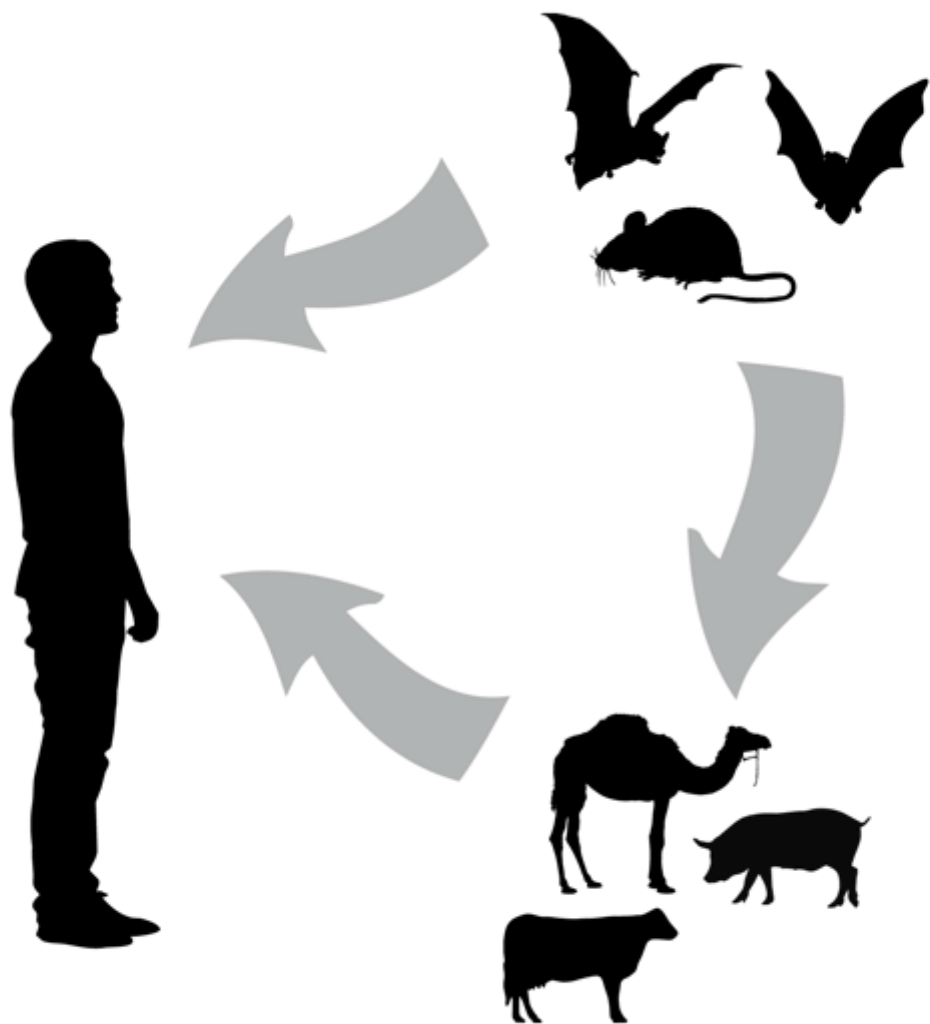


Emerging viral zoonoses

Prof. Isabella Eckerle, MD, DTM&H

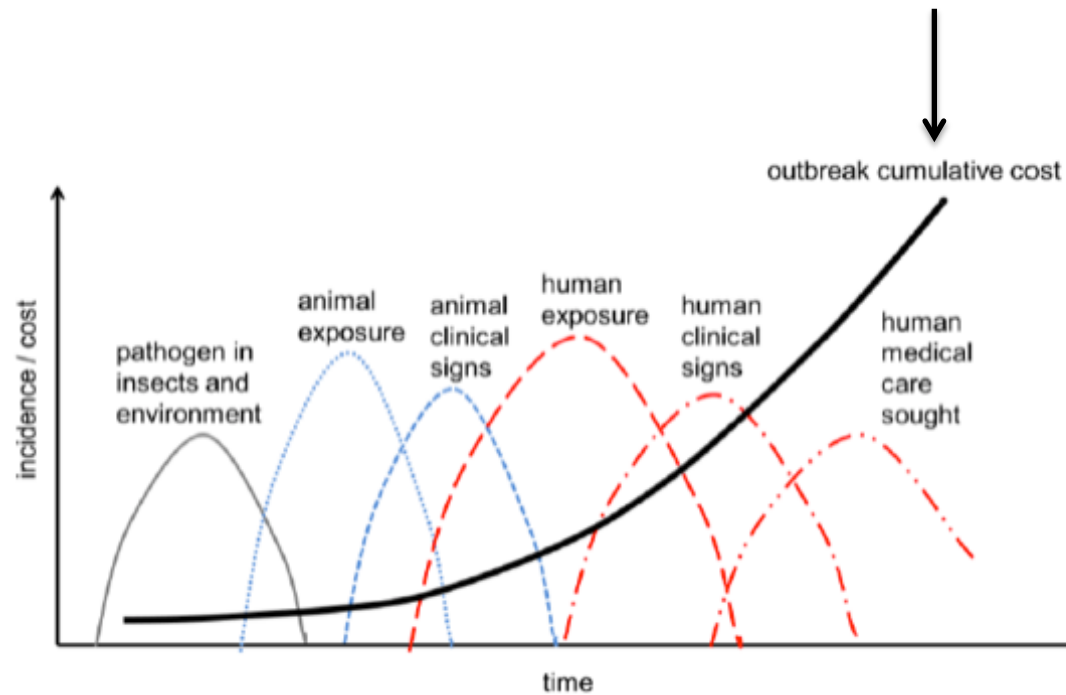
Geneva Centre for Emerging Viral Diseases
University Hospital of Geneva
University of Geneva

