CANADIAN WILDLIFE HEALTH COOPERATIVE

PERMAFROST THAWING AND THE RISK OF EMERGING INFECTIONS

SUMMARY

Climate change is melting permafrost that has been frozen for hundreds to thousands of years. The thaw is exposing dead people and animals that had previously died of infectious diseases, including the 1918 influenza pandemic, anthrax and smallpox. Recent studies have show that some long-frozen viruses and bacteria could be revived. The low human population density mitigates risk by reducing the probability of exposure and spread, but some occupational or cultural groups with close contact with the natural environment or some communities where human remains, or animal carcasses are being unearthed with permafrost melting may more likely be exposed. The public health implications are unknown and caution is required in assuming risk due to the sparseness of information. Novel One Health citizen science surveillance may be helpful in identifying emerging exposure opportunities. Targeted risk reduction messaging may be warranted for high risk groups. The risks for emerging infections are, to date, hypothetical, whereas other public health impacts from permafrost melting are already being realized and require attention.

THE ISSUE

Temperatures have been increasing faster in the Arctic than elsewhere in the Northern Hemisphere, outpacing current climate model predictions. Climate change in the Arctic may increase zoonotic disease risks due to expansion of vector habitats, development of climatic conditions favourable to vectors and hosts that normally do not reside in the Arctic, changes in human-animal associations and permafrost degradation (1,2). Climate factors can directly and indirectly impact disease transmission by changing human behaviors, vector ecology, or pathogen survival (3). Significant numbers of viable microorganisms are known to be present within the permafrost, include those recovered from permafrost dating back millions of years (4). Evidence supports the hypothesis that pathogens also are preserved in glaciers, ice sheets, and lake ice (5). Permafrost and ice are thawing at higher latitudes and to greater depths than ever recorded. As the permafrost and ice thaw, buried carcasses of infected animals and people have been exposed and ensuing flooding and soil disruption are creating plausible avenues for pathogen dispersal. Degradation of existing sanitary infrastructure could amplify these avenues for transmission. The revival of 4 viruses of amoeba from permafrost over 30,000 years old (6,7) plus outbreaks of anthrax in Siberia (8) are fueling concerns that melting permafrost and Arctic ice may be a source of re-emerging known pathogens and/or the revival of ancient yet unknown pathogens. Permafrost has been considered an impermeable barrier to the movement of contaminants from burial sites but as it melts organic matter in the soil become available for remobilization and introduction into aquatic systems (9).

The public health significance of these findings is unknown but can be questioned. The revived virus affecting amoeba are not human pathogens and have evolved to live in colder conditions than the human body. Anthrax outbreaks have been a constant feature of the Canadian Arctic, well-before this accelerated rate of permafrost melt. Arctic populations are relatively small and widely dispersed, a factor that might delay transmission of a pathogen exposed by ice or permafrost melting. Studies of ancient pathogens in frozen environments are sparse in the literature. Care must be taken in reviewing new findings of revived arctic pathogens. Many of the laboratories performing this work often also deal with contemporary microbes, making it necessary to ensure sample contamination has not occurred.

IMPLICATIONS FOR PLANNING

Widely dispersed populations plus lack of health infrastructure will necessitate novel means for detecting risks or outcomes relate to pathogen emergence with permafrost or snow melt. Citizen science programs alerting public health officials to newly exposed human or animal remains may be an early warning option. One Health surveillance approaches may be especially warranted for agencies striving for early detection of emerging pathogens under these circumstances.

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Many infectious diseases risks in the north threats will be from zoonotic infections and are likely to disproportionately affect those who have a close connect with the natural environment (10). Targeted personal protection messaging may be warranted for this higher-risk group. Protocols for managing exposed human or animal remains may be warranted. Mapping forecasts of permafrost melting and using thin information when planning new burial sites may be one means of future risk reduction. There is a wider and more immediate set of public health implications of permafrost loss including; reduced access to subsistence resources, damaged infrastructure preventing travel for work or health care or access to functional sanitary systems, loss of surface water as soils become more porous, loss of housing and medical facilities, and psychosocial distress associated with the changes (11).

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