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Short communication

Using local knowledge in emerging infectious disease research

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ABSTRACT

Emerging infectious diseases (EIDs) are a growing global health threat. The Stockholm Paradigm suggests that their toll will grow tragically in the face of climate change, in particular. The best research protocol for predicting and preventing infectious disease emergence states that an urgent search must commence to identify unknown human and animal pathogens. This short communication proposes that the ethnobiological knowledge of indigenous and impoverished communities can be a source of information about some of those unknown pathogens. I present the ecological and anthropological theory behind this proposal, followed by a few case studies that serve as a limited proof of concept. This paper also serves as a call to action for the medical anthropology community. It gives a brief primer on the EID crisis and how anthropology research may be vital to limiting its havoc on global health. Local knowledge is not likely to play a major role in EID research initiatives, but the incorporation of an awareness of EIDs into standard medical anthropological practice would have myriad other benefits.

1. Introduction

Emerging infectious diseases (EIDs) present a major threat to global health. They are communicable human diseases that have recently grown in their geographic and/or host range. For example, West Nile fever, Lyme disease, and methicillin-resistant *Staphylococcus aureus* (MRSA) infection are EIDs that have spread geographically in recent decades. EIDs that have recently jumped the species barrier from infecting non-humans to infecting humans are called zoonoses, and they include Ebola virus disease, HIV/AIDS, and COVID-19. Zoonoses comprise about 75% of all EIDs that have emerged in recent years, and they are especially feared for the toll they could take on global health over time (World Health Organization, 2014).

That toll is expected to grow. The 20th century paradigm of host-pathogen interaction suggests that species barriers should be very difficult for pathogens to overcome, but the Stockholm Paradigm, a new but well-substantiated understanding of pathogens, challenges this. It proposes that species barriers tend to be much lower than previously thought and tend to fall significantly in the face of ecological change (Brooks et al., 2014, 2019). For example, anthropogenic climate change is already associated with many recent vector-borne disease outbreaks (Reisen, 2015), and there is ample historical evidence for the connection between environmental change and disease emergence (e.g. Schmid et al., 2015). Furthermore, EIDs have been discovered at a rate of more than three per year since the 1980s (Woolhouse and Gaunt, 2007), and that rate has been increasing since the 1940s, even after

controlling for reporting bias (Jones et al., 2008). As such, researchers from various disciplines view EIDs as a mounting crisis—one that requires interdisciplinary research (Parkes et al., 2005; Gayer et al., 2007; Goodwin et al., 2012; Kelly et al., 2017; Bloom and Cadarette, 2019). This paper aims to contribute to that research agenda.

The main research protocol for preventing infectious disease emergence is DAMA (documentation–assessment–monitoring–action). It proposes an integrated research initiative to isolate and categorize unknown pathogens (‘documentation’), identify which are most likely to become EIDs (‘assessment’), develop surveillance networks for those pathogens (‘monitoring’), and take proactive steps to minimize human exposure to them (‘action’) (Brooks et al., 2014, 2019). DAMA is still very much on its first phase of implementation. The largest research program to date that has studied zoonosis emergence was PREDICT, a ten-year effort funded by the U.S. Agency for International Development (USAID) and launched in 2009. It focused on isolating and identifying pathogens from animals in likely hotspots of zoonotic emergence, i.e. low-income areas of Africa and Asia (Carlson, 2020). As yet, that seems to be the only tested strategy for ‘documentation.’ This paper suggests that utilizing local knowledge may also be a useful strategy for documenting potential EIDs.

Local knowledge refers to “the knowledge that people in a given community have developed over time, and continue to develop. It is based on experience; often tested over centuries of use; adapted to the local culture and environment; embedded in community practices, institutions, relationships and rituals; held by individuals or communities;

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and dynamic and changing” (Food and Agriculture Organization, 2004). The concept of ‘local knowledge’ significantly overlaps with concepts of ‘traditional knowledge,’ ‘indigenous knowledge,’ ‘traditional ecological knowledge,’ and ‘situated knowledge. This paper uses the term ‘local knowledge,’ as it is the broadest of these concepts, but I primarily use it to refer to the experience- and community-based knowledge of indigenous and other vulnerable groups in low- and middle-income countries. Borrowing from the idea of local knowledge as ‘situated knowledge’ (e.g. Haraway, 1988; Nazarea, 1999; Tschakert et al., 2016), I refer to these groups as ‘locally-situated communities.’

