GLOBAL TRENDS IN ANTIMICROBIAL USE IN FOOD ANIMALS

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I have **never** worked at an NGO, or in industry

I have **not** received funding from industry

I have **not** received payment for this talk

...  

I am **not** ... **vegetarian**
Animal Production Intensification

Extensive Production

Intensive Production

mechanization
breeds
concentration
Drugs
More than 73% of all antimicrobials sold in the world are used in animals.

2. GLOBAL TRENDS CONSUMPTION

some more bad news.
Objectives


2. Project the trends for future consumption of antimicrobials in 2030 (if not actions are taken)
Modelling assumptions

SALES
38 OECD Countries

Projected Meat Consumption
2010 → 2030

TOTAL (Kg)

Extensive
Intensive

Robinson & Pozzi, 2011
Consumption in food animals

PRIORS: Literature search

\[ Ab \text{ (mg)} = \alpha_{Ca} \cdot \text{KgCattle}_{\text{Int}} + \alpha_{Ch} \cdot \text{KgChickens}_{\text{Int}} + \alpha_{Pg} \cdot \text{KgPigs}_{\text{Int}} \]

POSTERIORS: Estimation in Bayesian framework

Van Boeckel et al, PNAS 2015
Global Antimicrobials consumption in livestock

GIS Layer: livestock.geo-wiki.org/

Van Boeckel et al, PNAS 2015
An alarming revision

3. WHAT CAN WE DO TO REDUCE RESISTANCE?

Global policy agenda, and solutions.
“AMR is one of the **most urgent global risk**, requiring increased attention and coherence at the international level”

- Animal play a role
- Country-level surveillance
- Re-evaluate, 18th of Sept 2018
- Targets for reduction
Global targets for reduction

- **Target 1: Regulations**
  - 1A: Cap 50mg/PCU
  - 1B: OECD+China cap 50mg/PCU

- **Target 2: Meat reduction**
  - 2A: Cap 40g/day
  - 2B: Meat growth mitigation and Cap 165g/day

- **Target 3: User fee**
  - 3A
  - 3B
  - 3C
  - 3D
  - 3E

- **Revenues from user fee (10 US$ Billion)**

Global distribution of antimicrobial resistance from 821 points prevalence surveys

Van Boeckel, do Couto Pires, et al, in prep
Thank You

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Center for Disease Dynamics, Economics & Policy
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Swiss Federal Institute of Technology Zurich
Joao do Couto Pires, Sebastian Bonhoeffer

Department of Ecology and Evolutionary Biology
Bryan Grenfell, Simon Levin, Aude Teillant, Dora Chen

Food and Agriculture Organization of the UN
Tim Robinson
QUESTIONS
ANIMALS
Putting things in perspective
Meat consumption (FAOSTAT 2016)

10g / day
190g / day
260g / day
Shifting to intensive production (2010-2030)

In each country, the proportion of animals raised extensively is correlated with GDP per capita.

- **2010**
  - log GDP per capita: c. $2.9
  - % extensive: c. 83%

- **2030**
  - log GDP per capita: c. $3.8
  - % extensive: c. 18%

From World Bank data

Aquaculture

“I’m searching for my keys.”

The streetlight effect is a type of observational bias where people only look for whatever they are searching by looking where it is easiest.

Salmon
Limitations

**SALES**
38 OECD Countries

**Extrapolation**
220 Countries

The good examples
Since 2013...

Antimicrobial Consumption ≠ Burden of livestock-associated resistant Infections
Food expenditures by families and individuals as a share of disposable personal money income in the U.S.

USDA Economics Research Service
Food Products


Table 3 Antimicrobial resistance profiles among *E. coli* isolated in retail chicken meat (n = 156)

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Frequency of resistant isolates</th>
</tr>
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<tbody>
<tr>
<td>AMC</td>
<td>4.0%</td>
</tr>
<tr>
<td>EKT</td>
<td>77.0%</td>
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<tr>
<td>TE</td>
<td>94.0%</td>
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<tr>
<td>AMP</td>
<td>53.0%</td>
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<tr>
<td>CIP</td>
<td>7.0%</td>
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<tr>
<td>CAZ</td>
<td>0.4%</td>
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<tr>
<td>K</td>
<td>8.5%</td>
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<tr>
<td>S</td>
<td>47.0%</td>
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<tr>
<td>CRO</td>
<td>18.0%</td>
</tr>
<tr>
<td>CN</td>
<td>1.0%</td>
</tr>
<tr>
<td>NA</td>
<td>23.0%</td>
</tr>
<tr>
<td>TET</td>
<td>28.5%</td>
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<tr>
<td>TRI</td>
<td>17.0%</td>
</tr>
<tr>
<td>CAZ</td>
<td>13.0%</td>
</tr>
</tbody>
</table>

Log10 [(mg/pixel)+1]

- 0 - 1
- 0 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- 9 - 10
- 10 - 11

Switzerland

Vietnam

Multi-Resistance

Kenya

Thailand

Colombia
Easy target: growth promoters

The Economic Costs of Withdrawing Antimicrobial Growth Promoters from the Livestock Sector. Ramanan Laxminarayan, Thomas Van Boeckel, Aude Teillant. 2015

- 1.3 - 3% (Global Meat Production US$)

Economics of Antibiotic Use in U.S. Livestock Production. Sneeringer et al. 2015

- 1 - 3% (U.S. Market level)
Easy target: growth promoters

EU: Ban on antimicrobial used as growth promoters in 2006.


