Emerging infectious diseases and the effect of climate change

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Infectious diseases have been around since the dawn of time, having afflicted human civilizations for millennia.[1] In 2007, WHO warned that since 1970, infectious diseases have been emerging at a rate never seen before.[2] These emerging health threats come with significant socio-economic costs and both direct and indirect impacts on healthcare systems, disrupting economic activity.[3]

The exact nature as to how and why these infections are changing is multifaceted and involves the interplay of many, frequently poorly determinable factors. With the rising human population, people living in closer quarters and travelling wider and more frequently than ever before, the potential for epidemics is high.[4] With ongoing climate change and rampant ecological degradation, further epidemics seem inevitable. In this article I will be focusing on the effect of global climate change on emerging infections.

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How do we define emerging and re-emerging infections?

The term 'Emerging infections' is broad and may be subcategorized into (i) previously undetected infections, (ii) known diseases which have spread geographically, (iii) infectious diseases with potential for bioterrorism, and (iv) those infections which had diminished in importance or frequency in the past, but are now resurfacing either due to a change in environment, society or virulence, or due to increasing antimicrobial resistance. The latter may be referred to as 're-emerging infectious diseases'.[4]

What about the effects of climate change?

Global warming, nowadays preferentially known as 'climate change', is one of the most complex challenges of the century. It is not yet clear whether the recent global temperature increases are solely attributable to human enterprise or whether they are also a function of a cyclical variation.[5] What is undeniable is that global temperatures have risen significantly since 1900 and during this century they will likely exceed the 'safe' 2°C threshold above average.[6] Furthermore, the average sea level has been rising by 1.8mm per year since 1961 and Arctic ice has been shrinking by 2.7% per decade.[7] Controversy still shrouds predictions of the consequences of climate change on infectious diseases, despite several climate-based models. Predictions range from descriptions of a worldwide spread of some infections, to more conservative analyses showing diseases expanding into areas while vanishing from others.[8] The latter scenario seems more likely, as most species, including infectious diseases and their vectors, have both upper and lower thresholds to temperature tolerance.[9]

So how does climate change affect infectious diseases?

Vector-borne Infections

Many infectious diseases are dependent on vectors for their transmission to humans. Mosquitos, ticks, and fleas are directly affected by changes in temperature, rainfall[10] and humidity.[7] For example, aquatic larvae of mosquitoes require pools of water for maturation, with several studies showing a positive correlation between heavy rainfall and outbreaks of mosquito-borne illnesses,[11] while flea diversity declines with increasing altitude and latitude.[12] Climatic changes may thus cause a progressive geographical shift of disease vectors from their endemic areas to locations where they were traditionally categorized as rare.[10] Rising temperature also affects the insect density within an area, the vector's rate of reproduction, the rate of pathogen maturation and replication within the vector itself, while increasing insect bite frequency.[13] In such a case, malaria, dengue fever and tick-borne encephalitis to name a few, may spread or translocate to different regions, potentially interfacing with human populations having little or no immunity to these diseases.[6] Climate change is less likely to result in new infectious diseases and more likely to result in a change in disease distribution, with the areas at highest risk being marginal areas where vectors can survive.[14]

Water-borne Infections

Water borne infections may also be affected by climate change. During times of drought, poor sanitation may result from water scarcity, with the population exposed to potentially contaminated water. Increased infection may also occur during times of flooding, from overwhelmed sewage lines or runoff from livestock excrement.[15] For example, cryptosporidiosis is related to severe weather events, and overwhelmed sewage treatment plants.[16] Flood-associated reports of hantavirus pulmonary syndrome from deer mice foraging in homes and outbreaks of leptospirosis were reported in South America and South-East Asia.[17] Climate related increases in sea temperature and level may also lead to a higher incidence of waterborne and toxin-related illnesses such as cholera and seafood poisoning.[10] In fact, Vibrio spp. bacteria native to the North Sea and the Baltic region, were shown to grow faster in a warmer summer in 2006,[18] while replication of Salmonella increases as temperature rises to 37°C.[7]

Migration

Since as many as 75% of emerging infectious diseases are zoonoses,[19] both human and animal migration play an important role in disease transmission. Human migration is not a new phenomenon - a search for better prospects, escaping civil strife and religious or political persecution are few of the many reasons for migration. Forecasts for climate change-induced migration vary from 25 million to 1 billion people by 2050, with 200 million being most widely quoted figure.[20] The proposed mechanisms for this migration include (i) the increase in severity and frequency of extreme climatic events, (ii) the potential loss of arable and habitable land due to sea-level rise and (iii) negative impacts on ecosystems which sustain livelihood, all of which would promote relocation to greener pastures.[21] Migrants may be exposed to new infections along their travel - to diseases which they might not have sufficient immunity or socio-cultural experience for. For example, people moving to areas with high malaria prevalence would be at particular risk of infection, morbidity, and mortality. Migrants may also act as carriers of infection along their journeys, exposing non-immune natives and introducing infections which may have previously been rare to the area.[21] The ongoing epidemic of cutaneous leishmaniasis in Syrian refugees in Lebanon, a country in which this disease had been previously hypoendemic is an example of this.[22] Sexually transmitted infections, Hepatitis B, HIV and Tuberculosis may also be spread via this route. Moreover, migrants might re-introduce infectious agents upon return to their native country, having been exposed during their travels.[21]

Airborne

Climate influences the pathogenesis of airborne infectious diseases through temperature, level of humidity and wind. Most notably, the influenza virus is reported to survive better at cold temperature and low relative humidity. A low relative humidity decreases mucosal barriers against infection, allows for better evaporation of bioaerosols from infected mammals and maintains viral particle stability in the air. Mammals were also found to shed viral particles in higher

quantities at lower temperature, although their innate immunity was not weakened by this.[23] It has also been suggested that wind may help transmission of viruses by transporting them across oceans on dust particles.[7]

Conclusion

Predictions of tropical diseases moving into wealthier, temperate regions have caught the public's attention.[9] While some regions may see reductions in infectious disease, populations in areas where infections will expand have genuine cause for concern.

Despite our incomplete knowledge of the full impact of climate change on infectious diseases, we should not remain passive bystanders to this. Countries should be proactive in taking measures based on regional scientific projections in order to mitigate the specific negative health impacts of climate change to the area. Some populations will face greater challenges than others due to variations in severity of weather events and differences in financial, and healthcare resources. Knowing that infectious diseases do not restrict themselves within an area or population group, developed countries should work together with the more vulnerable, less-developed countries, with the aim of reducing the exposure to climate change related health threats.[7]

Healthcare workers, in particular, serve a vital role in mitigating this problem. Public health officials must establish surveillance for unusual or drug resistant diseases, help inform clinicians about appropriate antimicrobial use, and advise on national programmes for disease control. Hospitals must ensure sufficient laboratory capacity and funding to investigate new agents and develop plans for handling infection outbreaks. National and international political commitment is also necessary for rapid containment of this global issue.[24]

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Cover Picture:
'Impulse'
Acrylic on canvas
By Pierre Mallia

Pierre Mallia started painting when he was young watching with his father; in the last few years he took up painting again and focuses on Maltese views, mountains, ships and animals. This cover painting was a spontaneous one which gave him the 'impulse' to start painting again.