Climate change presents a fundamental threat to human wellbeing. Discuss how it impacts health, disease, and pathology.

Earth is a febrile planet. Since 2003, the U.K. has experienced ten of its hottest recorded years. And, given the interconnected nature of humans and our planet, as Earth sweats, so does humanity. Whether the effects of climate change manifest directly, such as a predicted 166% increase in heat-related U.K. deaths by the 2030s[1], or indirectly, climate change will function as an amplifier of hazards threatening global and local health security.

Climate change potentiates the exacerbation of 78% known human pathogenic diseases[2], with issues centred around range expansion of vector-borne diseases (VBDs) and spillover events. For example, *Aedes albopictus* (*Ae. albopictus)*, native to Asia, acts as an arbovirus vector, causing dengue, chikungunya, and West Nile virus outbreaks across mainland Europe[3]. Although there are no current established populations in the U.K., London and the surrounding areas presently have been deemed suitable *Ae. albopictus* habitats due to increasingly longer, warmer, and wetter seasons, with the remainder of the U.K. set to follow by the 2070s[4]. On a grim note, there are no presently available vaccines for the West Nile or chikungunya virus and QDenga has only just been introduced to Europe[5].

However, climate change also enables the emergence of previously unknown threats. For example, *Candida auris* (*C. auris*) is the first human pathogenic fungus to have emerged due to climate change[6], as *C. auris* adapted to become highly thermotolerant in response to increasing ocean temperatures. First clinically isolated from a case of otitis media in 2009[7], it has since been characterised as multi-antifungal-resistant yeast[8,9] capable of causing serious invasive infections with a 30–72% mortality rate[10]. Moreover, it can be transmitted between patients and survive, despite being dried out, for at least 28 days[11].

Zoonoses, such as SARS-Cov-2 or HIV, already challenge public health infrastructure, but novel spillover hotspots are predicted to increasingly arise following migratory variations and geographical overlap in animal populations driven by climatic changes, amplifying the emergence of known

and novel zoonotic threats[12]. Concurrently, droughts and weather extremes have been predicted to hit Earth's mid-latitudes the hardest, creating 'climate change refugees' and increased population densities. Both human and animal migrations, combined with differing population susceptibilities and limited resources (i.e., clean water, sanitary supplies) have the capacity to challenge public health measures and guidelines all over the globe.

Finally, and perhaps most insidiously, climate change has the capacity to aggravate non-communicable diseases. Already cancer imposes a heavy burden on global healthcare, with an estimated 20 million new cancer cases and 9.7 million related deaths in 2022[14]. Aside from heat-related deaths in a vulnerable aging population, the incidences of various cancers (particularly melanomas and carcinomas) and chronic inflammatory disorders (e.g., chronic obstructive pulmonary disorder) are likely to increase in a future world of increased UV exposure, environmental pollutants, and carbon emissions[15].

But how do these snapshots relate to pathology? In the face of shifting disease landscapes and events, pathologists must continue to stand sentinel against known and emerging climate change threats, whether they are pathogenic illnesses or cancers. The success of pathology within this capacity was most recently illustrated by the COVID-19 pandemic. The rapid progress from SARS-CoV-2 identification to the development of diagnostic PCR tests and a successful vaccine in under a year (a historical first), was down to the combined efforts of a great many pathologists, such as virologists, immunologists and histopathologists.

However, COVID-19 was a singular, overwhelming threat at the given time. It is possible that the convergence of VBDs, emerging and novel pathogens, as well as increasing burden of non-communicable diseases may ultimately "divide and conquer" available pathology services. Little to no routine vaccinations or preventative measures exist in the U.K. for the vast majority of tropical diseases pushed northwards by climate change. Cancer is an old and ever-present threat, still yet to be unravelled despite decades of research. Therefore, not only would routine screening need to continue at a similar or greater rate than before, but other screening, diagnostic and monitoring measures against climate-change derived threats would need to be introduced on top.

Yet for the aging, increasingly overweight population of the U.K. that is no easy task. Demands on health services have only grown, with 5% and 2% annual increase in demand for blood and microbiology tests[16]. Presently, 10% of consultant haematologist positions remain vacant and only 3% of laboratories are adequately staffed to meet clinical demand[17]. Already, these issues directly impact patient care as only 62.8% of patients in England begin treatment within two months of an urgent referral, missing the critical care target of 85%[18]. At this stage, pathology must adapt with the changing times and climate to simply keep running as always, as the services provided are invaluable and indispensable to patient care. However, with the advent of artificial intelligence and integration of technological advances, there remains hope.

On top of all this, it is also important to recognise that, beyond the laboratory bench, healthcare drives climate change just as it effects healthcare – if it were a country, the healthcare industry would be the fifth largest polluter, accounting for 4–5% of global greenhouse emissions[19]. Therefore, prevention of climate change driven effects on public health is not solely limited to what pathology can provide by way of screens, tests, and other patient-focused measures, but what the practice of pathology can adapt within itself to reduce environmental costs, such as integration of the OneHealth approach. Without such measures, healthcare-related emissions could triple by 2050, with patient sample collection and phlebotomy leaving the largest carbon footprints[20].

In conclusion, the effects of climate change cannot be seen in isolation and the effects upon health are complex. A warming earth means increased freak weather and temperature extremes, which, amongst others, drive massive environmental changes that impact directly upon population and individual health. Therefore, while its role in prevention and management of current and future health crises cannot be understated, pathology must adapt to keep pace with the rapid environmental alterations and the burdens they introduce into existing healthcare infrastructure.

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