VECTOR-BORNE ZOONOSES
HOW DO WE PROTECT EUROPE?

M. C. Escher – Metamorphosis II, modified

SWISS TPH WINTER SYMPOSIUM 2018  Basel, Switzerland –7 December 2018
GIULIA PATERNOSTER –PhD Candidate in Epidemiology and Biostatistics
OUTLINE

1. VECTOR-BORNE ZOONOSES: an opportunity for ONE HEALTH

2. ONE HEALTH IN PRACTICE: the case of West Nile virus (WNV) integrated surveillance in Emilia-Romagna

3. ECONOMIC EVALUATION of WNV integrated surveillance in Emilia-Romagna
   → ONE HEALTH & PROCESS EVALUATION of WNV integrated surveillance in Northern Italy

4. LESSON LEARNT & FUTURE PERSPECTIVES
VECTOR-BORNE ZOONOSES

- Human and animal illnesses caused by parasites, viruses, and bacteria, transmitted by vectors
- Affect hundreds of millions of people and animals globally
- Highest direct impact in tropical and subtropical areas
  - Indirect economic impact on the poorest populations through animal disease
- Distribution determined by complex interaction of demographic, environmental, social and economic factors
VECTOR-BORNE ZOONOSSES

- Distribution determined by complex interaction of demographic, environmental, social and economic factors → “ideal case” for ONE HEALTH approach in public health

ONE HEALTH

- Integration
  → knowledge
  → perspectives

- Transdisciplinarity
  → society and science
  → health professionals as agents of change
ONE HEALTH

Any added value in terms of human and animal lives saved, reduced cost and sustained social and environmental services that can be achieved by a closer cooperation of human and animal health and other disciplines which could not be achieved if the sectors worked separately [Zinsstag 2015]

NEED FOR POLICY EVALUATION

→ provides accountability for policy makers
→ should be a change oriented process

“evaluate to evolve”
THE ADDED VALUE OF ONE HEALTH... CAN WE MEASURE IT?

Economics of One Health: Costs and benefits of integrated West Nile virus surveillance in Emilia-Romagna

Giulia Paternoster1, Sara Babo Martins2,3, Andrea Mattivi4, Roberto Cagarelli4, Paola Angelini4, Romeo Bellini5, Annalisa Santi1, Giorgio Galletti1, Simonetta Pupella6, Giuseppe Marano6, Francesco Copello7, Jonathan Rushton6, Katharina D. C. Stärk2,3, Marco Tamba1

1 Istituto Zooprofilattico Sperimentale della Lombardia e dell’Emilia-Romagna (IZS-LER), Brescia, Italy,
2 Department of Production and Population Health, Royal Veterinary College, Hatfield, United Kingdom,
3 SAFOSO AG, Bern-Liebefeld, Switzerland, 4 Regional Health Authority of Emilia-Romagna, Bologna, Italy,
5 Centro Agricoltura Ambiente “G. Nicoli”, Crevalcore, Italy, 6 National Blood Centre, National Institute of Health (Istituto Superiore di Sanità, ISS), Rome, Italy, 7 Occupational Medicine Unit, IRCCS AOU San Martino-IST teaching Hospital, Genoa, Italy, 8 Institute of Infection and Global Health, University of Liverpool, Liverpool, United Kingdom
WEST NILE VIRUS (WNV)

- **Complex interactions** among **animals**, **humans** and their overlapping/shared ecosystems
- In humans: ~80% asymptomatic | ~20% West Nile fever (WNF) | <1% West Nile Neuroinvasive disease (WNND)

• **Blood transfusion**
• **Organ transplantation**
• **Breast feeding**
• **In utero**
EMILIA-ROMAGNA (ER), ITALY

Population ~ 4.5 M. Surface ~ 22,000 km²
Strong tradition of blood donation
1st WNV detection in 2008

- **WNV integrated surveillance** since 2009 targeting humans, horses, wild birds, mosquitoes
  - → **early detection** WNV circulation
  - → prevention of WNV transmission via **blood transfusion**
WNV INTEGRATED SURVEILLANCE

Prevention of WNV transmission via **blood transfusion**
Systematic WNV blood donation testing at the province level (adm2)