Swiss TPH Winter Symposium 2018
7.12.2018, Basel



Ebola
MERS
Zika

...





The screenshot shows the WHO R&D Blueprint website. The top navigation bar includes links for Home, Health Topics, Countries, News, Emergencies, and About Us. The main heading is 'R&D Blueprint'. On the left is a sidebar menu with links: Blueprint, About, What the Blueprint does, Priority diseases (highlighted), Key actions, and Meetings and events. The main content area is titled 'List of Blueprint priority diseases' and features a large image of various pathogens. Below the image is a section titled '2018 annual review of the Blueprint list of priority diseases' with a paragraph explaining the tool's purpose. To the right, under 'R&D key actions by diseases', is a list of diseases: Crimean-Congo haemorrhagic fever (CCHF), Ebola/Marburg, Lassa Fever, MERS-CoV, Nipah, and Zika.

- Crimean-Congo haemorrhagic fever (CCHF)
- Ebola virus disease and Marburg virus disease
- Lassa fever
- MERS-CoV & SARS-CoV
- Nipah and henipaviral diseases
- Rift Valley fever (RVF)
- Zika
- Disease X

„Several diseases determined to be outside of the scope: **dengue, yellow fever**, HIV/AIDs, tuberculosis, malaria, **influenza** causing severe human disease, smallpox, cholera, leishmaniasis, **West Nile Virus** and plague. These diseases continue to pose major public health problems and further research and development is needed through existing initiatives.“

Other zoonotic viruses of relevance: hepatitis E, rabies

MERS-CoV – a paradigm of a zoonotic virus

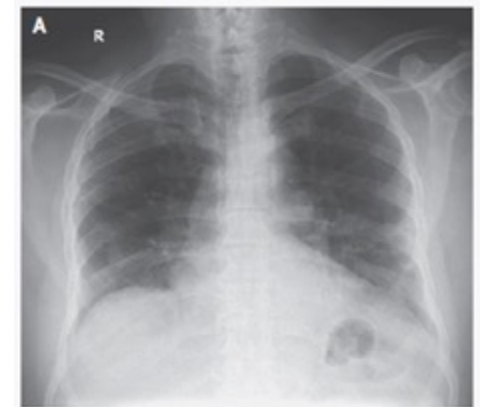
MERS-Coronavirus

- 1. case: 2012 in Jeddah, Saudi Arabia
- Severe respiratory syndrome due to a novel coronavirus
- Evolutionary origin in bats
- High antibody prevalence found in camels
- Zoonotic transmission: continuous spillover from animals to humans, few cycles in humans, H2H transmission chain run out
- Import into > 27 countries, risk of global spread
- Estimated $R_0 < 0,5$ (Drosten, Meyer, Müller et al., New England Journal of Medicine 2014)
- All major human outbreaks were hospital-related

