Globalisation of One Health and Emerging Infectious Diseases

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Outline

ONE HEALTH

EMERGING INFECTIOUS DISEASES

GLOBALISATION

Antimicrobial resistance
Ross River virus
Emerging Infectious Diseases (EIDs) include...

- Pathogens: novel, old, evolving
- Increasing incidence
- Geographic expansion
- New populations at risk
- New species at risk
- Changing drivers of transmission
Examples of dramatic outbreaks of EIDs


Zoonoses account for >60% of EIDs
Human activities are the major drivers of EIDs

- Globalisation
- Population growth
- Environmental change
- Urbanisation
- Disasters
- Interactions with animals
- Culture, behaviour, lifestyle
- Health systems & services
- Economy, politics, governance

Emerging Infectious Diseases
Globalisation

- Increased global interconnectedness of people, governments, and economies
- Enabled by advances in transportation and communication
- Unprecedented growth in international flow of people, animals, vectors, pathogens, food, ideas, knowledge, information, technologies, culture, …..
- Unprecedented volume, speed, and reach

- One Health interactions can have global-scale influences
- Need to expand our thinking from local to global
Global Travel – Unprecedented Volumes

- In 2016, 1.5 billion international tourism departures

Source: World Tourism Organization
Global Travel – Unprecedented Reach & Speed

Source: www.visualcapitalist.com
Effective distance vs time to arrival of EID

Spread of Swine Flu from Mexico

Spread of SARS from China
Effective distance vs time to arrival of EID

Spread of Swine Flu from Mexico

Spread of SARS from China

Increasing connectivity = increasing reach and speed of global spread
Links between Travellers & EIDs

- **As victims** –
  - Travellers at risk infection if travelling to high-risk destinations

- **As carriers and transmitters** –
  - Major role in global dissemination of pathogens
  - Change in global distribution of diseases
  - Seed virgin soil outbreaks

- **As sentinels** –
  - Provide signals of disease epidemiology at travel destinations
  - Provide early warning of emergence/outbreaks

- **Sometimes as all three**
ANTIMICROBIAL RESISTANCE
Antimicrobial Resistance

CAUSES OF ANTIBIOTIC RESISTANCE

Antibiotic resistance happens when bacteria change and become resistant to the antibiotics used to treat the infections they cause.

- Over-prescribing of antibiotics
- Patients not finishing their treatment
- Over-use of antibiotics in livestock and fish farming
- Poor infection control in hospitals and clinics
- Lack of hygiene and poor sanitation
- Lack of new antibiotics being developed

A One Health Problem

www.who.int/drugresistance

#AntibioticResistance
Role of travellers in global spread of AMR

Journal of Travel Medicine

Editorial

Multidrug-Resistant Bacteria Without Borders: Role of International Trips in the Spread of Multidrug-Resistant Bacteria

Jordi Vila MD, PhD*

Travel and the Spread of Drug-Resistant Bacteria

Kevin L. Schwartz¹,²,³ · Shaun K. Morris²,⁴,⁵

Travel and acquisition of multidrug-resistant Enterobacteriaceae

Voyages et acquisition d’entérobactéries multirésistantes

L. Armand-Lefèvre⁶,⁷,*, A. Andremont⁶,⁷, E. Ruppé⁶,⁷
Role of travellers in global spread of AMR

Antimicrobials Increase Travelers’ Risk of Colonization by Extended-Spectrum Betalactamase-Producing Enterobacteriaceae

Anu Kantele,1,2,3,4 Tinja Lääveri,1,2 Sointu Mero,5 Katri Vilkman,2,3 Sari H. Pakkanen,3 Jukka Ollgren,6 Jenni Antikainen,5 and Juha Kirveskari5

Antimicrobial resistance acquisition after international travel in U.S. travelers

Dana M. Blyth1, Katrin Mende1,2,3, Ashley M. Maranich4, Miriam L. Beckius1, Kristie A. Harnisch1, Crystal A. Rosemann1, Wendy C. Zera1,2,3, Clinton K. Murray1 and Kevin S. Akers1,5

Colonisation with Escherichia coli resistant to “critically important” antibiotics: a high risk for international travellers

K. Kennedy · P. Collignon
Netherlands
~2000 travellers

- Overall: 34.3% colonised
- Travel to South Asia: 75.1% colonised
- Risk factors
  - Used antibiotics during travel: Odds ratio 2.69
  - Traveller’s diarrhoea: Odds ratio 2.31
  - Pre-existing chronic bowel disease: Odds ratio 2.10
- Probability of transmission to household member 12%
Acquisition rates of MRE by region of travel

Systematic Review

Fig. 1. Acquisition rates of multidrug-resistant Enterobacteriaceae (MRE) depending on the destination of travel (based on the most recent and important studies).

