

## LETTER

**Scientific advances facilitate formulation and practical implementation of climate-conscious clinical medical ethics**

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Global climate change due to anthropogenic carbon emissions has created and deepened problems in medicine and public health, such as ecological upheavals and ambient heat-associated health detriments. The fields of biomedicine and biomedical ethics must pay heed to problems arising from global climate change, but such reflection on research into climate change-responses appear inadequate [1]. A number of authors have proposed changes or climate change-related extensions to existing biomedical ethics frameworks. These range from Hantel and colleagues' scope-expanding and climate-conscious updates [2] to Jonsen and Siegler's four-topics principles of clinical medical ethics (CME) ("medical indications," "preferences of patients," "quality of life," and contextual features) [3], which are lucid and informative. However, prescriptive theoretical frameworks have limits in their epistemic construction and practical constraints in implementation. Below, I shall cite three examples that illustrate how advances in science and research are needed to facilitate climate-conscious extensions to more classical CME.

- (i) Strict regulation and administration of antimicrobials to minimise the development of bacterial or parasitic drug resistance. Antimicrobial resistance is fast becoming a severe global health problem, chiefly caused by indiscriminate prescription and/or use of cheap and affordable drugs (ie. patients' preference). This often results in incomplete eradication and selective survival of resistant subpopulations of an infectious agent (for example, the development of drug resistance by *Plasmodium falciparum* to antimalarial drugs). As climate change drives both human infection susceptibility and resistance development of infectious agents, it is more prudent than ever for clinicians to commit towards climate-conscious CME in treatment and drug prescriptions.
- (ii) Exposure to health-impairing cumulative extreme events in a person's lifetime resulting from global climate change. Research showed that even under the relatively mild 1.5°C global warming pathway as per the 2015 Paris Agreement, 52% of people born in 2020 will experience unprecedented lifetime exposure to heatwaves [4]. If global warming reaches 3.5°C by 2100, this fraction will rise to 92%. We all know that the future generations are the ones that will bear the brunt of the climate-change burden, but these scientific numbers remind us to further contemplate the quality-of-life from a climate change perspective.

- (iii) Climate change has aggravated vector-borne infectious diseases worldwide, and one apparent strategy against transmission would be to simply eliminate the vectors. However, we know that such biophobic killings, albeit inevitable on occasions, must be carefully planned, assessed and restricted to minimise destruction to the ecological environment and the ecosystem. The lessons learned from ecological damage due to widespread dichloro-diphenyl-trichloroethane (DDT) use should serve as an ample warning of what might happen if we take a fast and easy route to apparent beneficence to humans without considering the potential environmental impact. The application of beneficence to patient suffering should be context-dependent and the various impacts of climate change have heightened the awareness of the environmental context in clinical care and CME. We have moved on from non-discriminate insecticidal chemicals to more target-specific approaches, such as *Wolbachia* harboring *Aedes aegypti* mosquitoes, the efficacy and eco-friendliness of which stemmed from advances in scientific research.

Classical ethical principles are individual-centred and founded on humanistic moral theories. Updates or extensions to these long-held principles would only be induced by important changes in the practice of medicine and would require novel epistemic inputs. A critical feature that applies to all three cases described above is that any extensions towards climate-conscious CME are often associated with, as well as facilitated by, advances in science and research. Thus, it appears that the former would be practically more meaningful and achievable if we intensify research on the natural and social sciences of diseases/ailments and all affected by these [5].

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