

A comprehensive approach to integrated one health surveillance and response

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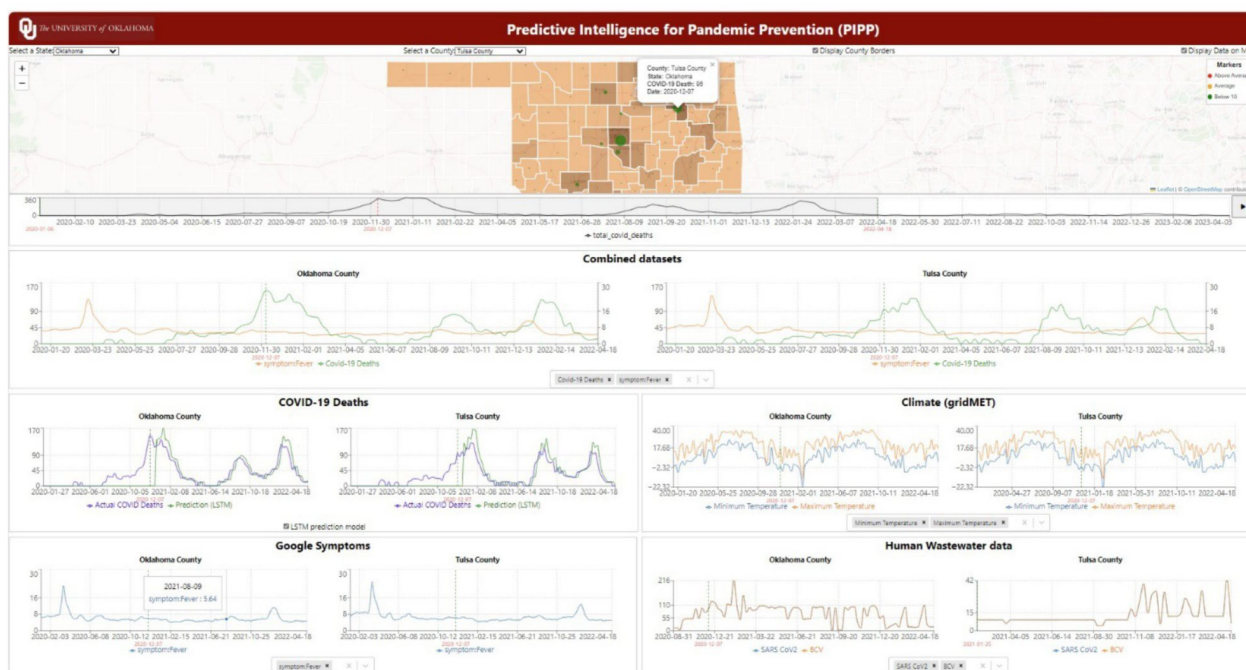


Figure 1: One Health Visual Analytics

Surveillance data plays a crucial role in understanding and responding to emerging infectious diseases; here, we learn why adopting a One Health surveillance approach to EIDs can help to protect human, animal, and environmental health

Over 75% of emerging infectious diseases (EIDs) affecting humans are zoonotic diseases with animal hosts, which can be transmitted by waterborne, foodborne, vector-borne, or air-borne pathways. ⁽⁷⁾ Early detection is important and allows for a rapid response through preventive and control measures. However, early detection of EIDs is hindered by several obstacles, such as climate change, which can alter habitats, leading to shifts in the distribution of disease-carrying vectors like mosquitoes and ticks. This can result in diseases such as malaria, dengue fever, and Lyme disease becoming more common in areas with established transmission or spreading to new areas entirely. ⁽⁴⁾ Environmental changes such as deforestation and urbanization disrupt ecosystems, increasing the likelihood of zoonotic disease spillover from wildlife to humans. In addition to working at the interface of these changes, detection and tracking of EIDs also requires sharing and standardization of complex data and integrating processes across different regions and health systems.

Applying One Health Surveillance to EIDs

One Health surveillance is a collaborative approach that recognizes that the health of humans is connected to the health of animals and the environment. This approach can create a better understanding of infectious diseases and, ultimately, a better foundation for their control and prevention. The One Health approach relies on diverse data sources (e.g., clinical and epidemiological data, veterinary records, wildlife monitoring data, climate and geospatial data). Because of their strong link to animals, climate, and the environment, understanding and monitoring EIDs requires adopting the One Health concept. Accordingly, One Health surveillance has been applied to several EIDs. For instance, in the case of West Nile Virus, the One Health approach consisted of integrating data from human clinical cases, veterinary records of affected animals, and environmental factors to understand the spread of the virus and devise comprehensive strategies for surveillance and response. ⁽⁶⁾ Overall, there is solid evidence that a comprehensive One Health surveillance system's interconnections offer more effective and timely detection and response.

By utilizing a One Health analytics approach, we can understand zoonotic diseases and their dynamics better, as well as facilitate information exchange and intervention strategies, ultimately contributing to improved health outcomes. ⁽²⁾ As we monitor animal health, we can identify potential zoonotic threats before they spill over to human populations. ⁽⁵⁾ Finally, One Health surveillance systems allow for more accurate predictive modeling that allows for better understanding and preparation of disease spread. ⁽¹⁾

A collaborative approach

Promoting collaboration among veterinarians, medical professionals, environmental scientists, and public health officials to enhance surveillance and response efforts is essential for the One Health approach to work in practice. Through this collaboration, a common understanding of collecting (surveillance) data, interpreting it, and ultimately acting on it is also required. Given the variety of data sources across different spatial and temporal scales in One Health data, integrated visual analysis tools are needed for effective analysis, correlation, predictive, causal analysis, understanding, and decision-making for effective management and response. ⁽³⁾ In addition, to make these data useful, various transformations and integrations, such as data cleaning and validation, standardization, integration, geospatial and temporal analysis, predictive modeling, and visualization, are necessary to ensure they can be effectively analyzed and used for decision-making (Figure 1).

In collaboration with public health officials, our project team has developed a One Health visual analytics system combining diverse health surveillance data sources. Our main objective with this system is to utilize a range of datasets and visual analytics methods to gain insight into and address outbreaks of infectious diseases, using the COVID-19 pandemic as a case study. The data sources in our project focus on proactive surveillance and timely public health interventions, utilizing One Health data encompassing humans, animals, weather, and geospatial information. Specifically, the data are derived from various sources, including traditional disease surveillance in

humans and animals and emerging data streams such as Google Trends, wastewater surveillance, and Breathomics. These data are combined to investigate the correlation between human infectious disease outbreak signals and corresponding signals from the other One Health sectors, creating an effective and actionable visual analysis environment for decision-making and intervention.

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