One Health in Practice: Identifying Emerging Infectious Diseases at the Human-Domestic Animal-Wildlife Interface

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Health Experts Meet in Atlanta to Tackle the Deadly Animal-to-Human Link in Illness
The “Interface”
Where the action is!

- Majority of emerging infectious diseases (EIDs) in people are of animal origin (zoonotic)
- 75% of emerging zoonoses have wildlife origins
- Human activities at the interface linked to EIDs (Nipah virus, SARS, Ebola)
- Annual population growth among highest in buffers to protected areas near wildlife
Emerging Zoonotic Diseases
Current Outbreak Detection and Response

Adapted from J. Davis, Climate Adaptation Workshop, Nov. 2003
Effective Health Early Warning

- Surveillance, Observations and Monitoring Information
- First Case
- Detection/Reporting
- Lab Confirmation
- Response
- Opportunity for control

Adapted from J. Davis, Climate Adaptation Workshop, Nov. 2003
Challenge

*Develop a strategic framework for identifying and responding to pathogens of pandemic potential that have not yet emerged*
Wildlife Surveillance Arm

Developing global capacity to anticipate and mitigate the spread of emerging zoonotic diseases from wildlife pathogens
PREDICT: Building a global early warning system for emerging diseases that move between wildlife and humans
SMART Surveillance

Probabilistic models

Laboratory investigations

Field studies
Wildlife SMART Surveillance

Initial Surveillance Targeting → Potential Pathogen Detected → Virulence & Pathogenicity Determination → Significance Screening → Prioritize for Response & Follow-up

- Targeting Surveillance: risk modeling, identifying interfaces, species considerations, remote sensing, situational analysis
- Diagnostics: clinical & pathological examination, screening for viral families & normative pathogens, number of individuals affected
- Rapid Epidemiologic Analysis & Modeling: incidence, host & number of species affected, demographics, location & spread
- Molecular Characterization & Modeling: relatedness to human pathogens, transmissibility factors, opportunity for spillover & spread, pathogenic potential in new hosts & ability to counteract host
Developing a **Targeted** Surveillance Strategy in high risk locations for emergence
Developing a **Targeted Surveillance Strategy**

along high risk disease transmission interfaces

- Land use change
- Hunting
- Markets/trade
- Wildlife/livestock conflict
- Extraction
- Water availability
- Global transportation
Digitized Risks and Interfaces
Developing a **Targeted** Surveillance Strategy

*for wildlife species of highest risk*
Taxonomic Groups

- Primates
- Bats
- Rodents
- Birds
- Suids
- Carnivores
- Ungulates
Developing a **Targeted** Surveillance Strategy

*using global information real-time*
Wildlife SMART Surveillance

Initial Surveillance Targeting
- Geospatial Risk Modeling
- High Risk Transmission Interfaces
- Species of Special Concern
- Digital Surveillance & Information Network
- Undiagnosed Human or Animal Event

Potential Pathogen Detected
- Virulence & Pathogenicity Determination
  - Known Pathogen Causing Disease
  - Uncharacterized Virus Causing Disease
  - Known Pathogen Unknown or No Disease
  - Uncharacterized Virus Disease Unknown

Significance Screening
- Disease at a Significant Level in Multiple Species, including Humans
- Disease in New Host Species
- Disease Unknown but New/Multiple Hosts
- Disease at a Higher than Expected Level in Known Host
- Disease at an Expected or Low Level in Known Host
- No Disease

Pathogen of Potential High Human Pathogenicity and Rapid Consequence
- Prioritize for Response & Follow-up
- Pathogen of Pandemic Potential in Need of Further Characterization
- Pathogen Unlikely to have Pandemic Potential or to Spillover to Humans

Outbreak Investigation
- Further Characterization
- Notification
- Intensified Surveillance
- Control Modeling
- Risk Reduction

Enhanced Surveillance
- Intensified Surveillance
- Impact & Spread Modeling
- +/- Notification
- Archiving
- Low-level Monitoring for Emergence

Diagnostics: clinical & pathological examination, screening for viral families & normative pathogens, number of individuals affected
Rapid Epidemiologic Analysis & Modeling: incidence, host & number of species affected, demographics, location & spread
Molecular Characterization & Modeling: relatedness to human pathogens, transmissibility factors, opportunity for spillover & spread, pathogenic potential in new hosts & ability to counteract host defenses, emergence & evolutionary history
Specimen type: Blood, swabs, urine, feces, tissues

Targeted screening for different wildlife taxa

- **primates**
  - Retro, Filo, Flavi, Orthomyxo, Paramyx, Pox, Corona, Arena

- **bats**
  - Flavi, Corona, Henipa, Rhabdo, Arena, Filo, Reo

- **rodents**
  - Arena, Hanta, Pox, Alpha, Reo

- **human**
  - Syndromic testing

- **birds**
  - Orthomyxo, Paramyx, Flavi

Family level primers

- **Orthomyxo**
  - Flavi, Corona

- **Paramyx**
  - Rhabdo, Arena, Filo, Reo

- **Flavi**
  - Henipa

- **Corona**
  - Hanta, Pox

- **Alpha**
  - Reo

Refine with specific primers or sequencing
Advanced pathogen discovery

20 PCR protocols developed and going out to countries

Follow-up on-the-ground field investigations
develop diagnostics
screen local human cases
screen local wildlife

Specific viral, bacterial testing
Universal Control 1

[Diagram showing the T7 Promoter and various viral gene targets, with labels for Filovirus, Seadornaviruses (heminested), Arenavirus, Coronavirus 2 (heminested), Paramyxovirus (heminested), Flavivirus, Hantavirus 2 (heminested), Alphavirus (nested), and Nipah Virus (nested).]
Post PCR / Gel Room
Building Wildlife Surveillance Capacity
PREDICT Surveillance Highlights

- Trained >1000 field personnel, veterinarians, laboratory technicians, public health workers and ministry officials from 20 countries
- Building capacity to test for viral families in 17 labs
- Collected samples from > 25,000 animals (bats, rodents, birds, carnivores, primates, and ungulates)
- Discovered 150 novel viruses in wildlife: corona, boca, herpes, retro, adeno, rhabdo
- Documented human pathogens in wildlife and animal-origin pathogens in humans
Importance of Early Detection

• Key to Control
• Reduction of Post-transfer Host Adaptation
• Potentially Lower Transmissibility
• Allows Sequencing to Improve Quality & Speed of Diagnostics
One Health is:

- Global
- Comprehensive
- Holistic
- Collaborative and trans-disciplinary