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In Practice

A mass mortality event in bats caused by extreme heat: surprising public health challenges

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Key points

- Climate change is likely to bring new public health challenges. Managing climate-related challenges requires coordinated, multi-agency responses
- It is important to move towards a 'one health' model of public health that recognises the interconnection between people, animals, ecosystems and environments
- Public health units must work with government agencies to ensure communities are climate ready

Abstract

Objectives: We examine the public health response to an unprecedented multiple mortality event in bats following an extreme heat event. The main public health risk associated with the event and the environmental clean-up was potential human infection with Australian bat lyssavirus. We also consider the public health implications as we enter an age of climate change, vulnerability and unexpected events.

Type of service: The Tropical Public Health Service of Far North Queensland worked collaboratively with the local council to coordinate a practical public health and health protection response to a mass mortality event in bats in late 2018.

Methods: A coordinated response was instigated to remove thousands of decaying bat corpses from residential areas. This occurred alongside a health education campaign advising the public to avoid handling bats.

Results: The combined efforts were successful; those requiring vaccination and post-exposure prophylaxis were treated appropriately and owing to a successful campaign, exposures were minimised. However, significant issues with misinformation and social media messaging were noted, alongside amateur bat carers handling sick and injured bats inappropriately, compounding the challenge for public health services. This mass mortality event has implications regarding the preparation for and management of other unexpected public health crises related to climate change.

Lessons learnt: It is vital that areas populated with bats be prepared for extreme heat events (EHEs). Public health units need to be prepared for the unexpected events of climate change, advocate for a 'one health' approach to public health, and work with local and national governments to become 'climate ready'.

Background

Heatwaves, also known as extreme heat events (EHEs), are the result of a complex interplay of changes in soil moisture, changes in tropical Pacific Ocean surface temperature and expedited Arctic warming.[1] High temperatures and stagnant warm-air masses are key features of EHEs, and the public health effects are likely to be exacerbated by air pollution, an ageing population and increasing urbanisation.

EHEs are the most lethal of severe weather events; in the US, they account for more deaths annually than storms, cyclones, floods and earthquakes combined.[2] EHEs cause dehydration, heat stroke and exacerbate chronic disease. Consequentially, it is the most vulnerable in society – the very young, the elderly and those with chronic disease – who are most severely impacted.[3]

EHEs are common in Australia and the public health impacts are severe. As a result of climate change, the frequency, intensity and duration of EHEs are increasing, and projected to worsen.[2] Summer temperatures are increasing across Australia year-on-year, with 2013–2017 being the hottest period on record.[4] The 2009 and 2014 heatwaves of Victoria resulted in 167 excess deaths (2014), a 25% increase in ambulance case load (2009) and a significant increase in heat-related emergency department presentations (both years).[5] The year of 2018 was Australia's third warmest recorded year since 1910, with a mean temperature 1.4 °C above average and accompanying severe drought.[6]

The heatwave in Far North Queensland began in November 2018, with multiple locations reporting significantly higher temperatures than previously recorded for any month, including several days exceeding 40 °C.[7] During the heatwave, paramedics attended 9% more incidents compared with the same period in the previous year, and a total of 25 heat-related cases were noted.[7]

Although the direct effects of EHEs on humans are well known, less expected are the indirect effects such as those related to the mass mortality event in the local bat population. The bat species endemic to the Far North Queensland region is the spectacled flying fox, or *Pteropus conspicillatus*. The heatwave caused a mass mortality event of more than 4000 of this predominant species of bat[7], leading to a number of unforeseen and potentially fatal public health consequences. The Tropical Public Health Service (TPHS) of Far North Queensland was called to respond to the event and address the risks of potential human infection with Australian bat lyssavirus (ABLV). Here, we describe the public health implications and lessons learnt as we enter an age of climate change, vulnerability and unexpected events.