China. April 2018, statement from the Director of Veterinary Bureau of the Ministry of Agriculture and Rural Affairs “Drugs Used as In-Feed Additives Will Be Totally Withdrawn By 2020”.

Teillant, Van Boeckel et al 2015. OECD Report
National Agenda - Netherlands

Figure 1. Antimicrobial veterinary medicinal product sales from 1999-2014 in kg (thousands; excluding use of AGPs in the years 1999-2005)

Source: Netherlands Veterinary Medicines Authority (SDa)
HUMANS
Scientific consensus?

1. What is the share of human AMR attributable to animals? **Impossible to say.**

2. Most public health scientists and WHO recommend **reducing** overall antimicrobial use and **prophylactic** use in animals.

3. Most public health scientists and WHO recommend **growth promoters** should be phased out.

WHO guidelines on use of medically important antimicrobials in food-producing animals 2017, Tang et al 2017.
We just need new antibiotics!

Sure but...

1960

2016
Economic incentive for conservation...

R&D costs for a new antibiotic is estimated to be 1-2 billions.
Demonstrating the obvious?

Yes, but...

**Crude infectious disease mortality rate in the U.S (100,000)**

- 40 states have health departments
- 1918 Influenza pandemic
- Use of chlorine in drinking water
- First use of penicillin

**Shortcut in medical history**

Laxminarayan et al, 2007. *Extending the Cure*
Figure 1. Ranked national antibiotic consumption, defined daily doses per 1,000 inhabitants per day (DDDs per 1,000 inhabitants per day), in (A) 2000 and (B) 2015. Each bar represents the antibiotic consumption rate (DDDs per 1,000 inhabitants per day) in a single country in the specified year. The dashed lines connect countries consumption rates between 2000 and 2015 for the LMIC countries with the largest increases in the antibiotic consumption rate. Source: QuintilesIMS MIDAS, 2000–2015, QuintilesIMS Inc. All rights reserved. Klein et al 2018 (in review)
Figure 2. Global antibiotic consumption by country income classification, 2000–2015. Panel A shows average per capita antibiotic consumption in defined daily doses (DDDs) per 1,000 inhabitants per day by income group. Panel B shows total antibiotic consumption (DDDs) by income group. The three leading consumers in each income group in 2015 are shown separately; each bar shows total consumption in the specified year for that country or group of countries. Source: QuintilesIMS MIDAS, 2000–2015, QuintilesIMS Inc. All rights reserved.
Legislation on antibiotics as growth promoters

\[ PCU_{k,s} = An_{k,s} \cdot (1 + n_{k,s}) \cdot \left( \frac{Y_k}{R_{CW, k}} \right) \]

where \( An_k \) is the number of living animals, \( n_{k,s} \) is the number of production cycles in each production system (extensive or intensive), \( Y \) is the quantity of meat per animal (carcass weight) obtained for each country from FAOSTAT, and \( R_{CW, LW} \) is the killing-out percentage (or dressing percentage)—that is, the ratio of carcass weight to live weight —obtained from literature estimates\(^{73}\). The last term of this equation can be interpreted as the animal weight reconstructed from country-specific productivity figures.
Figure 1
How Usage Overlaps for Antibiotics in Food Animals
Gaps in FDA’s policy to reduce antibiotic misuse may allow some injudicious practices to persist

- 12% 34 products withdrawn entirely
- 9% 26 prevention labels that “maintain weight gain” in the presence of an ambiguous condition
- 23% 66 labels with fully overlapping growth promotion and prevention dosages and no duration limits
- 50% 144 labels with no overlapping growth promotion and prevention dosages
- 29% 83 labels with overlapping growth promotion and prevention dosages
- 5% 13 labels with fully overlapping growth promotion and prevention dosages, but with duration limits
- 1% 4 labels with partially overlapping dosages
About one-quarter of medically important antibiotics (66 of 287) can be used in at least one species for disease prevention at levels fully within the range of growth promotion dosages and with no limit on the duration of treatment. FDA classifies 29 of these 66 antibiotics as critically important in human medicine, and 37 as highly important.

Note: These data reflect FDA’s decision to classify several label indications as preventive rather than for growth promotion, such as: “Use for aid in the maintenance of weight gains in the presence of respiratory disease such as shipping fever.” Despite their reference to weight gain, such labels, which have no growth promotion indications as FDA defines them, are not counted among the 83 labels that overlap.


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