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EDITORIAL

Reliance on fossil fuels: ethical implications for intensivists

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We are living in the Anthropocene, the geological era in which humanity has altered the planet. Geochemical manifestations include air pollution and climate change due to exponential use of fossil fuels, and massive distribution of manufactured materials, such as plastic, concrete, pesticides, fertilizers and aluminum [1]. All of these changes harm people's health and quality of life, and are interconnected with the daily practice of intensive care medicine.

A central ethical issue is how we should weigh the short-term benefits and the rights of doctors and hospitals to have a relatively large carbon footprint (from use of fossil fuel energy, plastics, etc.), against the longer term harms of such a footprint (increased climate change, with its devastating consequences for planetary and human health), the longer term benefits of reducing this footprint (e.g., having healthier patients), the rights of countless patients to have healthy lives, and justice concerns (since climate change disproportionately harms poorer individuals and countries). We argue that the latter considerations outweigh the former, and that intensivists should thus work to reduce this footprint.

It is estimated that the health care sector contributes to climate change with ~ 2Gt (Giga tons) CO_2-equivalent (CO_2-e) per year—5.2% of the world's CO_2-e emissions [2]. The level of the CO_2-e emissions depends mainly on the energy source (coal, gas, wind, solar) and to a lesser extent on the implementation of energy saving strategies [3]. Intensive care units (ICU) are amongst the highest energy and resource intensive services [4]. Yet the energy needs of large hospitals could potentially be fulfilled by 100% renewable sources (see supplementary material). Indirect healthcare-related greenhouse gas emissions come from traffic and transportation (patients and employee commuting, business traffic), purchased medical and instrument equipment, downstream waste management and construction.

Fossil fuel energy use not only drives climate change, but also causes air pollution. Every year, 4.2 million deaths result from ambient air pollution, which exceeds the 6.5 million deaths due to coronavirus disease 2019 (COVID-19) registered during the past 3 years (see supplementary material). Exposure to fossil fuel-related ambient air pollutants cause oxidative stress, endothelial dysfunction and systemic inflammation, exacerbating cardiovascular and respiratory diseases [5], and risks of stroke, myocardial infarct, lung cancer, and acute respiratory distress syndrome (ARDS) [6]. Ambient air pollution also increases COVID-19 incidence, morbidity and mortality [7].

Heat stress caused by fossil fuels impedes health, too. Today, anthropogenic climate change account for 37% (range 20.5–76.3%) of warm-season heat-related deaths [8]. During heat waves, intensivists will confront rising numbers of patients suffering heat strokes, cardiovascular diseases, electrolyte imbalances and acute renal failure. The mortality rate among heat stroke patients is 21–63% [9]. Without consequent climate change mitigation, by 2100 global warming will exceed 3–4 °C, which is rated as a catastrophic warming scenario to humankind [10]. Humans are physiologically limited in their ability to adapt to a warming climate that involves both increasing temperature and humidity. Humans maintain a body core temperature at ~ 37 °C. Hence, in higher ambient temperature, we cannot emit heat to the environment, and sweating in high humidity becomes ineffective. The wet-bulb temperature (T_w) is the temperature measured

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(See figure on next page.)
Fig. 1 **a** Health impacts from fossil fuel use in the health care sector. *ADHD* attention deficit hyperactivity disorder. **b** Planetary health aspects for intensivists

by covering a standard thermometer bulb with a wetted cloth and fully ventilating it. For humans, T_w of 35 °C is the critical limit, at which point we cannot lose heat, no matter how wet or well ventilated we are. Today, deadly heat conditions occur only in tropical countries for about 11 days per year, but by 2100, ~ 74% of the global population will be exposed to more than 20 days per year of this deadly climate condition, if business-as-usual fossil fuel emissions continue (see supplementary material).

