Onehealth surveillance integrating human, animal, food, genomics, and telemedicine

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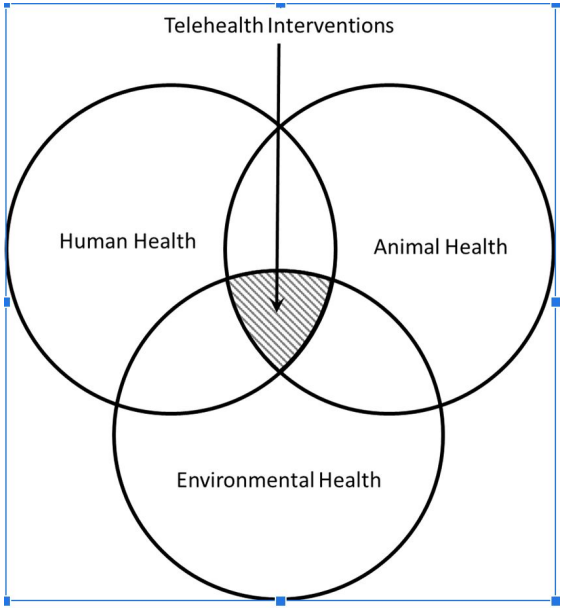
Introduction

- One Health
- One health surveillance
- Components of One Health Surveillance
- Frameworks
- Role of Whole Genome Sequencing
- How Telehelath can help

One Health Trifecta



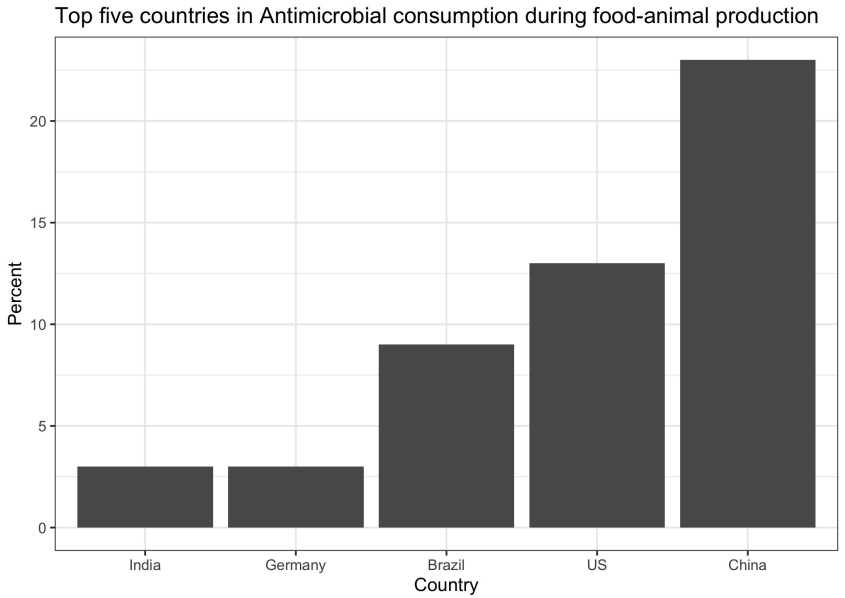
Trifecta of One health

- Ecosystem health
- Animal Health
- Human Health
- We will argue that telehealth interventions can be integral to the three components

One Health Applications

- Antimicrobial resistance
- Antimicrobial stewardship
- Zoonoses
- Food borne outbreaks and food security

The contribution of five major countries in food-animal production



Source: Rene S. Hendriksen and and Patrick Munk et.al (2019). Global monitoring of antimicrobial resistance based on metagenomics analyses of urban sewage. Nature Communications, 10,

One health surveillance

A OH surveillance system is a system in which collaborative efforts exist between at least two sectors (among human health, animal health, plant health, food safety, wildlife and environmental health) at any stage of the surveillance process, to produce and disseminate information with the purpose of improving an aspect of human, animal or environmental health

(Bordier 2020)

Source: Bordier, M., Uea-Anuwong, T., Binot, A., Hendrikx, P., & Goutard, F. L. (2020). Characteristics of One Health surveillance systems: A systematic literature review. *Preventive Veterinary Medicine*, *181*, 104560.

Four Organisational and functional characteristics of OH Surveillance

- Institutional collaboration across sectors for the governance and operation of the surveillance system;
- Collaboration at the different scales of the decision-making process
- Collaboration across disciplines
- Collaboration through public-private partnership

(Bordier 2020)

Source: Bordier, M., Uea-Anuwong, T., Binot, A., Hendrikx, P., & Goutard, F. L. (2020). Characteristics of One Health surveillance systems: A systematic literature review. *Preventive Veterinary Medicine*, *181*, 104560.