Local knowledge is already used as a source of empirical knowledge by different disciplines. Traditional ecological knowledge is a bountiful source of pharmaceutical knowledge, as well as knowledge about ecology and environmental health (e.g. Alves and Rosa, 2007; Comberti et al., 2015; Finn et al., 2017). Moreover, the study of local disease knowledge about biomedically-known diseases is well-established within medical anthropology (e.g. Tschakert et al., 2016; Fearnley, 2018).

I propose that local knowledge is also a useful source of information about potential EIDs that are unknown to biomedicine. Local knowledge can be a problematic source of information, both ethically (Ebata et al., 2020) and in terms of its relevance to scientists. However, it likely contains relevant information about human diseases, animal diseases, and zoonoses that has not yet been empirically documented. I will now discuss this possibility with reference to theoretical considerations and some limited case studies.

2. Discussion

2.1. Theoretical considerations

There are theoretical reasons to suspect that local knowledge could be useful for identifying potential EIDs. As already mentioned, ethnobiological systems can surpass empirical knowledge of certain subjects. Those subjects are generally distant from the purview of empirical knowledge gathering systems, e.g. geographically remote or in low-income settings, and they are often salient to local life. Human and animal diseases present in locally-situated communities meet both of those criteria.

Social science literature contains examples of such communities having novel, useful information about diseases of which the scientific community was already aware. A study of local knowledge in Ghana about Buruli ulcers, a poorly understood, necrotic infection caused by *Mycobacterium ulcerans*, revealed information that is likely useful for understanding the etiology and life cycle of the disease (Tschakert et al., 2016). Similarly, local knowledge in Malaysia and Latin America has been helpful in identifying neglected hideouts of the vectors that transmit dengue fever (Dickin et al., 2014) and Chagas disease (Abad-Franch et al., 2011). Given that such communities have independent knowledge of diseases already known to science, it is likely that they have knowledge of diseases not known to science. This is not a valid inference if biomedicine is assumed to have a complete knowledge of existing and potential human diseases, but this is not the case. Accurate estimates of global pathogen diversity are very difficult to obtain, but it is likely that only a small fraction of potential human pathogens has been empirically documented (Pedrós-Alió and Manrubia, 2016).

Moreover, there are ecological reasons why locally-situated communities are more likely to be in contact with animal diseases than other communities. Locally-situated communities often live in highly biodiverse environments. Cultural diversity correlates with biodiversity on a global scale (Gorenflo et al., 2012), and it is likely that this principle applies to pathogen diversity as well (Guernier et al., 2004). Therefore, locally-situated populations are arguably in closer proximity to a higher density of animal disease than any other population just because of their geography—not to mention because of any economic or subsistence-driven need for such communities to interact with

animals.

It is likely that locally-situated communities face relatively high rates of zoonotic infection, in particular. Sharing an ecosystem with a great diversity of pathogens increases the risk of zoonotic transmission in and of itself, given that risk of zoonotic infection is a function of ecological connectivity (Brooks et al., 2019). Additionally, ecological degradation is a risk factor for zoonosis (Ostfeld, 2009; Bonds et al., 2012), and locally-situated communities are among the most likely to live in recently or currently degrading ecosystems, e.g. due to poor environmental regulation, the presence of pollution-prone industries, and/or development-related changes to the environment (Hoover et al., 2012; Sapkota and Bastola, 2017; Tallman et al., 2020). Such communities are also least able to mitigate the effects of climate change in their environments. For locally-situated Arctic communities, this is especially true because warming is happening faster there than any other region of the planet (Dai et al., 2019; Parkinson et al., 2014). Therefore, locally-situated communities can be expected to be in especially frequent proximity to human diseases, animal diseases, and zoonoses that are unknown to the scientific community.

One can expect those communities to have biomedically-useful knowledge of at least some of those diseases. Zoonoses, as novel human diseases, should always have a high degree of salience within communities. Animal diseases should also be salient, given that indigenous communities often rely on the animals in their environment for subsistence, understand their complex ecologies, and have a relatively high degree of psychological connection with them (Salmón, 2000). There is the problem that pathogens themselves are too small to be observed without formal training, and the same may apply to certain symptoms of human and animal diseases. Ethnobiological theory recognizes that the size of natural features limits the perceptual salience of those features (Hunn, 1999). Despite that, locally-situated communities do, in fact, tend to have extensive knowledge about animal disease. Therefore, since there is likely a high density of biomedically-known, potential EIDs in those communities and those communities have likely noticed many of those diseases, their local knowledge can be expected to be a useful source of novel knowledge about potential EIDs.

