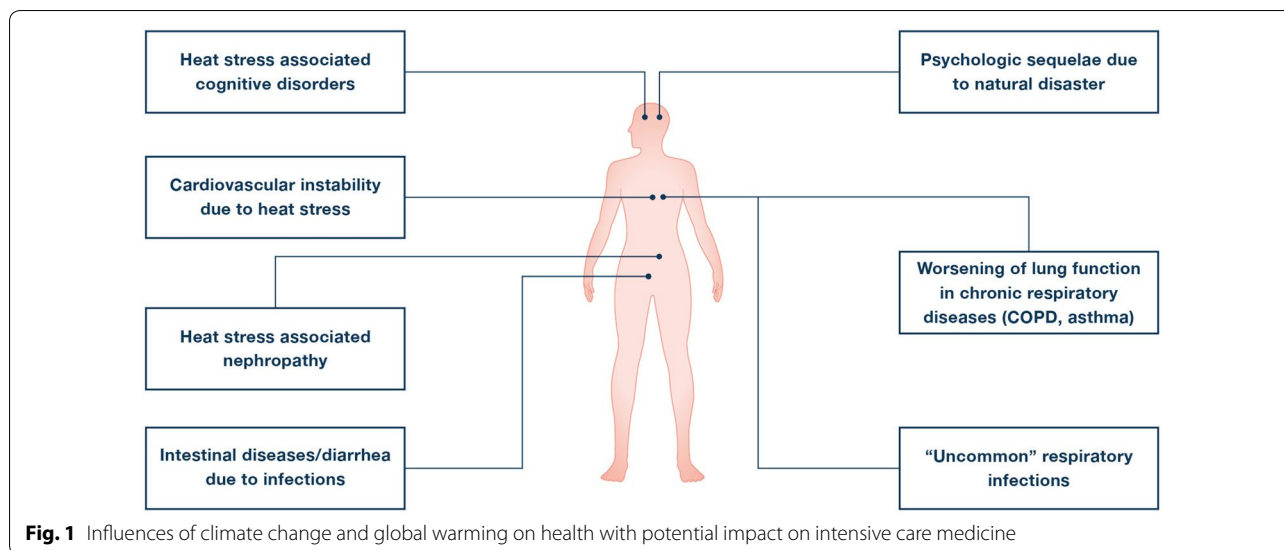
According to statistical models to estimate the global burden of infectious diseases due to climate change, in 2030, there could be a 10% increase in diarrhoeal diseases, primarily in young children, and the population at risk for malaria could increase by 3–5% [7]. Of late, in Germany, the first incidence of meningitis caused by mosquito-borne *West Nile virus* infection was reported in a man who never had travelled abroad [8]. In consequence, in future, the European intensivist—who already should be aware of uncommon vector-borne diseases due to global tourism—must be further sensitized to presently uncommon or tropical mosquito-borne diseases such as malaria and dengue, or other vector-borne viral, fungal, or bacterial transmissions like coccidioidomycosis or avian influenza.

What should we expect regarding the impact of climate change on respiratory health? *Lungs in a warming world* [9] become more vulnerable, especially those that are yet damaged. In patients with serious lung diseases like asthma or chronic obstructive lung disease (COPD), an aggravation of severity or increased mortality has been described as a consequence of global warming. Increasing concentration of greenhouse gases, air pollution, forest fires, prolonged heat waves, droughts, and floods

*Correspondence: thomas.bein@ukr.de

¹ Faculty of Medicine, University of Regensburg, 93042 Regensburg, Germany

Full author information is available at the end of the article



contributes to increased respiratory morbidity and mortality. During the 2006 heat wave in Portugal, for each 1 °C increase COPD morbidity increased by 5.4%, especially in women and in persons aged over 75 years [10]. Furthermore, a rapid spread of viral respiratory infections (e.g. Hantavirus, respiratory syncytial virus) as well as fungal respiratory infections (coccidioidomycosis, aspergillosis) can be expected [11].

Dehydration and volume loss could be the other consequences of climate-related extreme heat exposure, leading to chronic kidney diseases or acute renal failure [12] apart from that caused by diabetes, hypertension, or glomerulonephropathy. A recent study [13] has recognized an epidemic of chronic kidney disease of unknown aetiology in Central America ('Mesoamerican Nephropathy'), which has been attributed to recurrent dehydration due to heat stress. Several studies have addressed potential cardiopulmonary health effects associated with climate change parameters [overview in 14], and these effects are expected to further increase in the coming decades. It seems that a rise in mortality, emergency room visits, and (intensive care) hospitalization due to cardiopulmonary diseases attendant on heat stress, extreme weather conditions, or air pollution are more certain than worst-case horror scenarios.

But what is about climate change and intensive care medicine? Do we have enough awareness (and answers) in the face of all these challenges for the healthcare system? In a recent survey on climate change and health on the members of the American Thoracic Society [15], the majority of the respondents stated that climate change is a fact that it is relevant for patient care. They confirm that physicians and physician organizations should play an active role in educating patients, the public, and

policy-makers about the effects of climate change on human health. Do we play such an active role yet? Are we prepared to confront the increased frequency of critical illnesses about which, in some cases, we have to learn first? [16] To our knowledge, there is presently no specific activity in intensive care medicine to face current and future challenges in the context of global warming and climate change, although it is expected that intensive care medicine will need more specialized capacities, better knowledge on the part of the intensivists, and better preparation for worst-case scenarios (heat stroke waves or infectious outbreaks) to manage the consequences of climate change adequately.

It has been shown that acute and intensive care services vary substantially across economic regions, in high-income as well as in low-income countries [17], and it is debatable whether the current structure of intensive care is yet armed for needs related to climate change. ICU bed capacities represent by far not the only challenge; changes in knowledge and organization are required to be prepared (Table 1). The intensive care staff will in the near future need specific knowledge about 'uncommon' diseases and heat stroke management (especially in the elderly), and the ICU must be organized so as to be able to effectively take care of larger numbers of rapidly incoming critically ill patients in the context of natural disasters. Especially in megacities and coastal regions, the number of ICU beds should be checked so that they are sufficient in times of natural disasters. A functionally adequate capacity for isolating patients with critical infections is indispensable for successful infection control management. Expert support from psychiatrists or psychologists must be available in situations of devastating floods, storms, or heat waves. Preparing intensive

Table 1 Challenges for intensive care medicine in the context of global warming and climate change

Challenge	Solution
Increasing number of critically ill patients due to heat waves, natural disasters, air pollution or forest fire	Increase capacity of ICU beds, especially in coastal regions or megacities
Mass casualties of critically ill patients due to rapid weather changes, floods, heat attacks	Implement a 'reserve' of staff and ICU beds, which can be easily activated
Increasing incidence of 'uncommon' infectious or non-infectious diseases	Provide sufficient capacities of patient isolation Instruct the ICU staff in the diagnosis and management of 'uncommon' diseases
Increasing number of nephropathy during heat waves	Provide sufficient machines for renal replacement

care medicine for the consequences of climate change does not mean neglecting the basic principle of medicine—the best cure is prevention. Therefore, supporting efforts that reduce or ideally stop global warming are the need of the hour.

Author details

¹ Faculty of Medicine, University of Regensburg, 93042 Regensburg, Germany. ² Department of Pneumology and Critical Care Medicine, Cologne Merheim Hospital, ARDS and ECMO Centre, Kliniken der Stadt Köln, Witten/Herd-ecke University Hospital, 51109 Cologne, Germany. ³ University Medicine, 37075 Göttingen, Germany.

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