Problems of implementing One health Surveillance

- Technical barriers (78.6% cases)
- Data Issues: Lack of standardisation/incomplete data
- Insufficient data-sharing across sectors including
- Unreliable cross-sectoral alert systems
- Incomplete multi-domain data analysis and interpretation

Bordiers' framework

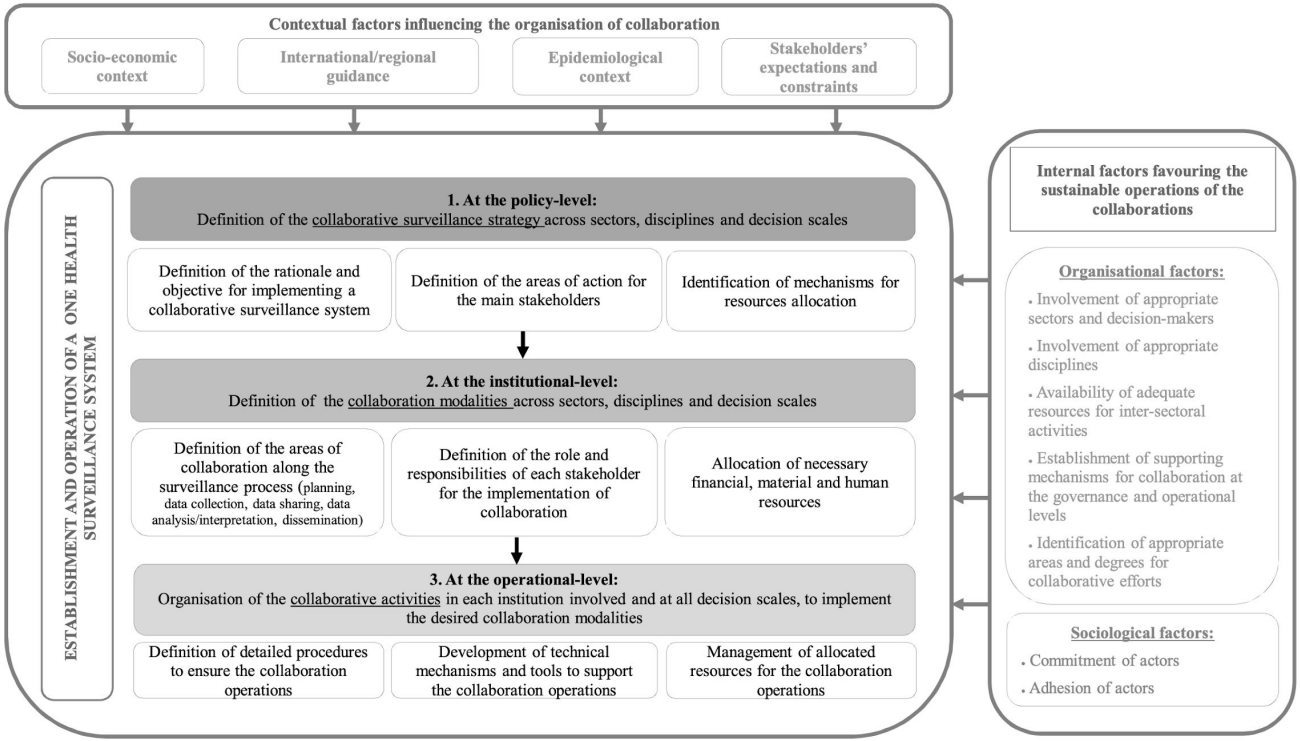


Fig. 3. Organisation of collaboration in a One Health surveillance system: a conceptual framework.

Source: Bordier, M., Uea-Anuwong, T., Binot, A., Hendrikx, P., & Goutard, F. L. (2020). Characteristics of One Health surveillance systems: A systematic literature review. *Preventive Veterinary Medicine*, *181*, 104560.

Role of genomic surveillance in One Health

- Need to track pathogens through the food chain from farm to fork can also be tracked
- WGS has become a key technology for understanding pathogen evolution and population dynamics on different spatial and temporal scales
- WGS captures neutral evolution as well as the evolution of AMR determinants

Global Antimicrobial Resistance Surveillance System (GLASS)

GLASS Surveillance Activities

The various types of AMR-related surveillance activities led by GLASS are grouped into technical modules (see figure opposite)

