Future infectious disease health threats faced by the EU and the implications for laboratory capacity

Mike Catchpole,
Chief Scientist
European Centre for Disease Prevention and Control
Determinants of Infectious Disease Incidence

Host

Environment

Pathogen
Drivers for the appearance of new threats

Determinants and Drivers of Infectious Disease Threat Events in Europe

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Determinants and drivers of infectious disease threat events, Europe, 2008–2013

- Globalization and environment
- Socio-demographic
- Public health systems
Infectious Disease Threats
determinants and drivers

<table>
<thead>
<tr>
<th>Globalization and environment</th>
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<tbody>
<tr>
<td><strong>Climate</strong></td>
<td>Temperature, humidity, wind, rainfall.</td>
</tr>
<tr>
<td><strong>Natural environment</strong></td>
<td>Land cover, vegetation, water ways, oceans, coastlines, water resources, land use, habitats, biodiversity.</td>
</tr>
<tr>
<td><strong>Human-made environment</strong></td>
<td>Urbanization, built environment, infrastructure, industries, intensive agriculture.</td>
</tr>
<tr>
<td><strong>Travel and tourism</strong></td>
<td>Movement of populations by automobile, train, ship, airplane.</td>
</tr>
<tr>
<td><strong>Migration</strong></td>
<td>Immigrant, emigrant, asylum seeker, settler.</td>
</tr>
<tr>
<td><strong>Global trade</strong></td>
<td>Import and export of goods and services across international boundaries via ship, airplane, rail, truck.</td>
</tr>
</tbody>
</table>
“For climate change, there is a relatively strong core-periphery pattern, with Southern regions faring worse”
Globalisation – International Travel
Global travel
Dissemination of infectious disease

SARS Timeline

- Nov 16 '02: First cases retrospectively recognized, Guangdong, China.
- Feb 28: Acute respiratory reported in Guangdong by China MOH.
- March 12: Hong Kong and Vietnam report outbreaks in hospital workers.
- March 19: WHO issues global alert.
- March 27: Reported in U.S. and Europe.
- April 9: India reports.
- April 14: Sequence of suspected agent, a coronavirus, established.
- April 17: First SARS in Africa.
- April 28: WHO issues travel advisories.
- July 03: Last case reported in China.
- Sept 03: Laboratory case in Singapore, no secondary cases.
- Dec 03: Laboratory case in Taiwan, no secondary cases.
- April 04: Two laboratory cases with secondary spread (nine cases, one death) Beijing and Hainan.

Carriage of multidrug-resistant Enterobacteriaceae in returning travellers, 2012-2013

Spread of MERS CoV (2012-2015)

ECDC. Numbers in the map indicate the total number of local and imported MERS cases. Map produced on: 13 Oct 2015.
Global Trade: importation of vectors

The Hidden Passenger of Lucky Bamboo: Do Imported Aedes albopictus Mosquitoes Cause Dengue Virus Transmission in the Netherlands?

Article (PDF Available) in Vector borne and zoonotic diseases (Larche) 2011. DOI: 10.1089/vbz.2008.0071 · Source: PubMed

1st Agnetha Hofhuis
nl 28.16 · National Institute of Public Health and the Environment, Bilthoven, The Netherlands

Abstract

Since 2005, Aedes albopictus mosquitoes have been detected in companies in the Netherlands that import ornamental plants from China. To assess the risks of dengue transmission, a study was carried out in 48 persons who are professionally exposed to these mosquitoes. No evidence for non-travel-related flavivirus infections was found.

vigilance is needed, because establishment of a potential arbovirus vector of a series of human arboviruses may lead to new infectious disease outbreaks
Aedes mosquitoes in Europe