Taux d’acquisitions d’entérobactéries multi-résistantes (EMR) en fonction des régions de voyage (fondé sur les études les plus récentes et présentant le plus grand nombre de patients inclus).

Duration of colonisation post-travel

COMBAT study (Achilla et al)
- Median duration of colonisation 30 days
- 11.3% remained colonised at 12 months

Fig. 3. Dynamic of clearance of intestinal carriage of multidrug-resistant Enterobacteriaceae (MRE) after traveling abroad [30,32].

Possible consequences of colonisation

- Infection in that individual:
  - Invasive infections, especially post-operative
  - Higher risk of treatment failure
  - Longer hospital stays, greater mortality
- Spread to household contacts
- Spread through hospitals
- Spread through environment

Impact of medical tourism on spread of AMR?

Estimated >10 million people travel each year for medical care

Risk factors for colonisation:
• Travel to tropics & subtropics (55% vs 17% in temperate zones)
• Destination: Highest in South Asia (77.6%)
• Surgical intervention
• Antibiotic use
% of studies focusing on drivers of AMR

Chatterjee et al. Quantifying drivers of antibiotic resistance in humans: a systematic review. Lancet Infectious Diseases 2018
Chatterjee et al. Quantifying drivers of antibiotic resistance in humans: a systematic review. Lancet Infectious Diseases 2018
Meta-genomic analysis of toilet waste from long distance flights; a step towards global surveillance of infectious diseases and antimicrobial resistance

Thomas Nordahl Petersen, Simon Rasmussen, Henrik Hasman, Christian Carøe, Jacob Baelum, Anna Charlotte Schultz, Lasse Bergmark, Christina A. Svendsen, Ole Lund, Thomas Sicheritz-Pontén & Frank M. Aarestrup

Tested toilet waste from flights arriving at Copenhagen from:
- Beijing
- Tokyo
- Islamabad
- Bangkok
- Singapore
- New York
- Washington DC
- Toronto
- Greenland

A new paradigm for pathogen surveillance

Human waste from long-distance airplanes is an attractive material for monitoring the occurrence, prevalence and dissemination of antibiotic resistance genes and pathogens.
Antibiotic resistance genes detected

- Red = South Asia
- Blue = North Asia
- Green = North America, Europe
Antimicrobial Resistance

- Travellers as victims, carriers, transmitters, and sentinels
- MDR bacteria from around the world are silently invading our homes, communities, and environments
ROSS RIVER VIRUS
Ross River virus (RRV)

- Endemic in Australia and Papua New Guinea
- Primary reservoir hosts: kangaroos, wallabies
- Primary mosquito vectors: *Aedes* and *Culex*
  
  ~40 mosquito species implicated as potential vectors
- Common symptoms: painful swollen joints, fever, fatigue, rash
- 55-75% of cases are asymptomatic
- Can cause debilitating joint pain lasting for months
- Infection results in lifelong immunity
- Deaths are rare, but significant morbidity and economic costs
Pathways of Ross River virus infection

Enzootic
Epizootic
Pathways of Ross River virus infection

Enzootic

Epizootic

Endemic
Pathways of Ross River virus infection

During epidemic transmission: non-marsupial animals can also act as short-term amplification hosts.
Ross River Virus in Australia

- ~5,000 reported cases/year
- Both endemic and epidemic transmission
- Highest risk in tropics

National Notifiable Diseases Surveillance System, accessed 8 Dec, 2018
Ross River Virus – Pacific Islands

  - Imported into Fiji by viraemic traveller from Australia
  - >500,000 reported cases
  - >90% of population in Fiji, 69% in Cook Islands, 44% in American Samoa, 33% in New Caledonia
Ongoing RRV transmission in Pacific Islands?

