Future preparedness for newly emerging infectious diseases

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Respiratory virus summit

Future preparedness for newly emerging infectious diseases (EIDs)

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Majority of EIDs are zoonotic

Allen et al., Nature Communications, 2017; Pike et al., PNAS, 2014
Key factors involved in EIDs

- Microbes are a key part of wildlife diversity & often drive population dynamics
- Anthropogenic environmental changes:
  - Land degradation: Microbe communities altered
  - Habitat loss: Increased interaction among animals & species

Spillover among wildlife, livestock, and people

Daszak et al. IPBES. 2020
Natural reservoirs of viruses

Olival et al., Nature, 2017
Bat viruses discovered by our team

Astrovirus
Adenovirus: 6 isolates
Adno-associated virus
Circovirus
Coronavirus: 3 isolates
Filovirus
Hantavirus
Hepadnavirus
Reovirus: 8 isolates
Paramyxovirus

Li et al., J. Virol, 2010;
Li et al., J. Gen Virol, 2010;
Ge et al., J. Gen Virol, 2011;
Ge et al., J. Virol, 2012;
Yang et al., J Gen Virol, 2015;
Tan et al., J Gen Virol, 2016; 2017;
Yang et al., Emerg Infect Dis, 2017; Luo et al., J Virol, 2018;
Yang et al., Nature Microbiol, 2019;
Zhou et al., Nature, 2020;
Guo et al., Emerg Microbe Infect, 2021
Genetic diversity of bat coronavirus in China

Fan et al., Viruses, 2019; Cui et al., Nat Rev Microbiol, 2019
SARS-related coronavirus in Rhinolophus bats

Hu et al., *Front Microbiol*, 2022 (in press)
MERS-CoV-cluster viruses in bats and utilizes human DPP4 as receptor

Luo et al., JVI, 2018

Wang et al., Cell Host Microbe, 2014

Lau et al., J Infect Dis, 2018, Nat Commun 2021
Swine acute diarrhea syndrome coronavirus (SADS-CoV), originates in Rhinolophus bats

- **9.8%** Rhinolophus bats carry SADS-related CoV
- Genome: 96-98% nt identity
- Spike protein: 87-98% aa identity
- SADS-CoV has a wide host range

**Zhou et al., Nature, 2018**
All human coronaviruses has an animal origin

Cui et al., Nat Rew Microbiol, 2019
How to predict and prevent the newly emerging infectious diseases

Adapted from Geohegan and Holmes, *Open Biology, 2017, 7(10):170189*
Pre-emptive strategies against future EIDs

**Surveillance & Precaution**
- Pathogen discovery
- Genomics characterization
- Mutation and evolution analysis
- Epidemiology testing
- Prediction modeling

**Pathogen biology**
- Structure and function
- Entry & replication mechanism
- Infection models
- Pathogenesis
- Cross-species risk assessment

**Countermeasure**
- Development & Reserve of
  - Diagnostic methods
  - Antivirals & Antibodies
  - Vaccines
Challenge

Pathogen investigation
Data sharing
Collaboration
Transparency
One-health implement
Thanks