History also tells us that this is likely the case. The most salient human and animal diseases were known first by ancient populations, who, of course, did not have modern methods for collecting biomedical knowledge (see Hoeppli, 1956).

There are practical problems with using local knowledge as a source of information about EIDs. Translating local knowledge into empirically relevant information can be difficult, especially if it is regarding a locally-described disease for which there is no biomedical name. Understanding the local description of a disease may require anthropological and/or linguistic analysis (Kleinman, 1980; Queenan et al., 2017). Empirically confirming the existence and nature of a disease may present further difficulties. I recognize that interdisciplinary integration is often difficult and costly, but the recruitment of anthropologists, linguists, and local guides can mitigate all of these challenges. If there is a paradigm shift towards viewing local knowledge as a source of disease surveillance, the opportunity costs of collecting and using it may fall.

Furthermore, incorporating an awareness of EIDs into medical anthropology has benefits even if no EIDs are discovered this way. In particular, I think that an awareness of EIDs can produce a more dynamic understanding of health progress and security. For example, the current COVID-19 pandemic has shown that although traditional statistics like infant mortality rates and life expectancy are usually good markers of health progress, the fundamental mark of a strong health system is its ability to respond to an emerging threat. Recognition of the fact that EID outbreaks are likely to become more common may lend new importance to the study of resilience in health systems, especially among those of locally-situated communities. Additionally, a recognition of the human-animal interface as a locus of risk may lead to the integration of human and veterinary health systems, which would yield

a variety of One Health benefits (Griffith et al., 2020). That said, I think that the limited case studies that follow show that there is real promise in discovering EIDs by using local knowledge.

2.2. Case studies

The literature on local knowledge and potential EIDs is scarce. I will discuss three useful but limited case studies below.

However, it does not seem that any anthropological or ethno-biological studies have been conducted with the explicit aim of learning about diseases unknown to science. This is not surprising. Anthropology is the discipline that has studied indigenous medicine and disease to the greatest extent. However, until recent decades, medical anthropology had focused more on the ritual and psychology of local medical systems than any biological or epidemiological knowledge that could be gained from studying them (Waldstein and Adams, 2006). There is now a slowly growing recognition within health science literature that non-scientist stakeholders can be vital in the production of empirical knowledge (e.g. Catley et al., 2012; Quinlan and Quinlan, 2016; Den Broeder et al., 2016). But, I found no studies of local health knowledge that engaged with the possibility that locally-situated communities might know of human infectious diseases, animal diseases, or zoonoses that are unknown to biomedicine. Most studies did not seem to account for that possibility in their design. I suspect that this disregard for local disease knowledge is partly due to the popular but incorrect perception that infectious disease emergence is an uncommon and unpredictable event (see Brooks et al., 2019). That thought presumably leads researchers to assume that local knowledge would not be helpful in gaining knowledge of unknown diseases, including potential EIDs. However, I present three somewhat promising case studies.

The first comes from a study of disease knowledge held by Fula-speaking pastoralists in the Far North Region of Cameroon (Moritz et al., 2013). Locals identified two diseases called *haahaande* and *gawyel*, which they said could infect both cattle and humans. The authors of this study dismissed this information, saying that heartwater (the scientific name for *haahaande*) and blackleg (the scientific name for *gawyel*) are not zoonotic diseases. Case reports suggest that the local knowledge may be correct.

Heartwater is a systemic cattle disease caused by *Ehrlichia ruminantium*; it is characterized by increased vascular permeability that causes fatal respiratory, cardiovascular, and neurological symptoms. There are reports that *E. ruminantium* can infect humans (Esemu et al., 2011; Reeves et al., 2008, in whom it may cause fatal encephalitis (Allsopp, 2005). Furthermore, *E. ruminantium* has been shown to infect a wide variety of wild and domestic animals (Peter et al., 2002), suggesting that it is a plausible zoonotic agent.