Aedes mosquitoes distribution as of January 2016

Aedes aegypti

Aedes albopictus

Map updates available from:
Infectious Disease Threats
determinants and drivers

Socio-demographic

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Population composition with regards to age, income, education.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social inequality</td>
<td>Uneven distribution of resources in society, including income, wealth, rights, privileges, social power, education.</td>
</tr>
<tr>
<td>Vulnerable groups</td>
<td>Children, premature infants, pregnant women, elderly persons, men who have sex with men, immunocompromised persons.</td>
</tr>
<tr>
<td>Prevention</td>
<td>Childhood vaccination programs, adherence to treatment regimes, appropriate prescription practices.</td>
</tr>
<tr>
<td>Lifestyle</td>
<td>High-risk behaviour, such as intravenous drug use or unprotected sex with multiple partners.</td>
</tr>
<tr>
<td>Occupational</td>
<td>Healthcare workers, veterinary and animal care personnel, butchers, farmers, cleaners.</td>
</tr>
<tr>
<td>Terrorism</td>
<td>Intentional release or dissemination of biologic agents.</td>
</tr>
</tbody>
</table>
Future challenges for EU Regions: Demographic factors

“For demographic change, there is significant variation across European regions, once again with slightly greater vulnerability in South and South Eastern regions”
HIV diagnoses, by mode of transmission, 2005-2014, EU/EEA

Data is adjusted for reporting delay. Cases from Estonia and Poland excluded due to incomplete reporting on transmission mode during the period; cases from Italy and Spain excluded due to increasing national coverage over the period.

“Do-it-yourself” gene engineering
Bedroom bioterrorism?

Risk related to the use of ‘do-it-yourself’ CRISPR-associated gene engineering kit
contaminated with pathogenic bacteria

Conclusions
On 24 March 2017, the German authorities reported the contamination of a ‘do-it-yourself’ bacterial gene engineering CRISPR kit produced in the US. The kit was contaminated with pathogenic bacteria (risk group 2), including some bacteria that are multidrug-resistant and ESBL-producing. The kits are still sold online and target
Determinants of Infectious Disease Incidence

Host

Public Health

Environment

Pathogen

System
# Infectious Disease Threats
determinants and drivers

## Public health systems

<table>
<thead>
<tr>
<th>Healthcare system</th>
<th>European healthcare structure for the delivery of health services, including general practitioners, hospitals, clinics.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Health</td>
<td>Veterinary services, animal health and welfare measures, intensive livestock practices.</td>
</tr>
<tr>
<td>Food and water quality</td>
<td>Agriculture, husbandry, farming, processing, handling, preparation and storage of food, manmade water systems, water treatment and distribution systems.</td>
</tr>
<tr>
<td>Surveillance and diagnostic capacity failure</td>
<td>Systematic ongoing collection, collation, analysis, and dissemination of infectious disease data.</td>
</tr>
</tbody>
</table>
Vaccination policy in Europe is not achieving its public health goals
elimination of measles in Europe by 2010, 2015, 2020 (?!)

Source: TESSy data on measles cases reported 1 January – 30 April 2015;
Measles vaccine coverage (two doses, 2012 – 2013)
Main conclusions and options for response

The vaccine shortage currently affecting some EU/EEA Member States has already had direct consequences for the delivery of national vaccination programmes.

In general, the supply situation appears similar to what was previously reported, and uncertainty prevails. Some countries had to make short-term arrangements with other countries to avoid interruption of their programmes.

Since 2015, nine EU/EEA Member States have adjusted their immunisation policies. Measures included the following:
Spread of carbapenemase-producing Enterobacteriaceae (CPE) in the EU/EEA: assessment by national experts

- No case reported
- Sporadic occurrence
- Single hospital outbreaks
- Sporadic hospital outbreaks
- Regional spread
- Interregional spread
- Endemic situation

Klebsiella pneumoniae
percentage of invasive isolates with resistance to all antibiotic groups under surveillance*, EU/EEA, 2013

*Third-generation cephalosporins, fluoroquinolones, aminoglycosides, carbapenems and colistin

Only among isolates that were tested for susceptibility to all these antibiotic groups were included.