**Uni-sectoral approach**
National regulation
- Human surveillance

**CURRENT SEASON**
Notification of the 1st human case (WNND, WNF)
&
**FOLLOWING SEASON**

**One Health approach**
ER blood safety policy
- Human surveillance
- Veterinary surveillance mosquitoes, wild birds, horses
- Sharing of information

**CURRENT SEASON**
1st WNV detection in any *spp.* targeted by the SS
until Nov. 30
ONE HEALTH APPROACH

REGIONAL CROSS-SECTORAL NETWORK for the activation of preventative measures to mitigate the risk of WNV transmission via blood transfusion in ER

Emilia-Romagna region
interdisciplinary group on VBD

Veterinary services
Veterinarians
Horse farm owners
Wildlife recovery centres
Hunters

Public health services
Physicians
Hospitals

Entomological unit

Regional blood centre
Activation of blood donation screening

Prompt communication of WNV circulation

Coordination & feedback

Samples consignment
Output of the network
**WNV INTEGRATED SURVEILLANCE**

**IDENTIFICATION OF COSTS & BENEFITS (ER, 2009-2015).** Application of the conceptual framework developed by Babo Martins et al., 2015

### COSTS

**Uni-sectoral approach**
- D1 National regulation

<table>
<thead>
<tr>
<th>Surveillance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human surveillance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Triggered actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood testing</td>
</tr>
<tr>
<td>Communication campaigns</td>
</tr>
<tr>
<td>Vector control interventions</td>
</tr>
</tbody>
</table>

### BENEFITS

**One Health approach**
- ER blood safety policy

<table>
<thead>
<tr>
<th>Surveillance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human surveillance</td>
</tr>
<tr>
<td>Veterinary surveillance – mosquitoes, wild birds, horses</td>
</tr>
<tr>
<td>Sharing of information</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Triggered actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood testing</td>
</tr>
<tr>
<td>Communication campaigns</td>
</tr>
<tr>
<td>Vector control interventions</td>
</tr>
</tbody>
</table>

**Averted costs** of potential WNND cases associated to infected transfusions
- Short term cost of hospitalization
- Compensation for transfusion associated disease
WNV INTEGRATED SURVEILLANCE

ESTIMATION OF COSTS (ER, 2009-2015)

<table>
<thead>
<tr>
<th>COSTS</th>
<th>Uni-sectoral approach</th>
<th>One Health approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>National regulation</td>
<td>ER blood safety policy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surveillance</td>
<td>Surveillance</td>
</tr>
<tr>
<td></td>
<td>Human surveillance</td>
<td>Human surveillance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Veterinary surveillance – mosquitoes, wild birds, horses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sharing of information</td>
</tr>
<tr>
<td></td>
<td>Triggered actions</td>
<td>Triggered actions</td>
</tr>
<tr>
<td></td>
<td>Blood testing</td>
<td>Blood testing</td>
</tr>
<tr>
<td></td>
<td>Communication campaigns</td>
<td>Communication campaigns</td>
</tr>
<tr>
<td></td>
<td>Vector control interventions</td>
<td>Vector control interventions</td>
</tr>
<tr>
<td>EUR</td>
<td>5,075,906</td>
<td>4,914,985</td>
</tr>
<tr>
<td></td>
<td>~1.2 M EUR savings</td>
<td></td>
</tr>
</tbody>
</table>
WNV INTEGRATED SURVEILLANCE

ESTIMATION OF BENEFITS (ER, 2009-2015)
Potential WNND cases associated to 18 infected blood components transfusions

p of WNND after infected blood transfusion

Avoided short term cost of hospitalization
Avoided compensation for transfusion associated disease

<table>
<thead>
<tr>
<th></th>
<th>BEST CASE SCENARIO (EUR)</th>
<th>INTERMEDIATE SCENARIO (EUR)</th>
<th>WORST CASE SCENARIO (EUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 cases</td>
<td>0</td>
<td>2 cases</td>
<td>18 cases</td>
</tr>
<tr>
<td>0</td>
<td>30,792</td>
<td>277,128</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>300,000</td>
<td>2,700,000</td>
<td></td>
</tr>
<tr>
<td>EUR</td>
<td>330,792</td>
<td>2,977,128</td>
<td></td>
</tr>
</tbody>
</table>

One Health approach
ER blood safety policy

0.66 %
10%
100%
OH IN PRACTICE

- OH approach to WNV surveillance can lead to accelerated viral detection and prevention of human infections.