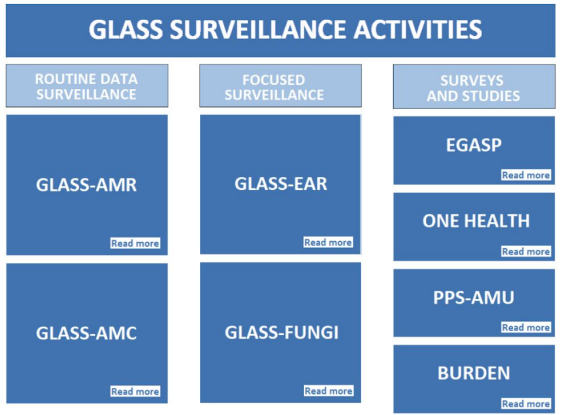
ROUTINE SURVEILLANCE

GLASS-AMR provides a standardized approach to the collection, analysis and sharing of national AMR data in samples collected routinely for clinical purposes for a set of pathogens that cause common bacterial infections in human. **GLASS-AMC** provides a common and standardized set of methods for measuring and reporting antimicrobial consumption (AMC) at country, regional and global levels. Both technical modules collect data on the implementation of the respective national surveillance systems.

FOCUSED SURVEILLANCE

GLASS-EAR, the emerging AMR reporting (EAR) module, supports the timely detection, reporting, risk assessment and monitoring of emerging resistance. **GLASS-FUNGI** focuses on the surveillance of invasive fungal bloodstream infections caused by *Candida* spp.

SURVEYS AND STUDIES



Click on the figure above to learn more about the GLASS technical modules

WHO Glass, see https://www.who.int/initiatives/glass/glass-modules-7

Surveillance of antimicrobial resistance

- GLASS collects national-level phenotypic AMR data using WHONET
- WGS data from E. coli isolates from children in South Asia and sub-Saharan Africa found that
- 65% of isolates were resistant against three or more antimicrobial classes
- LMICs are disproportionately impacted by AMR
- international movement of people and livestock facilitate AMR spread

One Health and Zoonoses: PREDICT project

- Majority of emerging infectious diseases (EIDs) are zoonotic
- Pathogens spill over in both directions
- Tuberculosis in nonhuman primates and Asian elephants has long been associated with contact with infected humans

See: https://p2.predict.global/

Whole Genome Sequencing for For wastewater surveillance

- Rapid urbanisation
- Urban population connected to a sewer system
- Does not require informed consent
- Proved useful for Global Polio Eradication

Metagenomic techniques

- Short-read next-generation sequencing data
- Quantify thousands of especially transmissible resistance genes in a single sample
- Data can be reanalyzed if novel genes of interest are identified
- Chracterised bacterial resistome from 79 sites in 60 countries
- 1625 different AMR genes belonging to 408 gene groups were identified

  (Source: Hendriksen 2019)

What did Hendriksen et al find

- The highest AMR gene levels observed in African countries
- Brazil had the highest abundance of all
- New Zealand and Oceania countries were at the lower end of the spectrum
- Toilet waste resistom from long-haul flights14 suggested that the AMR levels in South Asia were higher than in Europe
- Clusters of antimicrobial resistomes across the world
- Antimicrobial use data and bacterial taxonomy explain a minor part of the AMR variation

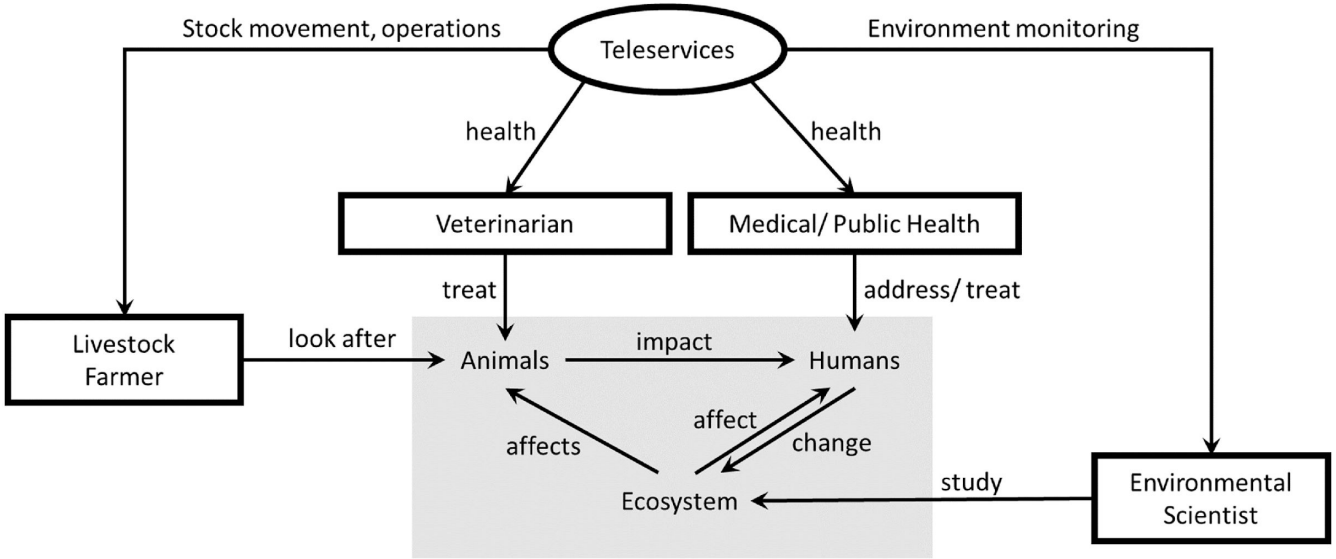
Information needs for One health surveillance