(i.e., less than 10 reported isolates were tested for susceptibility to all these antibiotic groups)
The annual reduction in global GDP caused by AMR could be as large as the losses provoked by the 2008 global financial crisis. However, the cost impacts of AMR on GDP would be worse than those of the financial crisis in two respects. First, they would be felt throughout the period to 2050, not just for a couple of very bad years. Second, with AMR, low-income countries would experience larger drops in economic growth than wealthy countries, so global poverty and economic inequality would increase.
Emerging zoonoses – what next?

Table 1. Examples of novel, emergent zoonotic virus diseases

<table>
<thead>
<tr>
<th>Year of isolation</th>
<th>Place of isolation</th>
<th>Virus</th>
<th>Reservoir/spillover host</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>Venezuela</td>
<td>Guaranito virus^{20}</td>
<td>Rodents</td>
</tr>
<tr>
<td>1992</td>
<td>Slovenia</td>
<td>Dobrava virus^{21}</td>
<td>Rodents</td>
</tr>
<tr>
<td>1993</td>
<td>United States</td>
<td>Sin Nombre virus^{22}</td>
<td>Rodents (Peromyscus maniculatus)</td>
</tr>
<tr>
<td>1994</td>
<td>Brisbane, Australia</td>
<td>Henora virus^{23}</td>
<td>Fruit bats (Pteropus sp.)/horses*</td>
</tr>
<tr>
<td>Sao Paolo, Brazil</td>
<td>Sabia virus^{24}</td>
<td>Rodents</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>Florida, USA</td>
<td>Black Creek Canal virus^{25}</td>
<td>Rodents</td>
</tr>
<tr>
<td>1996</td>
<td>Ballina, Australia</td>
<td>Australian bat lyssavirus^{26}</td>
<td>Fruit and insectivorous bats</td>
</tr>
<tr>
<td>Argentina</td>
<td>Andes virus^{27}</td>
<td>Rodents</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>Hong Kong (China)</td>
<td>Influenza HSN1^{28}</td>
<td>Wild birds/domestic poultry*</td>
</tr>
<tr>
<td>Menangle, Australia</td>
<td>Menangle virus^{29}</td>
<td>Wild birds/domestic poultry*</td>
<td></td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>Alkhurma virus^{30,31}</td>
<td>Wild birds/domestic poultry*</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Peninsular Malaysia</td>
<td>Nipah virus^{32,33}</td>
<td>Camels and sheep↑</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fruit bats/pigs*</td>
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Scientific Opinion

Joint Scientific Opinion on any possible epidemiological or molecular association between TSEs in animals and humans^{1}

EFSA Panel on Biological Hazards (BIOHAZ)^{2,3}

European Food Safety Authority (EFSA), Parma, Italy

European Centre for Disease Prevention and Control (ECDC)^{4,5}

Stockholm, Sweden
Level of microbiology capabilities by country (N=29 EU/EEA countries, 2015)

Level of target capabilities by country (N=29 EU/EEA countries, 2015)

Target 3.3 National outbreak response support

Target 3.4 Capability for (re-)emerging diseases preparedness
Radar graphs for target indices, (30 EU/EEA countries), 2013 (blue) and 2014 (red)
Emerging viral pathogen detection capabilities in the EU/EEA

**Figure 13.** EU/EEA distribution of 2015 results by country for the 20 EULabCap indicators on laboratory-based surveillance and epidemic response support and mean scores, 2013–2015

