Archives of Medicine©
15 (03) 2023 : 001-003 • MINI REVIEW

Acoustic monitoring for infectious disease epidemiology: Uses and advancements

Kharbanda Duong*
Department of Surgery, Hanoi Medical University, Hanoi, Viet Nam

SUMMARY

Global public health continues to be severely impacted by newly emerging infectious illnesses, and there is an urgent need to better understand the patterns of transmission that emerge at the nexus between human activities and wildlife habitats. Passive acoustic monitoring (PAM), which is more frequently used to study biodiversity and conservation issues, offers the chance to gather and analyse audio data in nearly real-time and at a cheap cost. With the growth of cloud-based computing, affordable hardware, and machine learning techniques, acoustic technologies are becoming more widely available. Acoustic data can supplement current surveillance techniques and offer a fresh toolkit for examining the crucial biological factors and ecological interactions that underlie infectious disease epidemiology when combined with deliberate experimental design.

Keywords: Eco-acoustics; Epidemiology; Soundscape; Passive acoustic monitoring

Address for correspondence:

Kharbanda Duong
Department of Surgery, Hanoi Medical University, Hanoi, Viet Nam
E-mail: kharbanda@hmu.edu.vn

Word count: 1180 **Tables:** 00 **Figures:** 00 **References:** 10

Received: 01.03.2023, Manuscript No. ipaom-23-13641; **Editor assigned:** 03.03.2023, PreQC No. P-13641; **Reviewed:** 15.03.2023, QC No. Q-13641; **Revised:** 20.03.2023, Manuscript No. R-13641; **Published:** 27. 03.2023

INTRODUCTION

Ecologists increasingly use bioacoustic methods to characterize the distributions and behaviors of wildlife species and monitor environmental change (see Glossary). The transmission of many infectious diseases is also determined by these ecological patterns and processes; however, epidemiological studies rarely incorporate acoustic monitoring. The biotic relationships between humans and their environment, host and vector species, and zoonotic and vector-borne diseases must be dissected in epidemiological studies in order to effectively monitor, predict, and control them. Acoustic monitoring technology and data can be incorporated into epidemiological studies and disease surveillance systems in this way [1].

LITERATURE REVIEW

Integrating data from a variety of biological processes and spatial and temporal scales is essential for comprehending the dynamics of disease transmission in complex multihost systems. We still know little about the mechanisms by which disease processes pose a threat to human health, aside from a few well-studied pathogens. Core epidemiological questions can be answered using bioacoustics, such as which species are present in a region, where and how key species move and behave across heterogeneous space, when species are active in a space, and whether host species, vectors, and/or human movement overlap spatially and temporally [2].

Classical field methods like transects, trapping, and questionnaires can help shed light on the micro-level social and ecological processes that contribute to disease risk by answering these questions. Be that as it may, being commonly work escalated and costly, old style techniques are not generally reasonable for grasping examples of hazard at scale. Techniques for studying the climate, utilizing sound recorders, including PAM, have progressed quickly in the fields of earthly and oceanic nature and protection, and ecoacoustic information are utilized actually in appraisals of biodiversity and environment wellbeing over wide spatial scales.

DISCUSSION

Acoustic data are currently being used to better understand infectious diseases, but there are only a few examples. Acoustic surveys are typically used in conservation biology to identify and monitor soniferous species, especially those that are visually cryptic or found in densely vegetated landscapes. The application of acoustic sensing in community-science-based mosquito surveillance has been the subject of some research in relation to human disease. Despite some implementation limitations, mobile phone devices can be used as acoustic sensors to track human–mosquito encounters and collect occurrence data without typical sampling biases to inform vector-borne disease control programs [3].

There are also examples of acoustic data used in a laboratory setting to comprehend the mating behavior of mosquito vectors. Aside from white-nose syndrome in bats, ecoacoustic data are used to survey hibernation sites monitor seasonal disease-related behavioral change and evaluate the effects of climate change on disease progression in the majority of existing applications. There are also a few examples of acoustic monitoring of amphibian diseases, such as studying changes in the call patterns of infected frogs and chytridiomycosis. According to Gibb et al.'s description, PAM survey data can be used to examine a number of biological and ecological processes.