- Good coordination between various players are needed
- Establishment of Data sources
- Easy accessibility of data sources

Changing circumstances

- Telehealth and Machine Learning/AI
- Telehealth can be a central component of AMR/AMS/Zoonoses
- Distance delivery of care
- Often as an afterthought

How telehealth can benefit



How telehealth can benefit One Health
Source: Arindam Basu (2022)

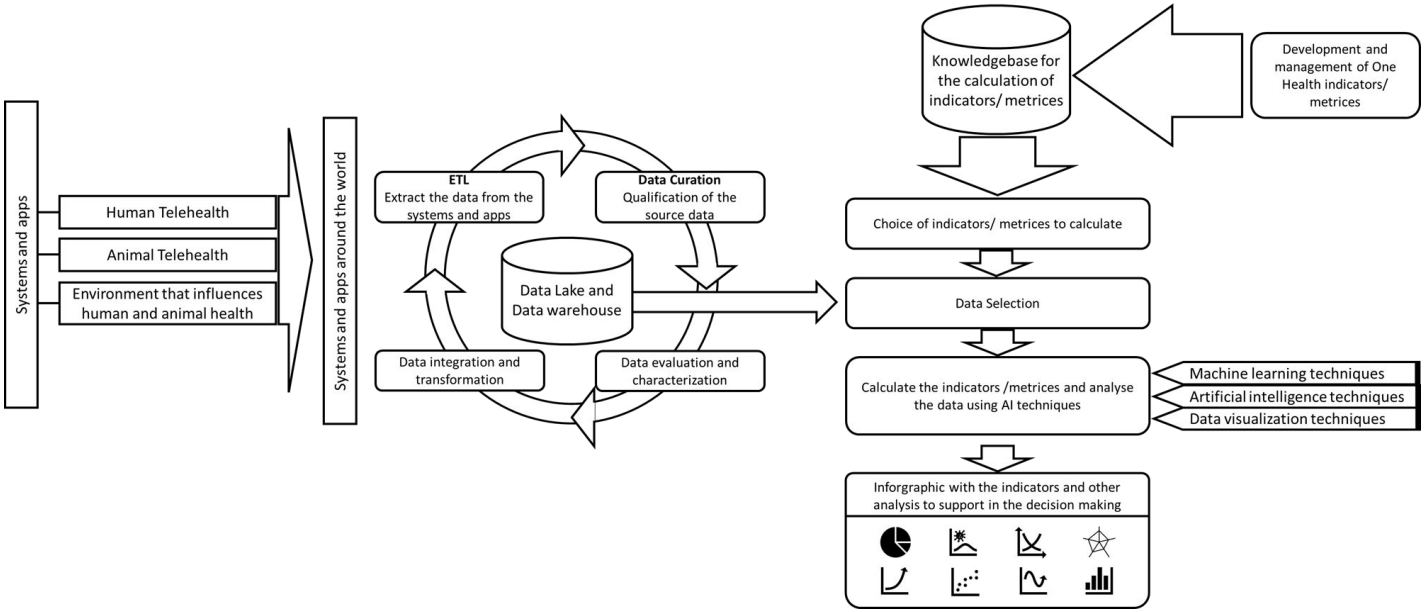
Potential for integration

- Will save lives
- Moves the surveillance system the other way
- Challenges: information organisation
- Telehealth and telemedicine comes to the rescue

Concept notes

- Telehealth as a connecting tool
- Farming to Central Website
- Veterinarians and Epizootiologists connect
- Medical doctors and public health specialists connect
- Information exchange across the sector

Information Architecture



(Source: Marcia Ito (2022) from an unpublished paper on Telehealth and One Health)

Conclusions

- We are doing disease surveillance
- In the opposite direction
- Start in the environment

References and further questions

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