Heatwave-induced bat mass mortality events

EHEs pose a significant threat to bats, as bats are highly susceptible to hyperthermia owing to their inability to engage in effective evaporative cooling at temperatures above that of their body.[8] Bat mortality due to EHE-related hyperthermia is well documented in the literature, including in India and several locations across the Pacific Island Nations.[9] Welbergen and colleagues note that 19 Australian EHEs since 1994 have killed more than 30 000 bats.[10]

The *P. conspicillatus* species is in significant decline and is listed as threatened or vulnerable under the *Environmental Protection and Biodiversity Conservation Act (1999)*.[11,12] This decrease in population poses ecological and economic concerns; *P. conspicillatus* are primary pollinators/seed distributers and numbers may become insufficient to service the paleotropical forests; this may impact the dependent economies.[13] Lack of seed dispersal and pollination will have significant impacts on several foods for human consumption, such as figs, bananas, mangos and durian fruits, and on trees used for their timber.[13] Decline in these resources will have stark economic impacts, particularly for disadvantaged populations.[14] *P. conspicillatus* populations have declined in Far North Queensland by around 60% over the past decade.[15] Further EHEs will endanger this species further, with wide-reaching impacts.

The impacts of decline in *P. conspicillatus* are not only limited to ecology and economy; there are significant public health implications, as pollinators, food variety and security may also wane under diminishing populations. However, there is little published information available about the implication of and public health response to bat mass mortality events, particularly in the context of EHEs.

Public health consequences of mass mortality events in bats

The 2018 mass mortality of bats in Far North Queensland posed significant new challenges for the TPHS and local council. Issues included the increased risk of zoonotic disease transmission and environmental health problems surrounding mass decomposition and the related clean-up efforts.

Bat mass mortality events are a public health threat largely because of the increased risk of disease transmission from bats to humans. Of significant concern is risk of ABLV, most commonly transmitted from direct contact with bats, particularly through being bitten or scratched.[16] Large numbers of sick or dead bats lying on the ground can increase transmission risk because of increased human–bat interaction, particularly if members of the public attempt to rescue unwell bats or remove

the remains of dead bats. During the mass mortality event, increased emergency department presentations of people who had been injured through handling bats were reported to the TPHS. Currently, public health advice is to give a combination of vaccine and human rabies immunoglobulin (HRIG) to any unvaccinated person who comes into direct contact with a bat.[17,18]

The effects of EHEs, such as exacerbation of drought, can lead to increased numbers of bats flying into urban areas in search of food and water.[12] Urban roosting is a cause of contact and conflict with humans as large numbers of bats, sometimes in excess of 50 000, may roost (camp) together. This can result in issues with noise pollution and faecal matter, and increases the risk of human–bat contact.[12] Although the blood and faeces of bats are not considered a risk for ABLV, it is recommended that any bat fluids be avoided.[19]

Our experience is that when bats die en masse in urban areas there are significant problems with dead and decaying corpses and associated increased human–bat contact, malodour and human distress. Addressing EHEs, and thereby reducing mass mortality events, requires significant measures to address the underlying causes of climate change.[20] Future EHEs will likely bring more bat mass mortality events resulting in extensive clean-up efforts. The public health risks of mass bat decay are not well documented, but it is expected that risks to health include: ABLV infection resulting from contact with corpses, and psychological impact of living with pungent malodour and the sight of mass-animal death.

Public health response

The Far North Queensland TPHS was unprepared for this bat mass mortality event and the subsequent public health issues relating to increased human–bat contact and decaying corpses, due to the unprecedented scale of the event. We identified multiple issues that need to be considered during the public health response. These can broadly be divided into direct human health risks resulting from contact with bats, and those risks related to the environmental situation and response from various organisations (Table 1).

The risk of ABLV infection increased not only in bat carers – a mix of volunteers and people who are employed in wildlife rescue – but also among members of the public trying to rescue sick bats or remove carcasses of dead bats from residential properties. These risks were managed firstly with effective post-exposure prophylaxis, but also with a public education campaign highlighting the risks of handling bats and providing a phone number to call if an injured or dead bat was found.

Efforts to care for the bats led to members of the public rescuing dying bats without personal protective equipment. Additionally, there was increased risk of injury from untrained members of the public using needles to try to administer intravenous rehydration to sick bats.

Social media revealed discontent from the public about authorities' handling of the bat mass mortality event. This dissatisfaction was largely owing to the lack of co-ordination and clarity of responsibilities between the leading organisations.