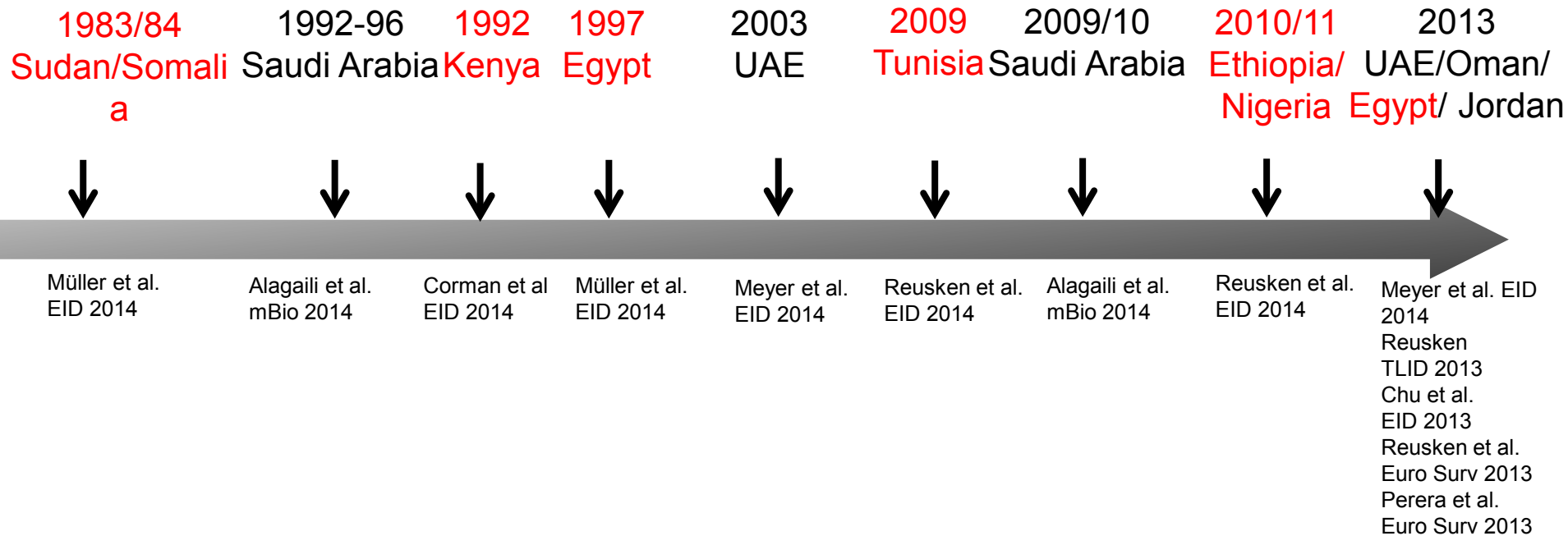
BRIEF REPORT

Isolation of a Novel Coronavirus from a Man with Pneumonia in Saudi Arabia

Ali Moh Zaki, M.D., Ph.D., Sander van Boheemen, M.Sc., Theo M. Bestebroer, B.Sc., Albert D.M.E. Osterhaus, D.V.M., Ph.D., and Ron A.M. Fouchier, Ph.D.



MERS-CoV has been circulating for long in dromedaries



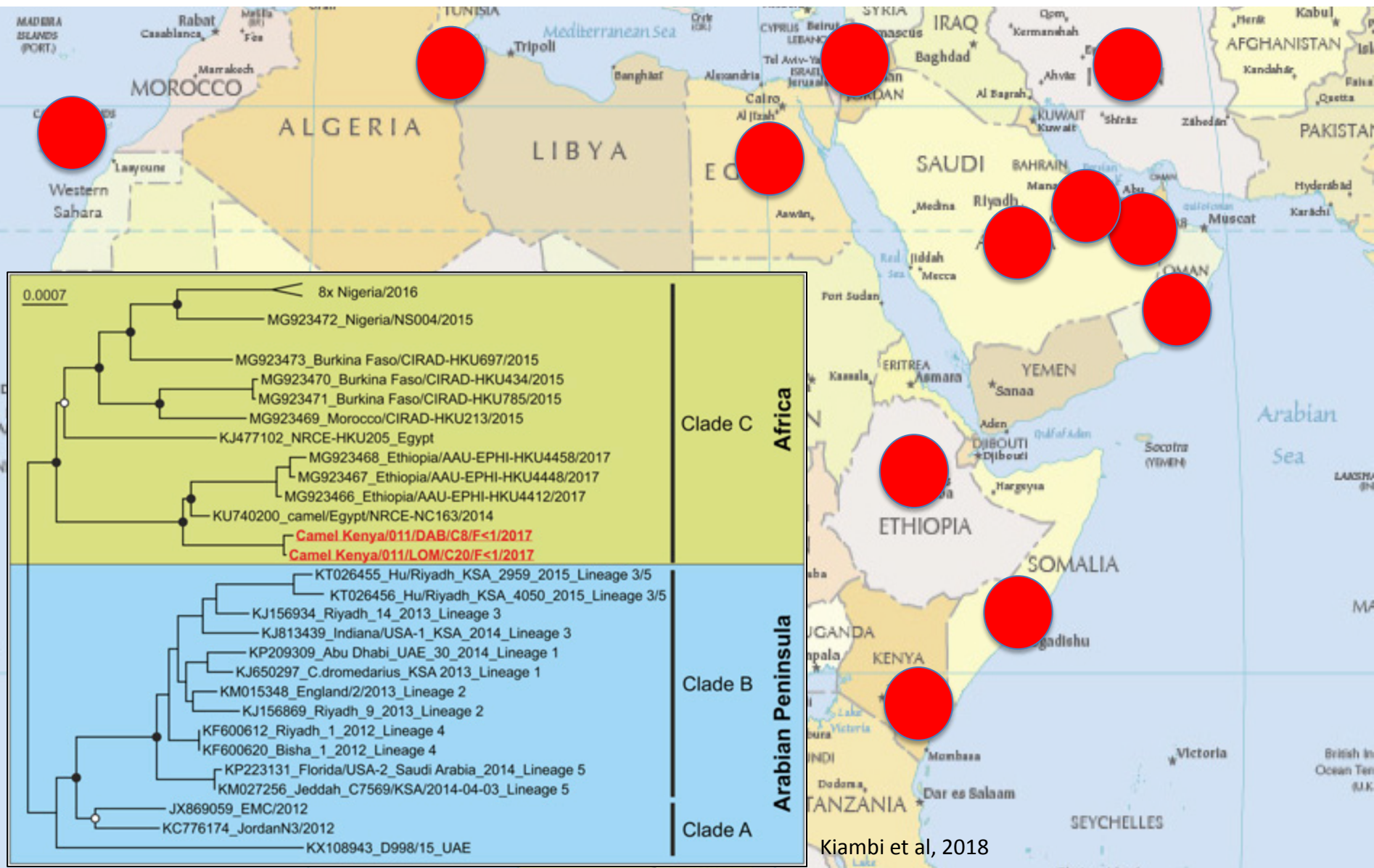
→ African camels had neutralizing MERS-CoV antibodies 3 decades ago

