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Research Article

Mapping Veterinary Microbiology Laboratories in the World for Enhanced Infectious Disease Surveillance

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Abstract

Veterinary laboratories are necessary to maintain animal health and store zoonotic infections safely, but they can present challenges for biosafety and biosecurity. Historical evidence shows that veterinary laboratory accidents have affected thousands of people. The lack of geolocation data on these laboratories and the pathogens they handle is a bottleneck in zoonotic disease surveillance and detection of veterinary laboratory accidents. Therefore, mapping the locations of veterinary laboratories will enhance the ability to detect outbreaks or potential laboratory leaks of veterinary pathogens.

Keywords: Veterinary laboratory, infectious disease surveillance, mapping

1. Introduction

1.1 Zoonotic infections, veterinary laboratories, and their public health importance

1.1.1 Zoonotic infections and surveillance

The majority (61%) of emerging infectious diseases in humans have a zoonotic origin (1). Traditionally, infectious disease epidemics are identified through indicator-based surveillance data reported by healthcare providers, hospitals, and laboratories. However, there is a time lag between symptom onset and disease confirmation. Syndromic surveillance, which uses symptoms before confirmation, can bridge this gap (2). Complementing syndromic surveillance with open-source intelligence could bring better early warning signals to detect infectious disease outbreaks (3, 4). It facilitates early intervention in exponential growth, thus averting an epidemic or pandemic and reducing disease-associated mortality and morbidity, complementing traditional public health surveillance (2). Some zoonotic pathogens, such as avian influenza, anthrax, brucellosis, and Crimean Congo haemorrhagic fever, are highly contagious and potentially fatal to humans.

1.1.2 Veterinary laboratories and their public health role

Veterinary laboratories have played a crucial role in vaccine production, drug development, diagnosis, research, and the storage of zoonotic pathogens (5, 6). They have also contributed to preventing and controlling infectious disease epidemics in humans. For instance, during the COVID-19 pandemic in the United States, the government mobilised veterinary diagnostic laboratories to support human COVID-19 testing (7). In response, seven veterinary laboratories in the animal health laboratory network participated in conducting COVID-19 testing for humans (8).

1.1.3 Evidence of veterinary laboratory leaks and public health impact

Laboratory leaks have and will continue to occur despite adherence to strict containment protocols (9). Brucellosis, a zoonotic disease, is the most commonly reported laboratory-acquired infection in humans worldwide (10). A 2019 brucellosis leak from a veterinary pharmaceutical company in Gansu, China, infected more than 10,500 people (11) and is considered one of the largest veterinary laboratory leak-related outbreaks in history. COVID-19 is also one of the ongoing pandemics speculated as a laboratory leak from China, where researchers were working on bat coronavirus research (12). Other laboratory leaks have also been recorded in different countries (13). In 2007, a laboratory leak of foot-and-mouth disease (FMD) occurred at the Pirbright Institute in the United Kingdom. This was attributed to the old, leaking pipes carrying viral effluent for decontamination and the subsequent off-site transportation of the FMD virus by muddy vehicles. Consequently, the herds of several local farmers were mandatorily slaughtered (14, 15).

Anthrax is listed as a zoonotic category A bioweapon agent, having the potential to cause a severe threat to human and animal health (16), has a long history of laboratory-related incidents, and use in bioweapons research (14). This is from the 2001 US anthrax deliberate release (17)MS to the Russian

accidental leak that has infected hundreds of people (18).

The avian influenza is a disease associated with large outbreaks in wild aquatic birds and farmed poultry, resulting in huge economic losses for farmers. A current public health concern is the potential adaptation of the virus to enable human-to-human transmission (19). Dual-use research of concern regarding this adaptation has been reported (20). This means that leaks from veterinary laboratories working with highly pathogenic avian influenza could pose a significant public health threat, and more robust evidence is needed to detect such events early.

1.2 Veterinary laboratories oversight, leak detection methods, and evidence gap

1.2.1 Veterinary laboratories oversight

Globally, oversight of biosafety laboratories is fragmented (21). Oversight regulations vary between countries; for instance, Canada and the United States have different regulations. In Canada, no national legislation exists on animal welfare in research. Instead, the Canadian animal care committees are responsible for overseeing animal research in universities and agricultural organisations. In contrast, the United States has two national laws that apply to oversee animals used in research (22). Moreover, the oversight of veterinary laboratories is often neglected compared to human BSL-3 and BSL-4 laboratories.

1.2.2 Geospatial mapping of veterinary laboratories and their potential to enhance early detection of laboratory leaks

The existence of substantial evidence of pathogen leaks from veterinary laboratories (11, 23-25), highlights the need for a more pragmatic and thorough approach to early detection. Geospatial mapping techniques, such as those used for COVID-19 outbreak mapping and early intelligence (26-27), could be customised for mapping veterinary laboratories and risk analysis of laboratory leaks. Some high-containment veterinary laboratories are included in the mapping of BSL-4 and BSL-3+ laboratories by Global Biolabs (28). However, this mapping lacks detailed information on the locations, names, and pathogens handled within the Animal Biosafety Level 2 (ABSL-2) and 3 (ABSL-3) laboratories. Hence, implementing mapping studies, such as red-flagging techniques, could help identify signals of outbreaks or leaks near these veterinary laboratories.