Blackleg is a myonecrotic disease caused by species of *Clostridium*. Moritz et al. (2013) suggested that *gawyel* could refer to infection by *C. chauvoei* or the less common *C. septicum*. *C. chauvoei* is known to have infected humans in at least two cases—though it is unclear whether those cases were zoonotic (Nagano et al., 2008; Weatherhead and Twardy, 2012). An analysis of *C. chauvoei* genomes concluded that the species has too little genetic diversity to infect non-ruminants (Rychener et al., 2017), but the Stockholm Paradigm suggests that intraspecific genetic diversity is often not necessary for pathogens to colonize new host species (Brooks et al., 2019). *C. septicum* is known to infect humans, and some human cases have been presumed to be zoonotic in origin (Barnham, 1998). However, neither species of *Clostridium* has been widely recognized as a zoonotic pathogen (e.g. Songer, 2010). This case study suggests that local knowledge can be a source of information about potential *E. ruminantium* and *Clostridium* zoonosis.

A second case study comes from research on Maa-speaking pastoralists in northern and eastern Tanzania (Mangesho et al., 2017). These pastoralists identified blackleg (locally called *emburuo*) as a zoonosis, which is a possibility discussed above. Additionally, they identified a respiratory infection called *mapafu ya kikohozi ya mbuzi*, which they

said humans contract from goats, and a fungal infection called *ndororo*, which they said humans contract by stepping in raw cattle remains or slurry. These two diseases were only mentioned in passing by the authors, and no attempts were made to identify a biomedical name for them or to anthropologically or medically validate their existence.

Ndororo and *mapafu ya kikohozi ya mbuzi* may refer to diseases that have already been empirically documented, diseases that are not empirically known, or they may be local constructions that do not correspond to any biomedical illness. *Ndororo* could refer to any number of foot fungi. *Mapafu ya kikohozi ya mbuzi* could be contagious caprine pleuropneumonia, a respiratory disease known to commonly infect goats in Tanzania. However, this disease has apparently never been reported in humans (Iqbal Yattoo et al., 2019), and there are other plausible goat respiratory disease candidates (see Kgotlele et al., 2019). In the absence of more information, there is no way to judge whether *ndororo* and *mapafu ya kikohozi ya mbuzi* are novel or even biomedically real. There are countless similarly brief and frustrating references in existing literature, e.g. *ente kurwaara omutima* and *okunvara ckine* in Katunguka-Rwakishaya et al. (2004), *eyaliyal* in Gradé et al. (2009), and numerous diseases in Catley and Mohammed (1996). I propose that much of this local knowledge may be useful for identifying potential EIDs and should, at least, be explicitly investigated.

A third case study comes from camel-herding pastoralists in Somalia and Northern Kenya. Surveys of these communities have consistently identified two camel respiratory diseases with distinct symptomatic and epidemiological characteristics (Wako et al., 2016). One is called *hergeb* in Somali; it is characterized by frequent outbreaks that cause nasal discharge and mortality among young camels. The other is called *dhuguta* in Somali; it is characterized by infrequent outbreaks that cause coughing and emaciation. There seems to be no further empirical knowledge of these diseases. Several respiratory pathogens are known to cause disease in camels, including strains of influenza, respirovirus, *Mycoplasma* sp., *Streptococcus* sp., small ruminant morbillivirus, and infamously, MERS-CoV. However, none of these have yet been identified as *hergeb* or *dhuguta*. Furthermore, either *hergeb* or *dhuguta* might be one of the many other locally-known camel respiratory diseases that have been described across Africa, e.g. *mhaz* in Volpato et al. (2015), *sonbobe* in Bekele (1999), and *ah* and *laxawgal* in Catley and Mohammed (1996). Given the limited scientific knowledge about camel respiratory diseases and the abundance of local knowledge about them, it seems that the local knowledge of pastoralists should certainly be given explicit study in the future.

3. Conclusion

Case studies show that local knowledge can be a useful source of new information about human diseases (e.g. Buruli ulcers), animal diseases (e.g. camel respiratory infections), and potential zoonoses (e.g. blackleg and heartwater). This is not surprising, given how sophisticated systems of ethnomedical and ethnoveterinary knowledge have been found to be. This is also not surprising given the apparent proximity of locally-situated communities to animal, pathogen, and zoonosis biodiversity.

This review is preliminary, but the theoretical considerations and limited case studies I present suggest that locally-situated knowledge can be an important source of information about potential EIDs. The DAMA protocol is currently our best defense against the growing EID crisis, and the documentation stage, the 'D' in DAMA, should not fail to include the documentation of local disease knowledge. The inclusion of anthropologists in various aspects of public health research is growing (e.g. Stellmach et al., 2018), and the study of EIDs is another area in which their expertise is needed.

Declaration of competing interest

None.

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