A map of the Balkan region. Sofia, Bulgaria is marked with a red star. Neighboring countries shown include Italy to the west, Montenegro to the north, and Georgia to the east. The Black Sea is to the northeast. Other cities labeled include Bilbao, Marseille, Catania, Podgorica, and Shymkent. Bodies of water like the Adriatic and Aegean are also indicated.

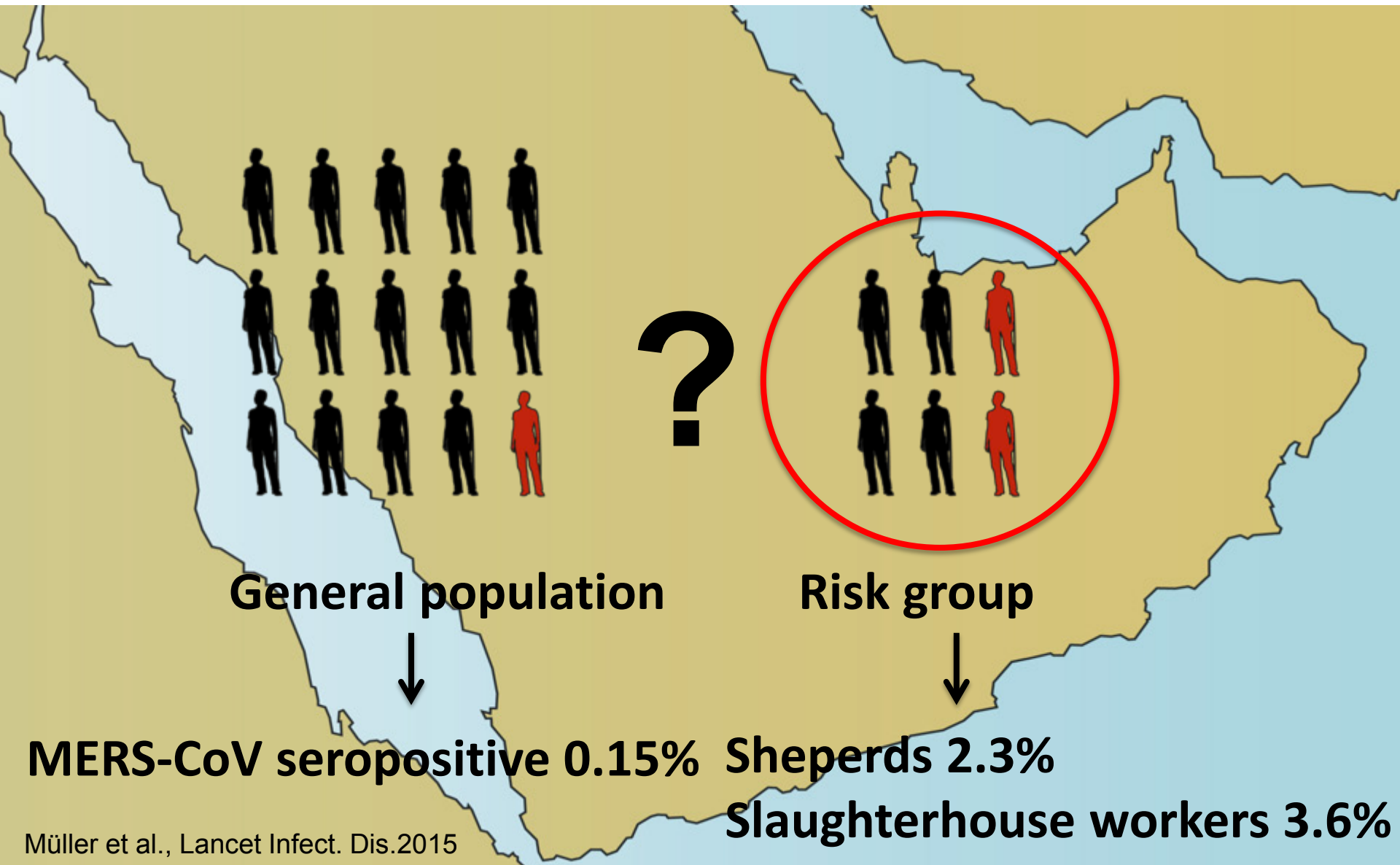


Kiambi et al, 2018

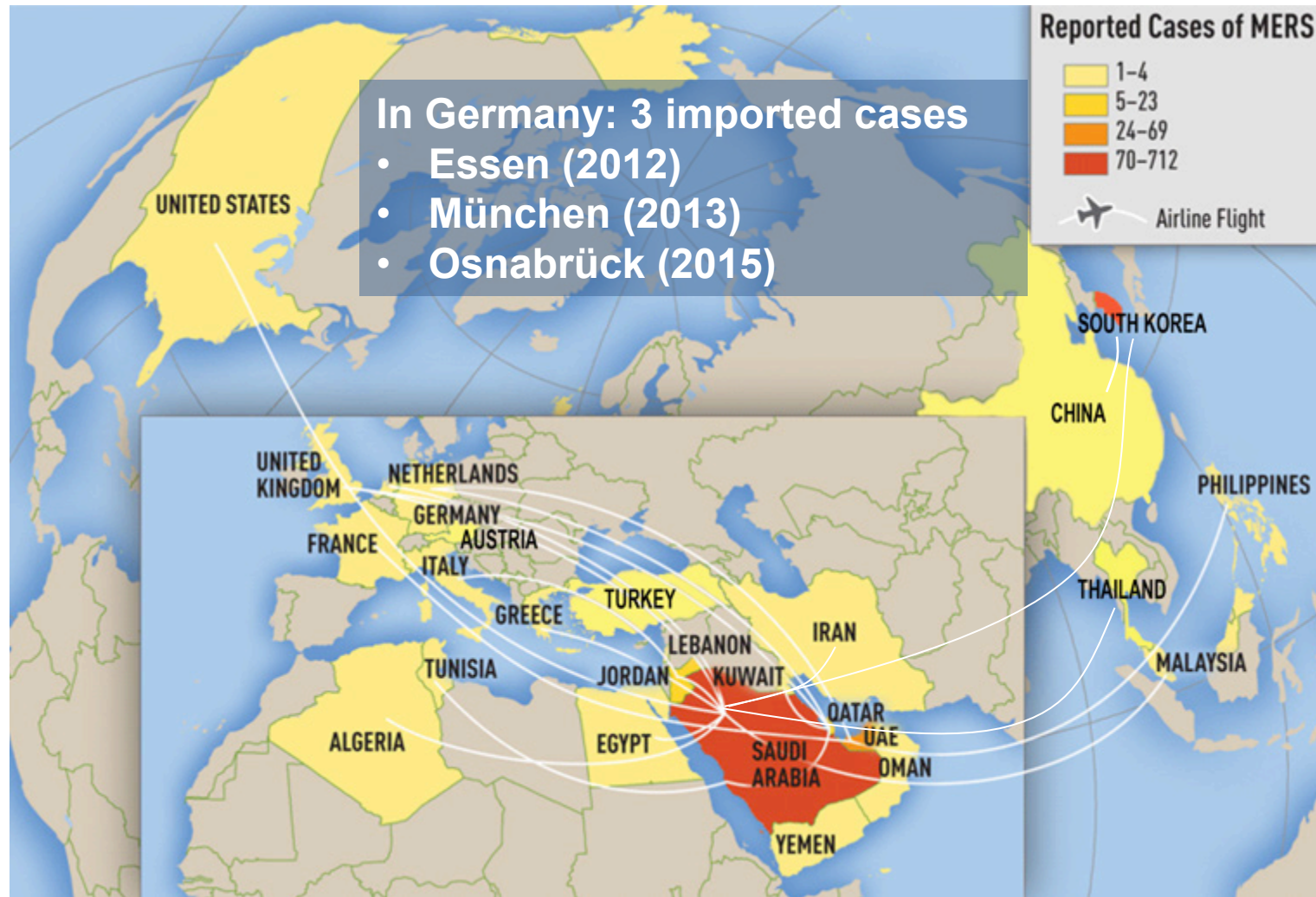
MERS-CoV has been circulating in dromedaries all over the African continent/ Middle East



Kiambi et al, 2018



MERS – a regional zoonosis with travel-related spread



2266 laboratory-confirmed cases, 804 deaths, 27 countries (WHO, date of 10/2018)

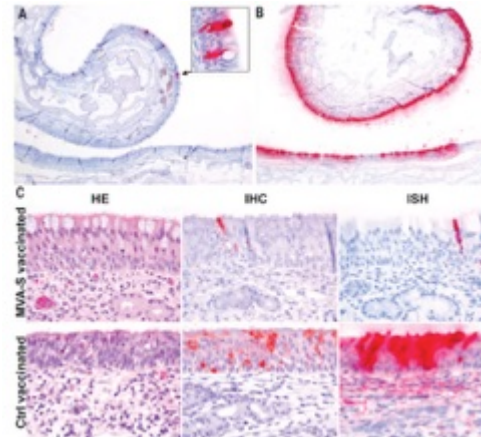
Control of MERS-CoV

- **Behavioural changes:** Recommendations to limit exposure, identify risk groups (farmers/shepherds, abattoir workers, animal sacrifices etc.)