ICUs discard huge amounts of single-use plastics daily [4]. Human-made plastic mass has exceeded 8Gt worldwide, which is double the living biomass of animals on earth [11]. Global plastic production has increased from 2Mt (million tons) in 1950 to 380Mt in 2015, with 99% produced from fossil fuels. Plastic causes long-lasting problems, since it accumulates on beaches, in rivers and oceans, and in the air as macro-, micro- or nanoplastics, which enter the human body via inhalation, ingestion and skin contact. Plastic production worldwide is increasing as is human exposure, and the health impacts of plastic throughout its lifecycle are overwhelming [12]. Plastics are associated with breast cancer, ovarian, prostate, cervical and lung cancer, and trigger cardiovascular diseases, endometriosis, obesity, diabetes, attention deficit hyperactivity disorder and Alzheimer's disease [12]. The COVID-19 pandemic has highlighted how much the health care sector depends on plastic disposable, single-use medical tools and packaging [13]. Until August 2021, the medical system generated more than 8Mt of pandemic-associated plastic waste, mostly related to personal protective equipment (73%) [13]. Hospital waste must be divided into infectious waste (~ 15% of which needs to be incinerated by 1000 °C), and general waste (~ 85%), from which parts can be recycled (~ 45%). However, most plastic waste should be avoided by reducing and reusing materials [14].

In 2019, 55.4 million all-cause deaths occurred worldwide, of which ~ 13.9 million were related to environmental pollution and global warming. The healthcare sector contributes to global warming, air and plastic pollution, and thus to these avoidable deaths every year (Fig. 1, upper panel).

Intensivists will be facing rising patient numbers related to heat stress, extreme weather events, environmental pollution and increasing numbers of infectious diseases (Fig. 1, lower panel). These changes will take place concurrently with aging societies, leading to more vulnerable patients. Climate change-induced water and food shortages due to increasing droughts, wildfires and flooding will further destabilize societies. These long-term harms to human health outweigh the short-term benefits of using non-renewable energy sources and non-reusable plastic supplies. Intensivists should switch to use renewable energies, reduce our energy needs and avoid single-use plastics, as far as possible [15].

The future is now—we should be part of the solution rather than part of the problem.

