One Health Approach in Infection Control

Jan Kluytmans
Amphia Hospital and UMCU
Disclosures

Financial support
The problem

Resistance to antibiotics could bring "the end of modern medicine as we know it", WHO claim

The world is entering an antibiotic crisis which could make routine operations impossible and a scratched knee potentially fatal, the head of the World Health Organisation has claimed.
Resistance is high and increasing and there are no new drugs.
exposition → selection → expansion

Susceptible population → resistant clones → spread

Use of antibiotics → Infection control
Once upon a time: It was simple
Classical model
Examples of How Antibiotic Resistance Spreads:

- Livestock
- Food
- Wastewater and environment
- Hospital and HCW

Treatment in the community

NH and Community after discharge

Simply using antibiotics creates resistance. These drugs should only be used to treat infections.
Increased prevalence of *Escherichia coli* strains from food carrying $bla_{NDM}$ and *mcr-1*-bearing plasmids that structurally resemble those of clinical strains, China, 2015 to 2017

**Xiaobo Liu**$^{1,2}$, **Shu Geng**$^2$, **Edward Wai-Chi Chan**$^{1,3}$, **Sheng Chen**$^{1,3}$

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**Correspondence:** Sheng Chen (sheng.chen@polyu.edu.hk)

Citation style for this article:


<table>
<thead>
<tr>
<th>Year</th>
<th>Number of food samples</th>
<th><em>mcr</em>-1-bearing <em>E. coli</em></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td><em>mcr</em>-1 positivity rate (%)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2015</td>
<td>747</td>
<td>98</td>
<td>25 (B)</td>
</tr>
<tr>
<td>2016</td>
<td>1,019</td>
<td>207</td>
<td>36 (C)</td>
</tr>
<tr>
<td>2017</td>
<td>371</td>
<td>97</td>
<td>46 (D)</td>
</tr>
<tr>
<td>Total</td>
<td>2,137</td>
<td>402</td>
<td>34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of food samples</th>
<th><em>bla&lt;sub&gt;NDM&lt;/sub&gt;</em>-bearing <em>E. coli</em>, with <em>bla&lt;sub&gt;NDM&lt;/sub&gt;</em> positivity rate (%)&lt;sup&gt;a&lt;/sup&gt;</th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>Total</td>
<td><em>bla&lt;sub&gt;NDM&lt;/sub&gt;</em> positivity rate (%)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2015</td>
<td>747</td>
<td>1</td>
<td>0.3 (E)</td>
</tr>
<tr>
<td>2016</td>
<td>1,019</td>
<td>5</td>
<td>1 (E)</td>
</tr>
<tr>
<td>2017</td>
<td>371</td>
<td>36</td>
<td>17 (F)</td>
</tr>
<tr>
<td>Total</td>
<td>2,137</td>
<td>42</td>
<td>4</td>
</tr>
</tbody>
</table>
One Health initiative
A unique situation for AMR: The Flemish/Dutch border
Antibiotic use in the community in Europe (DDD per 1000 inhabitants per day)

- **NL**: 10.4
- **EU**: 21.9
- **BE**: 27.6
“If you cannot measure it, you cannot improve it”

Lord Kelvin
1824-1907
How to create transparency?

• Develop uniform, objective and relevant measures
  • Infection control
  • Antibiotic use
  • Antibiotic resistance
The infection risk scan (IRIS): standardization and transparency in infection control and antimicrobial use

Ina Willemsen¹,²* and Jan Kuytmans¹,³
How to create transparency?

- Develop uniform, objective and relevant measures
  - Infection control
  - Antibiotic use
  - Antibiotic resistance
- Present the results in a way that is easy to understand for those who can act on it
  - ICP
  - Nurses, MD, cleaning
  - Administrators
ESBL-rectal carriage (%)  
Medical devices (%)  
Antimicrobial use (%)  
McCabe score (comorbidity)  

1 = transmission of ESBL⁸ (%)  
2 = inappropriate use of medical devices (%)  
3 = inappropriate use of antibiotics (%)  
4 = environmental contamination (score);  
5 = handhygiene non-compliance (%)  
6 = personal hygiene HCW⁸  
7 = preconditions infection control

#ESBL = Extended Spectrum Beta-Lactamase  
⁸HCW = Healthcare Worker

**Fig. 1** Example of the IRIS for hospitals. The left part of the figure shows the risk-profile, and the right part of the figure shows the improvement-plot.
Example: environmental contamination
How to measure cleanliness?
ATP measurement
ATP-measurements cut-off

<table>
<thead>
<tr>
<th>Category</th>
<th>RLU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>&lt;1000</td>
</tr>
<tr>
<td>Intermediate</td>
<td>≥1000 t/m &lt;3000</td>
</tr>
<tr>
<td>Dirty</td>
<td>≥3000 t/m &lt;10000</td>
</tr>
<tr>
<td>Extremely dirty</td>
<td>≥10000</td>
</tr>
</tbody>
</table>
aggregate ATP score for a ward (30 samples are taken)

Clean = 0
Intermediate = 1
Dirty = 2
Extremely dirty = 3

The scores of 30 surfaces or items are added to a ward score.