- **Vaccination of animals**

An orthopoxvirus-based vaccine reduces virus excretion after MERS-CoV infection in dromedary camels

Bart L. Haagmans,^{1*} Judith M. A. van den Brand,¹ V. Stalin Raj,¹ Asisa Volz,² Peter Wohlsein,³ Saskia L. Smits,¹ Debby Schipper,¹ Theo M. Bestebroer,¹ Nisreen Okba,¹ Robert Fux,² Albert Bensaid,⁴ David Solanes Foz,⁴ Thijs Kuiken,¹ Wolfgang Baumgärtner,⁵ Joaquim Segalés,^{5,6} Gerd Sutter,^{2*} Albert D. M. E. Osterhaus^{1,7,8*}



Science, 2016

- No sterilizing immunity (infection despite neutralizing antibodies)
- MVA-specific antibodies cross-neutralized camelpox (-> acceptance)

- **Vaccination of humans**

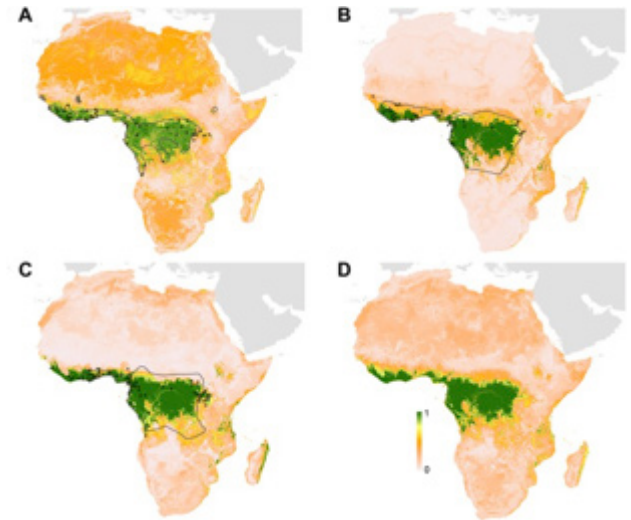
- Safety and Immunogenicity of a Candidate MERS-CoV Vaccine (MERS001), Biological: ChAdOx1 MERS (Centre for Clinical Vaccinology and Tropical Medicine, Churchill Hospital Oxford, United Kingdom)
- Safety, Tolerability and Immunogenicity of Vaccine Candidate MVA-MERS-S, Biological: vaccine candidate MVA-MERS-S (University Medical Center Hamburg-Eppendorf, Hamburg, Germany)
- Number needed to vaccinate? Commercial interest in the vaccine?

Control of zoonotic viruses:

The case of Ebola

Ebola – a bat reservoir, but many unknowns?

- Myriad of animals & even plants screened for Ebola virus
 - ➔ virus could not be isolated from any wild organism
- Next-generation sequencing has not yet yielded coding-complete pathogenic Ebola virus genomes in samples from any wild organism
- Genome fragments of Ebola strain Zaire in bats in 2005 (Leroy et al., 298-bp of polymerase)
- Contradicting results on species of origin: Fruit bats vs. microbats
- Other species: Duiker, great apes
- Ecological niche modelling has been done to predict endemic zones for the Ebola virus: much wider areas identified than affected by outbreaks
- Seropositivity found in many humans and animal in wide areas, without understanding the relevance of this finding
- Novel Ebola virus found in microbats in Sierra Leone (Goldstein et al. Nat. Microbiol, 2018), pathogenicity for humans unknown



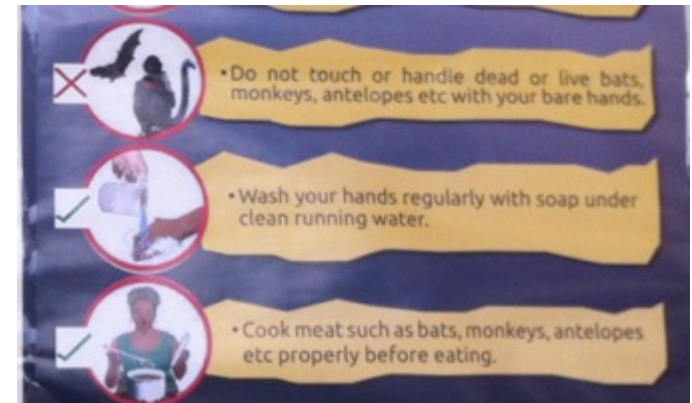
Pigott et al, 2014

The discovery of Bombali virus adds further support for bats as hosts of ebolaviruses