The occupancy, abundance, and detectability of species over space or time, as well as the estimation of species' spatial and temporal overlap, appear to be answers to many of the same questions that are essential for epidemiology and the study of disease transmission. Epidemiological variables that could be obtained from bioacoustics and their potential applications to the surveillance and control of infectious diseases. Despite the fact that there is no existing literature on the application of acoustic data to understand processes underlying disease transmission, By offering another device to illuminate pertinent boundaries, acoustic overviews could be profitable in concentrating on a scope of irresistible sickness frameworks, especially those with sylvatic microorganism repositories [4].

For instance, acoustic data could be utilized to identify shifts in host behavior or location that could increase risk, such as wildlife entering livestock compounds or human settlements host die-offs indicative of an epizootic or livestock ranging into human settlements. This includes, but is not limited to, diseases like yellow fever and zoonotic malaria, which have reservoirs in non-human primates; small mammals and canids (such as rabies and trypanosomiasis). Toxoplasmosis and Rift Valley fever in livestock and small ruminants bats (the Marburg, Ebola, Nipah, and Lyssa viruses) and wild birds, including Japanese encephalitis and West Nile virus.

PAM is already widely used in some fields; here, the benefit for irresistible illness examination would be of applying existing work processes to epidemiological inquiries. Bats are one example of a target for applying existing acoustic methods to human epidemiology. The analysis of bioacoustic data is already a mainstay methodology in this field to investigate population dynamics and behavioral trends. Certain species are known to host a variety of viral pathogens with existing or emerging zoonotic potential. For instance, existing acoustic techniques could be used to more readily comprehend the scattering of nonhaematophagous bats and illuminate metropolitan rabies observation and control [5].

Acoustic data could also monitor behavioral indicators of disease risk in a well-studied vocal species: For instance, there is evidence that the Egyptian fruit bat Rousettus aegyptiacus's breeding season coincides with high levels of human Marburg virus risk. In addition, it has been demonstrated that, in comparison to using a single data source, combining acoustic data with other high-effort, high-quality data types (such as GPS tagging, mark-recapture, point count surveys, and so on) can produce superior models, improve parameter estimation, reduce detection biases, and improve estimates of abundance and population size [6].

Acoustic data may also present a novel opportunity to fill technological voids in infectious disease research at the moment. Unmanned aerial vehicles (UAVs), satellite sensing, and LiDAR (Light Detection and Ranging) data are all examples of remote sensing technologies that are becoming increasingly used to infer patterns in disease risk and model transmission. PAM, on the other hand, may provide a significant advantage for monitoring the distribution and movement of species in forested or closed landscapes [7].

Although UAVs have been successfully used in aerial population surveys of livestock reservoirs and in mapping mosquito vector breeding sites this technology is best suited to large animals and features of open grassland landscapes. The recent development of low-cost sensors or autonomous recording units (ARUs) that are optimized to work in such contexts can benefit epidemiological studies that are unfamiliar with using acoustic technology, particularly those that collect data in remote areas [8-10].

CONCLUSION

The use of PAM to continuously collect data on the acoustic environments around it has become easier thanks to advancements in wireless sensor technology. Open-source acoustic sensors are now readily available, and devices based on microprocessors like AudioMoth offer options that are affordable to manufacture and adaptable enough for users who are not experts. AudioMoth devices support sampling rates up to 384 kHz and sampling distances within radii of 50 m to 1500 m depending on the source. Users can adjust sampling rate, gain, sampling intervals (how frequently devices record audio), and sampling durations (length of recordings and recording schedule) based on the research question (i.e., target species, spatiotemporal scale). Commercial suppliers also sell other recording devices that are more specialized (such as Cornell Swift recorders or larger monitoring projects like Wildlife Acoustics).

ACKNOWLEDGEMMENT

None.

CONFLICT OF INTEREST

None.

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