Table 1. Risks identified during the public health response to the bat mass mortality event

Direct human health risks
Exposure of residents to communicable disease
Inadequate use of personal protective equipment among those caring for bats
Public engagement in bat rescue and recovery
Potential for needle-stick injuries from equipment used to re-hydrate bats
Disorientated bats flying around public areas
Environmental and response risks
Extensive numbers of deceased and injured bats lying in residential and public areas
Lack of coordinated clean-up plan leading to long delays
Open public access in heavily bat-populated areas
Malodour of multiple decaying carcasses resulting in some residential properties being vacated
Lack of clarity of roles and responsibilities of agencies involved in the response

One unforeseen consequence of the bat mass mortality event was the impact on health services. The bat deaths led to increased exposure of the public and wildlife carers to potential ABLV. This resulted in strain on the health service, which was further increased when members of the public began reading on social media that a "free" vaccine was being administered at the local hospital. This resulted in mass presentation of worried individuals with no exposure history.

Problematic social media messaging from unofficial sources led to dissemination of inaccurate health information. Misinformation on social media included a suggestion that wound cleaning was an adequate substitute for post-exposure prophylaxis, and there were unfounded rumours about vaccine shortages.

The central business district in Cairns is known to have several *P. conspicillatus* camps in city-centre trees. Disorientated bats were frequenting the area to the extent that some footpaths had to be closed for several days to reduce public exposure.

One residential area was so severely affected from decaying bat corpses that several residents had to vacate their homes for a period of time. Consequentially, residents felt forced to help in the clean-up operation themselves, with a notable lack of personal protective equipment, leading to further exposure risks.

Overall, the public health and council responses were very effective, however unreasonable delays in the response were problematic and largely due to

under-preparedness for an unusual event of this scale. There appears to be very little in the published literature pertaining to the public health management of bat mass mortality events.

Discussion

Although predictions of extreme weather events relating to climate change are already coming to fruition, the exact effects remain to be seen, and they include exacerbation of EHEs.[21] In a world with a changing climate, it is increasingly challenging to predict and prepare a public health response for all possibilities. Climate change increases the urgency with which we need to prepare for EHEs.

The bat mortality event in Far North Queensland is an excellent example of the need for changes within the public health service from acting as self-contained units towards a 'one health' systems-based approach. The one health approach arises from the fact that people, animals, ecosystems and environments are inextricably linked, and true problem solving can only occur with acknowledgement of the complex structures and dynamics of which they are composed.[22] Future events can therefore only be managed in partnership with other organisations.

Technological advances and tools such as social media are fundamental to modern-day responses. If public health teams cannot use these tools effectively, there is a risk that preventive medicine will be left behind. With climate change, it is likely that future events will grow in both severity, frequency and breadth of effects. Extreme events such as the bat mass mortality event in Far North Queensland must be used as a driver for change within Australian public health services. Multiple agency planning is required if Australia is going to be climate ready.

Recommendations

There is a strong trend of increasing EHEs[2] and other effects of climate change. Public health units must begin preparing for such events now and, in doing so, to expect the unexpected. Multiple lessons can be learnt from the bat mass mortality event in Far North Queensland, including devising and incorporating animal mass mortality plans into response protocols, and ensuring clarity of roles in future events before they occur. Public health units must also work to increase capacity to use social media resources.

Bat mass mortality events such as this will likely increase in frequency, with severe impacts on bat populations. Bats are important for food security. Decline of any bat population could therefore have knock-on effects for local food production and the economy. We recommend using a one health approach that advocates for systems thinking in health and wellbeing. Using this model, it is imperative that public health services partner with other agencies to prepare for future events related to climate change.

We recommend that public health units devise teams dedicated to assessing and preparing for climate-related risks, particularly in areas where the effects of climate change are likely to be varied and wide reaching, such as in Far North Queensland. These teams would be responsible for engaging with stakeholders and the public to advocate for actions to mitigate the effects of climate change and additionally to manage the specific impacts of climate change on public health. There is a need to focus on a systematic approach towards planning for extreme weather events. For climate change, the issue is no longer if, but when. By taking a one-health approach, we will be better prepared to respond to the inevitable and broad-ranging public health impacts.

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Competing interests

All authors are employed by Queensland Health and, as part of their work, were directly involved in the public health response to the mass bat mortality event discussed in this manuscript.

Author contributions

LM led the drafting and editing of the manuscript. CT contributed to drafting and editing the manuscript. JE contributed to drafting the manuscript and was responsible for reviewing and providing feedback. RG supervised the drafting of the manuscript and was responsible for reviewing and providing feedback.

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