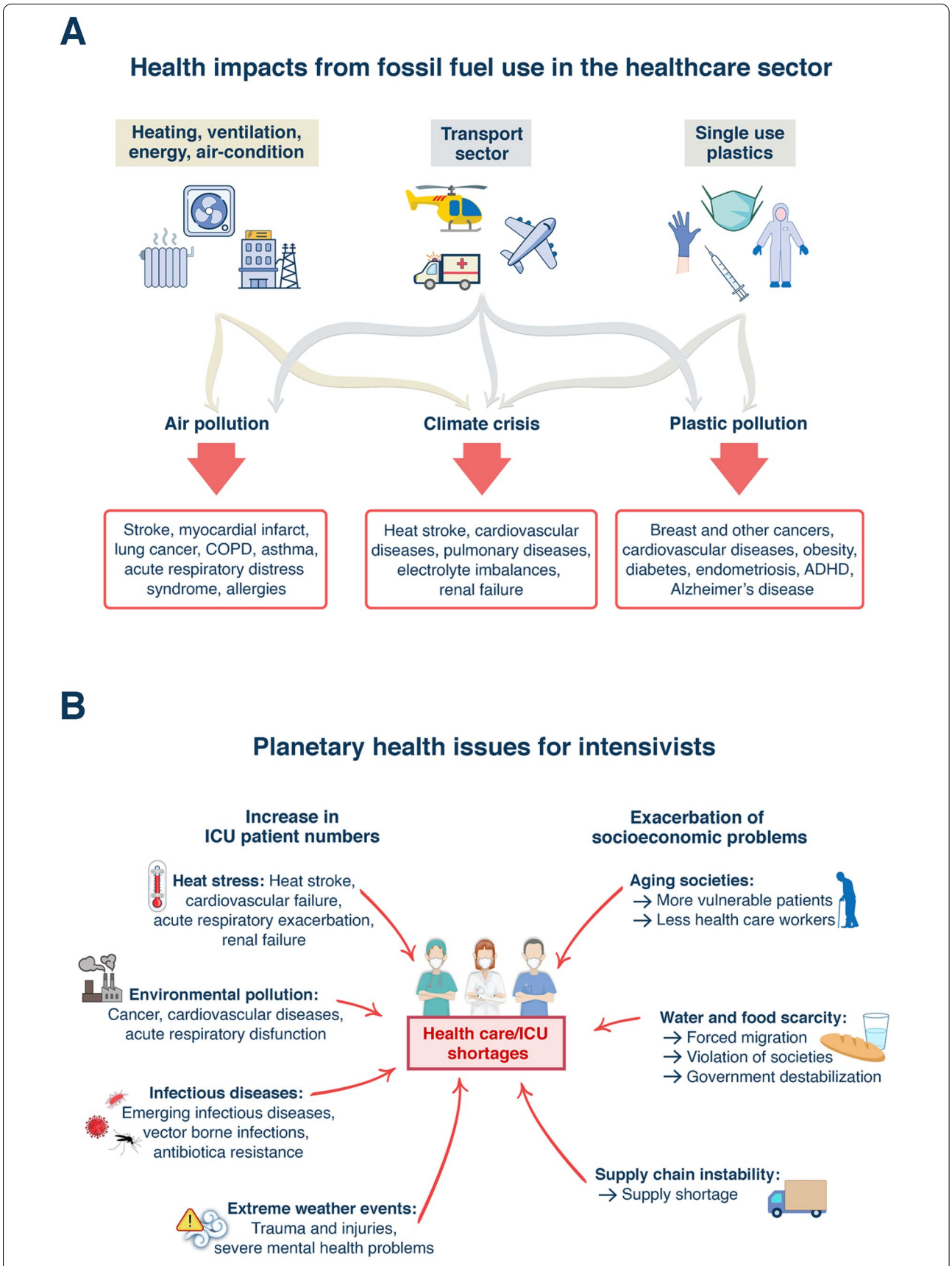

Fig. 1 (See legend on previous page.)

Supplementary Information
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References