- Is cost saving and has potentially additional economic benefits due to early warning in endemic ER region (evaluation results are context specific!)

- Allows the collection of data that are useful to understand the epidemiology of WNV infection.

EVIDENCE ON THE ECONOMIC RETURN OF CROSS-SECTORAL COOPERATION FOR VBZ MITIGATION IN EUROPE, BUT...

Further evaluations including intangible costs, social, and ecological dimensions, would allow a deeper understanding of the economic context of the disease and its mitigation, allowing to better inform public health decision makers.
VBZ WITHOUT BORDERS

WNV integrated surveillance is an inter-regional challenge

Case study in three regions of the Po Valley: Emilia-Romagna, Lombardy, Piedmont

Legal framework

Piedmont region
interdisciplinary group on VBD

Emilia-Romagna region
interdisciplinary group on VBD

Lombardy region
interdisciplinary group on VBD

Veterinary services
Public health services
Entomological unit
Veterinary reference laboratory
Public Health reference laboratory

Veterinarians
Horse farm owners
Wildlife recovery centres
Hunters

Physicians
Hospitals

Coordination & feedback
Samples consignment
EVALUATIONS

System definition and description of the initiative followed by the evaluation of

1. KNOWLEDGE INTEGRATION
DEGREE OF OH IMPLEMENTATION

One Health Index

2. PROCESS

Focus groups
- One for each region
- Max 8 participants, 90'
- “Privileged observers”
- Final focus group with participants from all regions

Process evaluation results
EVALUATIONS RESULTS

1. KNOWLEDGE INTEGRATION

Critical points

→ communication
→ learning

2. PROCESS

Critical points

→ communication
→ funding

The degree of One Health implementation in West Nile virus integrated surveillance in northern Italy, 2016


The parable of the "Blind men and an elephant". Illustrated by Robert W. Williams, 2017, modified

GRAZIE THANKS DANKE!
VECTOR-BORNE ZOONOOSES & OH
LESSON LEARNT, FUTURE PERSPECTIVES

FOSTER DIVERSITY
- Ideas
- Disciplines: TRANSDISCIPLINARITY (beyond MD-DVM collaboration)
- Biological organisms: BIODIVERSITY
- Gender
- Perspectives (stakeholders)
  - Local knowledge
  - Citizen science, co-production of knowledge

COMMUNICATION, COLLABORATION
- Interregional coordination
- Legal systems & infrastructures

(MOBILE) TECHNOLOGIES
- Social media
- Infodemiology

EDUCATION, RESILIENCE

---

**Lyme Disease**

Much of Ostfeld and Keesing’s (6, 7) work is based on a single, albeit important case study: Lyme disease in the northeast of the United States. Lyme disease in humans is a debilitating illness caused by the spirochete *Borrelia burgdorferi*, which is transmitted to humans via ticks, primarily the nymphal stage of *Ixodes* spp. (7). The nymphal ticks are host generalists, feeding on a variety of mammal species. One, the white-footed mouse *Peromyscus leucopus*, is a particularly competent host for the spirochete and as a small-bodied habitat generalist, persists in the smallest habitat patches (7). Where a high diversity of alternative hosts is present, many ticks will feed on these species, most of which are less-competent reservoirs for *Borrelia*, reducing the likelihood that nymphal ticks will transmit the infection to humans.
VECTOR-BORNE ZOONOSES
HOW DO WE PROTECT EUROPE?

TOGETHER, FOSTERING DIVERSITY, COLLABORATION, RESILIENCE

Christopher Chase-Dunn, sociologist, world-systems theory
Please join us in NEOH by:

1. Becoming a member of ECOHEALTH INTERNATIONAL
   www.ecohealthinternational.org

2. Writing an email to Sara Savic sara@niv.ns.ac.rs letting her know that you have joined so that we can contact you for our first online meeting
THANK YOU FOR YOUR ATTENTION

THANKS TO ALL COAUTHORS & TO MY TEAM @ UZH: Paul Torgerson, Simon Rüegg, Sonja Hartnack, Duriya Charypkhan, & Anou Dreifuss (previous members included!)

Maria Sibylla Merian (1647–1717) entomologist, naturalist, scientific illustrator. Metamorphosis insectorum Surinamensium

giulia.paternoster@uzh.ch
Table 6. Overall costs of the One Health and uni-sectoral scenarios, Emilia-Romagna, Italy, 2009–2015.