Given the high risk associated with laboratory leaks, the absence of a comprehensive, publicly available list of veterinary laboratories and the pathogens they work with is a concern. Obtaining and collating this information will allow for enhanced surveillance in areas containing these laboratories and the early detection of potential laboratory leaks. Therefore, mapping veterinary laboratories that have the potential to work with high-risk pathogens could improve biosafety and related threats.

2. Methods and preliminary findings

We identified veterinary laboratories using various search terms, including “Animal Biosafety laboratory/ies”, “Animal containment laboratory”, “veterinary biosafety laboratory”, “ABSL-2”,” ABSL-3”, “ABSL-4”. The latitude and longitude of each laboratory were then manually extracted from Google Maps. Finally, we mapped these veterinary laboratories using ArcGIS Pro. The preliminary mapping indicated that veterinary laboratories are concentrated in Europe and the United States, with few in Africa and the South American region (**Figure 1**).

3. Limitation

Manual extraction of latitude and longitude may lack precision, and the results are based on preliminary analysis that may be interpreted with caution, as they may require further comprehensive evidence for the lists of veterinary laboratories.

4. Conclusion and recommendations

Historical incidents of laboratory leaks from veterinary laboratories indicate the need for comprehensive geospatial mapping and enhanced surveillance. Expanding mapping studies of these laboratories could improve biosafety and help protect the public from laboratory-acquired epidemics or accidental leaks.

Declarations

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Ethics

Ethics approval was not required for this study.

Competing interests

There were no relevant disclosures.

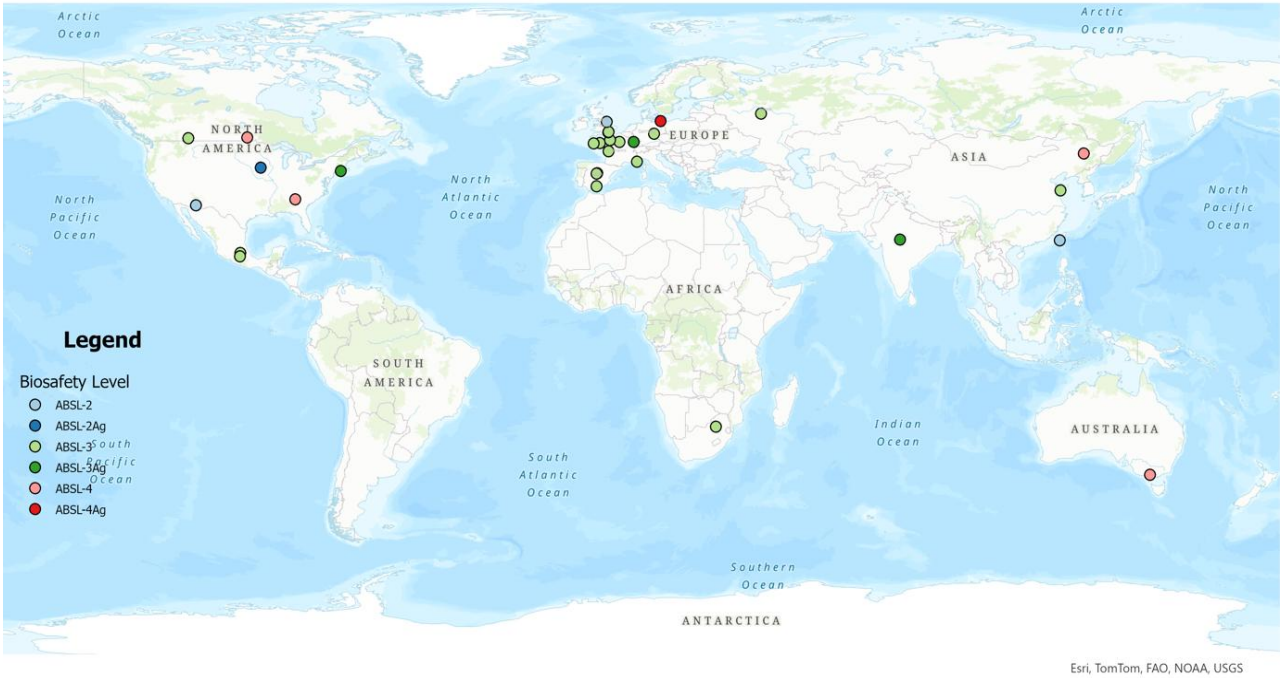

Figure 1: Global mapping shows the preliminary results of the veterinary microbiology laboratories

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