- After virgin soil outbreak, RRV transmission assumed to have ceased because no known competent reservoir hosts, and no further reports of outbreaks, but ……

- Intermittent reports of RRV in travellers returning from Pacific Islands:
  - 5 New Zealanders after travelling to Fiji, 1979-2009
  - 2 Canadians after travelling to Fiji, 2003-2004
  - German traveller after visiting Pacific Islands, 2009

American Samoa

- Suspicion from local clinicians and entomologists that RRV might still be circulating after the 1979-1980 outbreak (44% attack rate)
- No RRV diagnostic tests available

Animal species:
- Bats (endemic)
- Rodents
- Dogs, cats
- Pigs
- (Cows, horses)

Competent vectors:
- Culex annulirostris
- Aedes aegypti
- Aedes polynesiensis
RRV Seroprevalence, American Samoa 2010

- 145 out of 196 samples ELISA IgG positive
- Seroprevalance 74%
- Seroprevalence 63% in people born after 1980 outbreak and had lived their whole lives in AS

![Graph showing seroprevalence by ELISA across birth years.]

= Endemic transmission

New evidence for endemic circulation of Ross River virus in the Pacific Islands and the potential for emergence

Colleen Lau\textsuperscript{a,\*}, Maite Aubry\textsuperscript{b}, Didier Musso\textsuperscript{b}, Anita Teissier\textsuperscript{b}, Sylvie Paulous\textsuperscript{c}, Philippe Desprès\textsuperscript{d}, Xavier de-Lamballerie\textsuperscript{e}, Boris Pastorino\textsuperscript{e}, Van-Mai Cao-Lormeau\textsuperscript{b}, Philip Weinstein\textsuperscript{f}
Similar findings in French Polynesia & Fiji

Silent Circulation of Ross River Virus in French Polynesia

Maite Aubry, Jérôme Finke, Anita Teissier, Claudine Roche, Julien Broult, Sylvie Paulous, Philippe Després, Van-Mai Cao-Lormeau, Didier Musso
Silent circulation?

How can such high infection rates go undetected for so long?

- Symptoms of RRV overlap with many other infectious and non-infectious diseases that are common in the tropics
- Diagnostic tests for RRV not available in PICTs
- Poor awareness and low clinical index of suspicion
- RRV usually asymptomatic in young children
- High seroprevalence = good herd immunity = no outbreaks
Global Implications of Findings

- Non-marsupials are capable of acting as reservoirs and sustaining endemic transmission
- All animal species in American Samoa are pan-global in distribution, i.e. RRV could potentially become endemic anywhere with competent mosquitoes
- Potential virgin soil outbreaks

BioScience

Another Emerging Mosquito-Borne Disease? Endemic Ross River Virus Transmission in the Absence of Marsupial Reservoirs

Emily J Flies, Colleen L Lau, Scott Carver, Philip Weinstein

BioScience, Volume 68, Issue 4, 1 April 2018, Pages 288–293,
https://doi.org/10.1093/biosci/biy011

Published: 07 March 2018
Risk of local transmission of RRV in NZ?

Four requirements for *epidemic* transmission:
- ✔ Competent mosquito vector
- ✔ Suitable climate
- ✔ Susceptible population
- ✔ Importation of virus

For *endemic* transmission, also need competent reservoir host
Risk of Ross River Virus Importation into NZ

- Estimated 100 viraemic travellers enter NZ from Queensland each year
- ....that was in 2007, and only from QLD
- ....what about from Pacific Islands?
- ....and the increase in number of travellers to NZ?
Ross River Virus

- Travellers as victims, carriers, transmitters, and sentinels
- Potential for global emergence, especially in places with extensive connectivity with Australia and Pacific Islands
NZ Resident Departures – 2015 to 2017

- Total resident departures: increased from 2.39M in 2015 to 2.83M in 2017 (18%)
- Total annual departures to Asia: increased from 383K in 2015 to 512K in 2017 (34%)

Source: www.stats.govt.nz
Total overseas visitor arrivals increased from 3.06M in 2015 to 3.69M in 2017 (21%)
Conclusions

- Globalisation has significant impact on the emergence and transmission of EIDs

- One Health and EIDs are no longer local issues

- Local One Health efforts are important, but not enough for sustainable gains

- Need to expand One Health thinking and efforts from local to regional and global

- Asia Pacific especially important to Australia and NZ because of extensive connectivity