1. Waters CN, Zalasiewicz J, Summerhayes C, Barnosky AD, Poirier C, Galuszka A, Cearreta A, Edgeworth M, Ellis EC, Ellis M, Jeandel C, Leinfelder R, McNeill JR, Richter DD, Steffen W, Syvitski J, Vidas D, Wagreich M, Williams M, An ZS, Grinevald J, Odada E, Oreskes N, Wolfe AP (2016) The Anthropocene is functionally and stratigraphically distinct from the Holocene. Science 351:137
2. Romanello M, Di Napoli C, Drummond P, Green C, Kennard H, Lampard P, Scamman D, Arnell N, Ayeb-Karlsson S, Ford LB, Belesova K, Bowen K, Cai W, Callaghan M, Campbell-Lendrum D, Chambers J, van Daalen KR, Dalin C, Dasandi N, Dasgupta S, Davies M, Dominguez-Salas P, Dubrow R, Ebi KL, Eckelman M, Ekins P, Escobar LE, Georgeson L, Graham H, Gunther SH, Hamilton I, Hang Y, Hanninen R, Hartinger S, He K, Hess JJ, Hsu SC, Jankin S, Jamart L, Jay O, Kelman I, Kiesewetter G, Kinney P, Kjellstrom T, Kniveton D, Lee JKW, Lemke B, Liu Y, Liu Z, Lott M, Batista ML, Lowe R, MacGuire F, Sewe MO, Martinez-Urtaza J, Maslin M, McAllister L, McGushin A, McMichael C, Mi Z, Milner J, Minor K, Minx JC, Mohajeri N, Moradi-Lakeh M, Morrissey K, Munzert S, Murray KA, Neville T, Nilsson M, Obradovich N, O'Hare MB, Oreszczyn T, Otto M, Owfi F, Pearman O, Rabbaniha M, Robinson EJZ, Rocklov J, Salas RN, Semenza JC, Sherman JD, Shi L, Shumake-Guillemot J, Silbert G, Sofiev M, Springmann M, Stowell J, Tabatabaei M, Taylor J, Trinanes J, Wagner F, Wilkinson P, Winning M, Yglesias-Gonzalez M, Zhang S, Gong P, Montgomery H, Costello A (2022) The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. Lancet 400:1619–1654
3. MacNeill AJ, Lillywhite R, Brown CJ (2017) The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems. Lancet Planet Health 1:e381–e388
4. McGain F, Burnham JP, Lau R, Aye L, Kollef MH, McAlister S (2018) The carbon footprint of treating patients with septic shock in the intensive care unit. Crit Care Resusc 20:304–312
5. Lakey PSJ, Berkemeier T, Tong HJ, Arangio AM, Lucas K, Poschl U, Shiraiwa M (2016) Chemical exposure-response relationship between air pollutants and reactive oxygen species in the human respiratory tract. Sci Rep-UK 6:1–6
6. Rhee J, Dominici F, Zanobetti A, Schwartz J, Wang Y, Di Q, Balmes J, Christiani DC (2019) Impact of long-term exposures to ambient PM2.5 and ozone on ARDS risk for older adults in the United States. Chest 156:71–79
7. Koch S, Hoffmann C, Caseiro A, Ledebur M, Menk M, von Schneidemesser E (2022) Air quality in Germany as a contributing factor to morbidity from COVID-19. Environ Res 214:113896
8. Vicedo-Cabrera AM, Scovronick N, Sera F, Roye D, Schneider R, Tobias A, Astrom C, Guo Y, Honda Y, Hondula DM, Abrutzky R, Tong S, de Sousa Zanotti Stagliorio Coelho M, Saldiva PHN, Lavigne E, Correa PM, Ortega NV, Kan H, Osorio S, Kysely J, Urban A, Orru H, Indermitte E, Jaakkola JJK, Ryti N, Pascal M, Schneider A, Katsouyanni K, Samoli E, Mayvaneh F, Entezari A, Goodman P, Zeka A, Michelozzi P, de Donato F, Hashizume M, Alahmad B, Diaz MH, De La Cruz Valencia C, Overcenco A, Houthuijs D, Ameling C, Rao S, Ruscio FD, Carrasco-Escobar G, Seposo X, Silva S, Madureira J, Holobaca IH, Fratianni S, Acquaotta F, Kim H, Lee W, Iniguez C, Forsberg B, Ragettli MS, Guo YLL, Chen BY, Li S, Armstrong B, Aleman A, Zanobetti A, Schwartz J, Dang TN, Dung DV, Gillett N, Haines A, Mengel M, Huber V, Gasparrini A (2021) The burden of heat-related mortality attributable to recent human-induced climate change. Nat Clim Chang 11:492–500
9. Misset B, De Jonghe B, Bastuji-Garin S, Gattolliat O, Boughrara E, Annane D, Hausfater P, Garrouste-Orgeas M, Carlet J (2006) Mortality of patients with heatstroke admitted to intensive care units during the 2003 heat wave in France: a national multiple-center risk-factor study. Crit Care Med 34:1087–1092
10. Xu Y, Ramanathan V (2017) Well below 2 degrees C: mitigation strategies for avoiding dangerous to catastrophic climate changes. Proc Natl Acad Sci USA 114:10315–10323
11. Elhacham E, Ben-Uri L, Grozovski J, Bar-On YM, Milo R (2020) Global human-made mass exceeds all living biomass. Nature 588:442
12. Kumar R, Manna C, Padha S, Verma A, Sharma P, Dhar A, Ghosh A, Bhattacharya P (2022) Micro(nano)plastics pollution and human health: how plastics can induce carcinogenesis to humans? Chemosphere 298:134267
13. Peng YM, Wu PP, Schartup AT, Zhang YX (2021) Plastic waste release caused by COVID-19 and its fate in the global ocean. Proc Natl Acad Sci USA. https://doi.org/10.1016/j.chemosphere.2022.134267
14. Sherman JD, McGain F, Lem M, Mortimer F, Jonas WB, MacNeill AJ (2021) Net zero healthcare: a call for clinician action. BMJ 374:n1323
15. Bein T, McGain F (2022) Climate responsibilities in intensive care medicine-let's go green! An introduction to a new series in Intensive Care Medicine. Intensive Care Med. https://doi.org/10.1007/s00134-022-06930-8