**Target 3.4 (Re)-emerging diseases laboratory preparedness and response support**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Mean Score</th>
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<tr>
<td>3.41 Diagnostic capability MERS-CoV</td>
<td>8.0 8.7 9.1</td>
</tr>
<tr>
<td>3.42 Diagnostic capability Influenza A(H7N9)</td>
<td>9.0 9.2 9.1</td>
</tr>
<tr>
<td>3.43 Diagnostic capability Ebola virus</td>
<td>5.0 5.2 5.5</td>
</tr>
<tr>
<td>3.44 Diagnostic capability for detection 5 rare agents</td>
<td>8.6 9.5 9.5</td>
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**Indicator 3.44 Diagnostic capability for detection 5 rare agents**
One or more reference virology laboratories in your country have detection capability for the following 5 rare AND/OR imported viruses: Chikungunya/Dengue/Hantavirus/Tick borne encephalitis/West Nile.
WGS application in EU/EEA countries for National Surveillance

Number of countries

- **L. monocytogenes**
- **S. enterica**
- **STEC/VTEC**
- **CPE/CRE**
- **AR-N. gonorrhoeae**
- **MDR-TB**
- **Human Influenza virus**
- **N. meningitidis**

**LEGEND**
- Green: Application in 2015
- Blue: plan to use by 2018

**Source:** NMFP surveys 2015 (n=28 respondents) and 2016 (n=29 respondents)
What are the biggest threats (a personal view)

<table>
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<tr>
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<td>AMR, vaccine hesitancy</td>
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NASA scientists successfully revived bacteria that had been encased in a frozen pond in Alaska for 32,000 years. The microbes, called *Carnobacterium pleistocenium*, had been frozen since the Pleistocene period, when woolly mammoths still roamed the Earth. Once the ice melted, they began swimming around, seemingly unaffected.

"there is now a non-zero probability that pathogenic microbes could be revived, and infect us. How likely that is is not known, but it's a possibility. If the pathogen hasn't been in contact with humans for a long time, then our immune system would not be prepared"
Information technology

The new driver for 21st century epidemics?
Scientific Scepticism & the “Post Factual” Age

Donald J. Trump
@realDonaldTrump

Lots of autism and vaccine response. Stop these massive doses immediately. Go back to single, spread out shots! What do we have to lose.

404 RETWEETS 205 LIKES

9:10 am - 22 Oct 2012
Lancet retracts 'utterly false' MMR paper

After medical council ruling last week that MMR doctor Andrew Wakefield was dishonest, journal finally quashes paper

The Lancet today finally retracted the paper that sparked a crisis in MMR vaccination across the UK, following the General Medical Council's decision that its lead author, Andrew Wakefield, had been dishonest.

The medical journal's editor, Richard Horton, told the Guardian today that he realised as soon as he read the GMC findings that the paper, published in February 1998, had to be retracted. "It was utterly clear, without any ambiguity at all, that the statements in the paper were utterly false," he said. "I feel I was deceived."
The impact of scientific misinformation

UK Public Opinion on MMR Safety 2001-2003

Chart 4: % of two year-olds receiving MMR vaccine - England, Wales and Scotland 1994-2008

Laboratory-confirmed Measles, England & Wales, 1995-2008
But what if we had a vaccine against cancer?

HPV vaccine is **CANCER PREVENTION.**
Vaccinate kids at 11-12 years.
HPV Vaccination in Denmark

Incidence of cervical lesions (CIN2+)

HPV vaccination introduced

Uptake of first HPV vaccine by year of birth, females, 1993-2003
NHS trust cancels operations after computer virus hits IT system

North Lincolnshire and Goole trust shuts down most of its network and cancels appointments and routine surgery at three hospitals.

All appointments and routine operations have been cancelled at three hospitals after a computer virus attacked critical systems.

Officials said around 1,000 patients would be affected at hospitals run by the North Lincolnshire and Goole trust after a major incident was declared due to the virus, which was identified on Sunday.
Acknowledgements

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Kåre Mølbak

Marc Struelens

ECDC Disease Programme Teams

- Antimicrobial Resistance and Healthcare Associated Infections
- Emerging and Vectorborne Diseases
- Food and Waterborne Diseases
- Influenza and Respiratory Viruses
- HIV Sexually Transmitted Infections and Hepatitis
- Tuberculosis
- Vaccine Preventable Diseases

Thank you!