Tracey Goldstein^{1,2,4*}, Simon J. Anthony^{2,3,4,5,6*}, Aiah Gbakima⁶, Brian H. Bird¹, James Bangura⁶, Alexandre Tremeau-Bravard¹, Manjunatha N. Belaganahalli¹, Heather L. Wells^{1,2}, Jasjeet K. Dhanota¹, Eliza Liang^{2,4}, Michael Grodus², Rohit K. Jangra⁶, Veronica A. DeJesus⁶, Gorka Lasso⁷, Brett R. Smith¹, Amara Jambai⁸, Brima O. Kamara⁹, Sorie Kamara¹⁰, William Bangura¹¹, Corina Monagin^{11,12}, Sagi Shapira^{11,13}, Christine K. Johnson¹, Karen Saylor¹², Edward M. Rubin¹², Kartik Chandran⁶, W. Ian Lipkin^{2,3} and Jonna A. K. Mazet¹

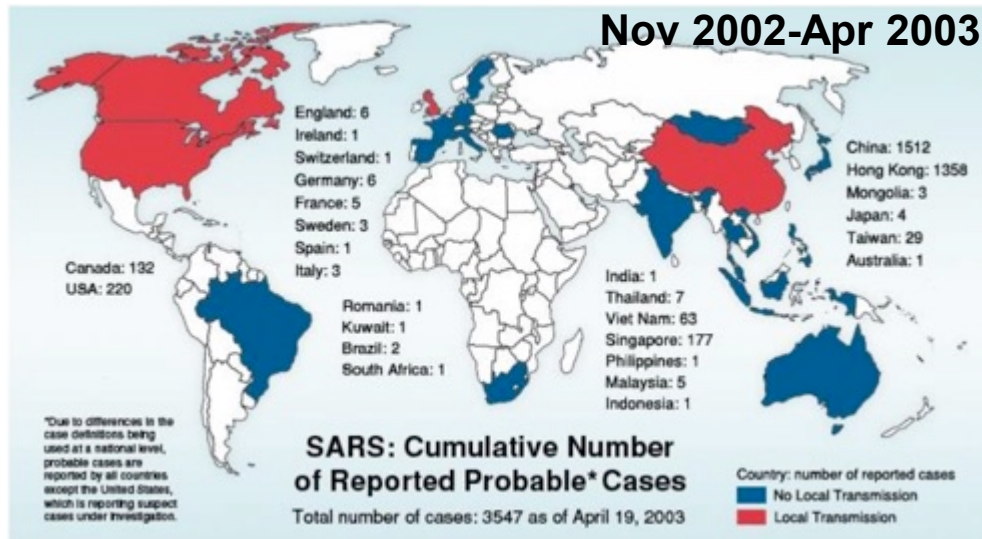
Control of Ebola virus outbreaks

- Significant progress has been made since 2015:
 - Vaccine available (rVSV-EBOV, still experimental)
 - Therapeutics (first randomised controlled trial starts right now in DRC (mAb114, Remdesivir (GS-5734), Zmapp, REGN-EB3)
- Control of reservoir or contact at the human-animal interface limited
- Predictive power for the next outbreak remains poor



Emerging viral zoonoses – Success stories in control

SARS-CoV – the first outbreak of the new millenium



Impact:

8000 cases

800 deaths (10% fatality rate)

Economic costs: 30-50 billion US\$

Source: www.cdc.gov



Rhinolophus sinicus

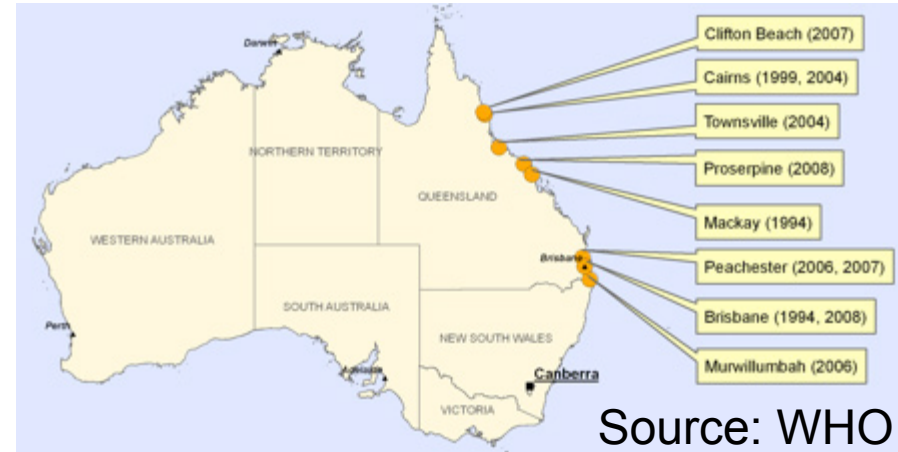
Paguma larvata

Homo sapiens

Successful eradication of the virus: e.g. broad case-definition, strict ID control, guidelines on PPE, patient management, aggressive contact tracing, travel advice, WHO updates, banning of civet cats from wet markets
but: patients not highly infective in the first week, virus not highly transmissible, quick availability of diagnostic test