**Aggregate score**

0-4 points

5-12 points

>12 points
ATP for wards

60% are red
## Preliminary data: prevalence of AMR

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>ESBL %</th>
<th>CRE %</th>
<th>VRE %</th>
<th>Cipro R % (N = 160 (B) en 384 (NL))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Belgium</strong></td>
<td>616</td>
<td>13,3</td>
<td>0,7</td>
<td>1,8</td>
<td>34,4</td>
</tr>
<tr>
<td><strong>Netherlands</strong></td>
<td>852</td>
<td>7,6</td>
<td>0,4</td>
<td>0,2</td>
<td>12,0</td>
</tr>
<tr>
<td><strong>Prevalence Risk Ratio</strong></td>
<td>1,8</td>
<td>1,8</td>
<td>7,6</td>
<td>2,9</td>
<td></td>
</tr>
<tr>
<td><strong>95% CI</strong></td>
<td>1,3-2,4</td>
<td>0,4-8,2</td>
<td>1,7-34,1</td>
<td>2,0-4,2</td>
<td></td>
</tr>
</tbody>
</table>
Prevalence of AB use

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>% with ≥ 1 AB</th>
<th>% with ≥ 2 AB</th>
<th>% with 3 AB</th>
</tr>
</thead>
<tbody>
<tr>
<td>België</td>
<td>622</td>
<td>41,6</td>
<td>11,7</td>
<td>3,1</td>
</tr>
<tr>
<td>Nederland</td>
<td>682</td>
<td>45,3</td>
<td>12,0</td>
<td>2,3</td>
</tr>
</tbody>
</table>

Large variations were observed between individual hospitals and wards: e.g. Cardiology 13,8% up to pulmonary diseases 78,8%
Reason for AMT and stop/review date recorded in patient record

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Indication for AB in medical record</th>
<th>Stop/review date in medical record</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>258</td>
<td>88,4 %</td>
<td>79,1%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>308</td>
<td>86,4%</td>
<td>51,3%</td>
</tr>
</tbody>
</table>
Is AMT indicated and according to local guideline?

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>According to guideline</th>
<th>Indication for AB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>321</td>
<td>80,4 %</td>
<td>92,6%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>377</td>
<td>80,9%</td>
<td>92,0%</td>
</tr>
</tbody>
</table>
Preliminary data: Top 5 antibiotics (approximately 2/3 of all antibiotic prescriptions)

<table>
<thead>
<tr>
<th></th>
<th>Belgium</th>
<th>Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Piperacillin-tazobactam (27%)</td>
<td>Amoxicillin-clavulanic acid (19%)</td>
</tr>
<tr>
<td>2</td>
<td>Vancomycin (15%)</td>
<td>Cefuroxim (17%)</td>
</tr>
<tr>
<td>3</td>
<td>Amoxicillin-clavulanic acid (9%)</td>
<td>Flucloxacillin (10%)</td>
</tr>
<tr>
<td>4</td>
<td>Ciprofloxacin (8%)</td>
<td>Ciprofloxacin (10%)</td>
</tr>
<tr>
<td>5</td>
<td>Meropenem (6%)</td>
<td>Amoxicillin (9%)</td>
</tr>
</tbody>
</table>
Conclusions

- Resistance is more prevalent in patients in Belgian Hospitals than in Dutch hospitals
- Belgian Hospitals are cleaner
- The prevalence of antibiotic use in hospitals in Belgium and The Netherlands is comparable
- The kind of antibiotics used are different
Infection Risc Scan (IRIS) in a One Health Approach
Number of samples cultured for antimicrobial resistance

**preliminary data**

![Bar graph showing the number of samples cultured for antimicrobial resistance across different categories: Hospital, Nursing home, Day care, Pigs, Broilers.](image-url)
Antimicrobial resistance (phenotypic)
preliminary data
Goals

• Use coaching to help farmers reduce their antimicrobial usage (AMU)
• Link AMU and antimicrobial resistance (AMR)
Selection of farms with relatively high AMU

30 broiler farms
30 pig farms
Biosecurity and health management
Collecting Fecal samples
ESBL-PE (sampling 1)