<table>
<thead>
<tr>
<th>Surveillance activities</th>
<th>One Health scenario cost (Euro)</th>
<th>Uni-sectoral scenario cost (Euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human surveillance</td>
<td>71,188</td>
<td>71,188</td>
</tr>
<tr>
<td>Entomological surveillance</td>
<td>646,505</td>
<td>0</td>
</tr>
<tr>
<td>Wild birds surveillance</td>
<td>245,320</td>
<td>0</td>
</tr>
<tr>
<td>Horse surveillance</td>
<td>2340</td>
<td>0</td>
</tr>
<tr>
<td>Sharing of information</td>
<td>156,800</td>
<td>0</td>
</tr>
<tr>
<td><strong>Triggered interventions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood testing</td>
<td>3,276,352</td>
<td>4,488,238</td>
</tr>
<tr>
<td>Communication campaigns</td>
<td>105,000</td>
<td>105,000</td>
</tr>
<tr>
<td>Vector control interventions</td>
<td>411,480</td>
<td>411,480</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td>4,914,985</td>
<td>5,075,906</td>
</tr>
</tbody>
</table>

https://doi.org/10.1371/journal.pone.0188156.t006
WNV INTEGRATED SURVEILLANCE

ESTIMATION OF COSTS (ER, 2009-2015)

Table 4. Cost evaluation for the One Health scenario—regional integrated West Nile virus (WNV) surveillance system, Emilia-Romagna, Italy, 2009–2015.

<table>
<thead>
<tr>
<th>Year</th>
<th>Human surveillance</th>
<th>Horse surveillance</th>
<th>Entomological surveillance</th>
<th>Omnipathological surveillance</th>
<th>Sharing of information</th>
<th>Communication campaigns</th>
<th>Vector control</th>
<th>Blood screening</th>
<th>Overall surveillance cost (Euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>5772</td>
<td>1100</td>
<td>50,000</td>
<td>28,380</td>
<td>16,900</td>
<td>16,065</td>
<td>15,000</td>
<td>102,870</td>
<td>531,540</td>
</tr>
<tr>
<td>2010</td>
<td>8362</td>
<td>240</td>
<td>50,000</td>
<td>34,770</td>
<td>11,550</td>
<td>12,180</td>
<td>15,000</td>
<td>102,870</td>
<td>117,540</td>
</tr>
<tr>
<td>2011</td>
<td>4884</td>
<td>80</td>
<td>50,000</td>
<td>23,325</td>
<td>14,650</td>
<td>12,810</td>
<td>15,000</td>
<td>102,870</td>
<td>143,149</td>
</tr>
<tr>
<td>2012</td>
<td>5476</td>
<td>220</td>
<td>50,000</td>
<td>28,815</td>
<td>15,500</td>
<td>18,480</td>
<td>15,000</td>
<td>102,870</td>
<td>155,891</td>
</tr>
<tr>
<td>2013</td>
<td>14,726</td>
<td>270</td>
<td>60,000</td>
<td>39,510</td>
<td>18,400</td>
<td>29,880</td>
<td>15,000</td>
<td>102,870</td>
<td>840,419</td>
</tr>
<tr>
<td>2014</td>
<td>16,798</td>
<td>230</td>
<td>75,000</td>
<td>49,455</td>
<td>15,600</td>
<td>24,900</td>
<td>15,000</td>
<td>102,870</td>
<td>948,548</td>
</tr>
<tr>
<td>2015</td>
<td>15,170</td>
<td>200</td>
<td>75,000</td>
<td>32,250</td>
<td>15,800</td>
<td>22,515</td>
<td>15,000</td>
<td>102,870</td>
<td>815,697</td>
</tr>
<tr>
<td>Total</td>
<td>71,188</td>
<td>2340</td>
<td>410,000</td>
<td>236,505</td>
<td>108,400</td>
<td>136,920</td>
<td>158,800</td>
<td>327,352</td>
<td>4,914,985</td>
</tr>
</tbody>
</table>

WNV: West Nile virus; WNND: West Nile neuroinvasive disease

Costs of entomological and omnipathological surveillance, and blood screening activities for the years 2009–2013 are from Table 5 of Bellini et al. [8]

Blood screening activities

The integrated WNV surveillance system has been implemented during the whole study period in the Emilia-Romagna region. However, only the results of human surveillance were taken into account to trigger blood screening activities until 2013, following the national regulation (uni-sectoral scenario). In 2013, according to the regional surveillance system, WNV nucleic acid testing (NAT) screening is applied to all blood donors in a province after reports of at least two positive mosquito pools or one positive bird by the entomological or omnipathological surveillance, within the limits of that province [9]. In 2014 and 2015 NAT screening at the province level is started after the confirmation of WNV in any species targeted by the surveillance system in that province. Therefore, for this scenario, blood screening data are estimated for 2009–2012, and real data for 2013–2015, based on the actual number of blood units tested and detected as positive.