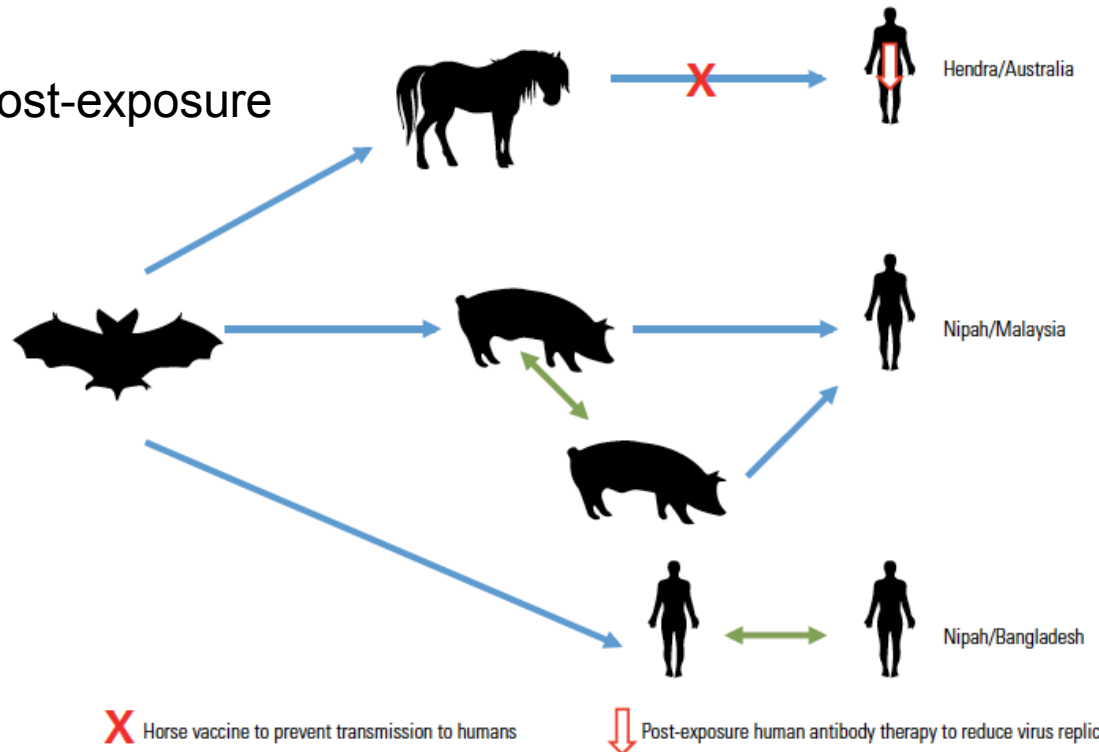
Hendra virus in Australia

- Emerged in Australia in 1994
- Severe disease in horses and humans
- Natural reservoir host in fruit bats
- Case numbers: 70 horses, 7 humans
- Human infection: horses only, not bats!



Control by:

- Vaccination of horses
- Monoclonal antibody (exp. post-exposure prophylaxis), humans
- Surveillance



Ahead of control:
Prediction of the next zoonotic virus ?

Predicting the next outbreak?

Globald Virome Project:

- Detect the majority of our planet's unknown viral threats
- Total number of potential zoonoses: 631,218 - 826,647
- Discover 71% of unknown viral diversity for \$1.2 billion
- Cost of EIDs over the next 30 years: US\$2.3 trillion



“no amount of DNA sequencing can tell us when or where the next viral outbreak will appear” - rather more proactive & real-time surveillance, rapid detection & diagnosis, primarily in human populations

- New digital technologies & artificial intelligence: A new approach in epidemic forecasting? (Joint initiative UniGe & Swiss TPH)

Control of viral zoonoses – Summary and challenges

For human medicine:

- Detection of outbreaks almost exclusively in the human population
- Our ability to predict is currently low
- New zoonotic diseases: Detailed knowledge on reservoir crucial for control
- In most cases: Elimination not possible → control!

For veterinary medicine:

- Include viruses that do not present as veterinary agents
- Wide implementation of vaccination, associated challenges
- Many reservoirs in wild-life, research questions extend beyond veterinary medicine (e.g. disease ecology, conservation)

Overall challenges:

Emergence at the human-animal interface needs a One Health approach for detection, surveillance and control – But challenges are not only grounded in biology of reservoir and host/medicine, but also in political & economical will and in the society

Save the date!

SYMPOSIUM FOR EMERGING VIRAL DISEASES

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Programme

Registration

Speakers

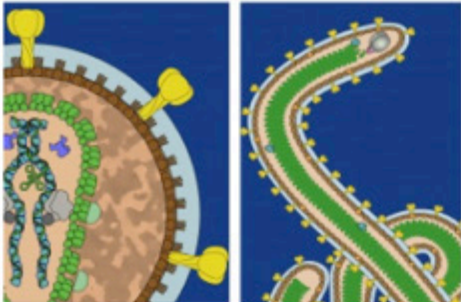
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2nd Symposium
10-12 April 2019



Pr Isabella Eckerle



Pr Laurent Kaiser

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Mrs Martine Moreillon

EmergingVirus.Geneva@hcuge.ch

tel: +41 22-372-98-00

<https://www.hug-ge.ch/centre-maladies-virales-emergentes>

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Thank you for your attention!