Belgium

The Netherlands
ESBL-genes detected in *E. coli* from broilers (n=45) & pigs (n=35)
wgMLST ESBL-PE from broilers en pigs

Poster 0456 de Koster et al.
Conclusions

• Belgian farms have higher antibiotic use and higher rates of resistance than Dutch farms
• Poultry has higher rates of resistance than pig farms
• ESBL genes are more diverse in pig farms
• Poultry farms share similar strains (pyramidal system)
• In some poultry and pig farms no resistant strains were found
Extended-Spectrum β-Lactamase–Producing Escherichia coli From Retail Chicken Meat and Humans: Comparison of Strains, Plasmids, Resistance Genes, and Virulence Factors

Jan A. J. W. Kluytmans,1,2,3 Ilse T. M. A. Overdevest,1,2 Ina Willemsen,1 Marjolein F. O. Kluytmans-van den Bergh,1 Kim van der Zwaluw,4 Max Heck,5 Martine Rijnsburger,3 Christina M. J. E. Vandenbroucke-Grauls,3 Paul H. M. Savelkoul,3 Brian D. Johnston,5 David Gordon,6 and James R. Johnson5

1Laboratory for Medical Microbiology and Infection Control, Amphia Hospital, Breda, 2Laboratory for Medical Microbiology and Immunology, St Elisabeth Hospital, Tilburg, 3Laboratory for Medical Microbiology and Infection Control, VU University Medical Centre, Amsterdam, and 4National Institute for Public Health and the Environment, RIVM, Bilthoven, The Netherlands; 5Veterans Affairs Medical Center, University of Minnesota, Minneapolis; and 6The Australian National University, Canberra
Figure 1. Distribution of extended-spectrum β-lactamase genes in chicken meat (A), human rectal swabs (B), and human blood cultures (C), the Netherlands. Values in parentheses are no. positive.
Figure ABuse01  Antimicrobial veterinary medicinal product sales 1999-2016 in kg (thousands)
ESBL in poultry meat from supermarkets

% ESBL

- 2009
- 2013
- 2015
RESEARCH ARTICLE

Trends in Extended Spectrum Beta-Lactamase (ESBL) Producing Enterobacteriaceae and ESBL Genes in a Dutch Teaching Hospital, Measured in 5 Yearly Point Prevalence Surveys (2010-2014)

Ina Willemsen¹*, Stijn Oome¹, Carlo Verhulst¹, Annika Pettersson², Kees Verduin³, Jan Kluytmans¹,²,³

1 Laboratory for Microbiology and Infection Control, Amphia Hospital, Breda, The Netherlands,
2 Department of Medical Microbiology and Infection Control, VU University Medical Center, Amsterdam, The Netherlands,
3 Julius Center for Health Sciences and Primary Care, UMC Utrecht, Utrecht, the Netherlands
Table 1. ESBL prevalence over time, including bacterial species and ESBL genes.

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitalised patients (incl. day-care), No.</td>
<td>667</td>
<td>642</td>
<td>598</td>
<td>601</td>
<td>652</td>
<td>3160</td>
</tr>
<tr>
<td>No perianal swab taken, No.</td>
<td>108</td>
<td>72</td>
<td>88</td>
<td>85</td>
<td>83</td>
<td>436</td>
</tr>
<tr>
<td>Negative growth control, No.</td>
<td>n.a.</td>
<td>6</td>
<td>3</td>
<td>8</td>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td>Evaluable cultures (patients), No.</td>
<td>559</td>
<td>564</td>
<td>507</td>
<td>508</td>
<td>557</td>
<td>2695</td>
</tr>
<tr>
<td>prevalence ESBL-E carriage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESBL positive patients, No. (%) A</td>
<td>25 (4.5%)</td>
<td>27 (4.8%)</td>
<td>20 (3.9%)</td>
<td>26 (5.1%)</td>
<td>37 (6.6%)</td>
<td>135 (5.0%)</td>
</tr>
</tbody>
</table>

Fig 3. Proportion of CTX-M-1 like ESBL genes over time. The vertical bars represent the percentage of CTX-M-1 like ESBL genes divided by the total number of ESBL genes. The line represents the logarithmic trendline.
ESBL genes in E. coli from blood cultures

2008-2009

2014-2016
The distribution of ESBL genes shows strong changes over time

Major effects on the prevalence of resistance in livestock can be achieved if concerted actions are taken

Reliable, objective and meaningful measurements are the basis for change

Simple and clear reports are needed for feedback to those that can affect the outcome
General conclusions

• The AMR sea level is rising
• Our feet are still dry but the dikes have to be raised
  • Transparency (objective and easy to understand)
  • Innovation (App’s, NGS)
  • Regional and trans-sectoral collaboration
  • Learn from differences
Thank you