In this year, blood screening surveillance in Emilia-Romagna does not follow the regional integrated WNV SS, but the national WNV surveillance plan. However, based on surveillance results, it is possible to predict how many blood units would have been screened should the ER surveillance system (OH scenario) have been followed. Costs were derived accordingly.

In this year, the blood units that would have been screened by the integrated WNV regional surveillance system happened to have been screened according to the national surveillance plan, so the number of positive blood units that would have been detected via the integrated WNV regional surveillance system is known.

In this year, blood screening activities are based on the results of the integrated SS. Blood screening data are based on the actual number of blood units tested and detected as positive.
## WNV INTEGRATED SURVEILLANCE

**ESTIMATION OF BENEFITS (ER, 2009-2015)**

Table 2. Items included in the calculation of avoided short term cost of hospitalization and avoided compensation for transfusion-associated disease for the estimation of benefits, West Nile virus (WNV) integrated surveillance system in Emilia-Romagna, 2009–2015.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean short term cost of hospitalization of WNV neuroinvasive disease (WNND)</strong></td>
<td>Date of admission and discharge to and from each hospital ward</td>
<td>Variable</td>
<td>Date</td>
<td>Intensive therapy, neurology, infectious and tropical diseases, haematology, neurology-rehabilitation etc.</td>
</tr>
<tr>
<td>Hospitalization data</td>
<td>Hospital ward type</td>
<td>Description</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Duration of hospitalization in each hospital ward</td>
<td>Description of primary and secondary diagnosis during hospitalization</td>
<td>Table 3</td>
<td>Days</td>
<td></td>
</tr>
<tr>
<td><strong>Hospitalization cost</strong></td>
<td>Daily cost of intensive therapy ward</td>
<td>1450</td>
<td>Euro/day</td>
<td>Direct costs: 1100 EUR/day Indirect costs: 350 EUR/day</td>
</tr>
<tr>
<td><strong>Mean compensation for transfusion-associated disease</strong></td>
<td>Daily cost of other hospital wards</td>
<td>450</td>
<td>Euro/day</td>
<td>Direct costs: 350 EUR/day Indirect costs: 100 EUR/day</td>
</tr>
<tr>
<td>Anamnestic data of WNND notified cases</td>
<td>Sex and profession, thirty-day follow up status, local health unit (LHU) of notification</td>
<td>Description</td>
<td>NA</td>
<td>Surveillance form for infectious diseases (SMI) database</td>
</tr>
<tr>
<td></td>
<td>Symptoms onset date, date of notification</td>
<td>Variable</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age at symptoms onset date</td>
<td>Variable</td>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Compensation for TAD</td>
<td>Compensation for TAD according to the subject’s income class</td>
<td>Variable</td>
<td>Euro/year for 15 years</td>
<td>[20,21]</td>
</tr>
</tbody>
</table>
## WNV INTEGRATED SURVEILLANCE

### ESTIMATION OF BENEFITS (ER, 2009-2015)

Table 3. Duration (days) of hospitalization of 52 West Nile virus neuroinvasive disease cases occurred in Emilia-Romagna, 2009–2015.

<table>
<thead>
<tr>
<th>Type of hospital ward</th>
<th>No. of WNND cases</th>
<th>Mean duration of hospitalization (days)</th>
<th>Range (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive care</td>
<td>4</td>
<td>32.8</td>
<td>7–73</td>
</tr>
<tr>
<td>Infectious and tropical diseases</td>
<td>29</td>
<td>13.2</td>
<td>2–55</td>
</tr>
<tr>
<td>Other hospital wards</td>
<td>33</td>
<td>29.5</td>
<td>1–184</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>52</strong></td>
<td><strong>28.6</strong></td>
<td><strong>3–215</strong></td>
</tr>
</tbody>
</table>

WNND: West Nile virus neuroinvasive disease

https://doi.org/10.1371/journal.pone.0188156.t003

### Parameter description

<table>
<thead>
<tr>
<th>Parameter description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of infected blood units intercepted in the One Health scenario only</td>
<td>6</td>
<td>Number</td>
</tr>
<tr>
<td>Number of assumed WNND cases avoided in the One Health scenario only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of confirmed WNND cases notified in Emilia-Romagna in 2009–2015</td>
<td>53</td>
<td>Number</td>
</tr>
<tr>
<td>Number of confirmed WNND cases in Emilia-Romagna in the study period with hospitalization records</td>
<td>52</td>
<td>Number</td>
</tr>
<tr>
<td>Number of hospitalization records considered in the estimation</td>
<td>76</td>
<td>Number</td>
</tr>
<tr>
<td>Mean hospitalization length of a WNND case</td>
<td>28.6</td>
<td>Days</td>
</tr>
<tr>
<td>Mean short term cost of hospitalization of a WNND case</td>
<td>15,396</td>
<td>Euro</td>
</tr>
<tr>
<td>Mean compensation for transfusion-associated disease per subject</td>
<td>150,000$</td>
<td>Euro</td>
</tr>
</tbody>
</table>

WNND: West Nile virus neuroinvasive disease

$^a$ Compensation in fifteen years.
### WNV INTEGRATED SURVEILLANCE

**ESTIMATION OF BENEFITS (ER, 2009-2015)**

Table 8. Benefits of the One Health scenario quantified as averted costs of potential human cases of West Nile virus neuroinvasive disease (WNND) associated to infected blood component transfusion. Best-case, intermediate, and worst-case scenario according to the probability of WNND transfusion associated transmission. Emilia-Romagna, Italy, 2009–2015.

<table>
<thead>
<tr>
<th></th>
<th>Best-case scenario</th>
<th>Intermediate scenario</th>
<th>Worst-case scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term cost of hospitalization avoided (Euro)</td>
<td>0</td>
<td>30,792</td>
<td>277,128</td>
</tr>
<tr>
<td>Compensation for transfusion-associated disease avoided (Euro)</td>
<td>0</td>
<td>300,000</td>
<td>2,700,000</td>
</tr>
<tr>
<td>Total benefit of the One Health scenario (Euro)</td>
<td>0</td>
<td>330,792</td>
<td>2,977,128</td>
</tr>
</tbody>
</table>

WNND: West Nile virus neuroinvasive disease

Benefits of the One Health scenario are estimated as potential transfusion associated West Nile virus neuroinvasive disease (WNND) cases avoided. Three scenarios are considered based on the assumed probability of developing WNND after receiving an infected blood transfusion. This probability was assumed to be 0%, 10%, and 100% in the best-case, intermediate, and worst-case scenario, resulting in 0, 2, and 18 potential WNND cases avoided, respectively.

https://doi.org/10.1371/journal.pone.0188156.t008
Integrated human and animal surveillance and response systems (iSRS) are one of the most important contributions of a One Health approach to mitigate effects of climate change. While public health surveillance is restricted to humans, understanding vector-borne diseases and climate change per se call for an integrated One Health approach (Semenza and Zeller 2014; Elbers, Koenraadt and Meiswinkel 2015). The above-mentioned example of integrated WNV surveillance in mosquitos, birds, horses and humans is a case in point (Paternoster et al. 2017). The World Bank makes a compelling case for integrated human and animal surveillance (Fig. 2), emphasizing that if emerging diseases can already be detected in vectors, livestock or wildlife, prior to detection in humans, very large costs could be averted (World-Bank 2012; Heymann and Dixon 2013).
Food for thought

- https://crowdfunding.wur.nl/project/muggenradar-app?locale=en
- https://www.google.com/search?q=rame+filo&client=safari&rls=en&source=lnms&tbm=isch&sa=X&ved=0ahUKEwipspSc5f_eAhUEXiwKHW2nCo4Q_AUIdigB&biw=1246&bih=727
- Sabbage
- Plastic bags breeding for malaria
  
  Wangari Maathai, the assistant environmental minister in Kenya and 2004 Nobel Peace Prize winner
  
  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5655677/

Action facilitating **exchange and collaboration between disciplines and between science and society.**