Associations between biosecurity, herd characteristics, production parameters and antimicrobial usage in pig production in four EU countries

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MINAPIG consortium – www.minapig.eu
While viruses may capture more headlines, arguably the greatest risk of hubris to human health comes in the form of antibiotic-resistant bacteria. We live in a bacterial world where we will never be able to stay ahead of the mutation curve. A test of our resilience is how far behind the curve we allow ourselves to fall.
Linking antimicrobial use to antimicrobial resistance in 7 EU countries based on surveillance data

(a) Aminopenicillins (ampicillin)
\[ y = -0.0002x^2 + 0.0255x - 0.0707 \]
\[ R^2 = 0.93 \]

(b) Third generation Cephalosporins (cefotaxime)
\[ y = 0.6887x^2 - 0.1812x + 0.0135 \]
\[ R^2 = 0.94 \]

(c) Fluoroquinolons (ciprofloxacin)
\[ y = 1.1278x^2 - 0.2875x + 0.0221 \]
\[ R^2 = 0.99 \]

(d) Amphenicols (chloramphenicol)
\[ y = 0.1313x^2 + 0.1234x - 0.0112 \]
\[ R^2 = 0.99 \]

(e) Aminoglycosids (gentamicin)
\[ y = -0.0021x^2 + 0.0241x - 0.0188 \]
\[ R^2 = 0.80 \]

(f) Aminoglycosids (streptomycin)
\[ y = -0.0149x^2 + 0.1752x + 0.0057 \]
\[ R^2 = 0.81 \]

Chantziaras et al., 2014
Linking antimicrobial use to antimicrobial resistance in 7 EU countries based on surveillance data

Chantziaras et al., 2014
Alternatives to the use of antimicrobial agents in pig production: A multi-country expert-ranking of perceived effectiveness, feasibility and return on investment

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Of the 120 experts that responded, 111 rankings were used for further analysis (Belgium n = 24, Denmark n = 30, France n = 8, Germany n = 17, Sweden n = 23, Switzerland n = 9)
<table>
<thead>
<tr>
<th>Perceived alternatives (Vets)</th>
<th>Average of effectiveness, feasibility, ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Internal biosecurity</td>
<td>7.5</td>
</tr>
<tr>
<td>Increased vaccination</td>
<td>7.2</td>
</tr>
<tr>
<td>Zinc/metals</td>
<td>7.2</td>
</tr>
<tr>
<td>Feed quality/optimisation</td>
<td>7.2</td>
</tr>
<tr>
<td>Diagnostics/action plan</td>
<td>7.0</td>
</tr>
<tr>
<td>External biosecurity</td>
<td>7.0</td>
</tr>
<tr>
<td>Climate/environmental</td>
<td>7.0</td>
</tr>
<tr>
<td>Communication/unified advice</td>
<td>6.6</td>
</tr>
<tr>
<td>Water quality</td>
<td>6.5</td>
</tr>
<tr>
<td>Age and transfer management</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Postma et al., 2015
Aim

- Study the relationship between Biosecurity, Management / production, Antimicrobial use, Country, and Herd Characteristics.
Study design

• Multi country:
  – Belgium = 47
  – France = 60
  – Germany = 60
  – Sweden = 60

• All herds ≥ 100 sows, 500 finishers
• Intention for representativeness / depending on willingness to cooperate
• Study performed between Dec. 2012 – Dec. 2013
Study design

• All herds visited by researcher or trained veterinarian

• Dedicated herd visit with data collection on
  – General health and production characteristics (preceding year)
  – Herd characteristics
  – Biosecurity
  – Antimicrobial usage (preceding year)
Study design

- General health and production characteristics
  - Weaned piglets per sow per year (WSY)
  - Mortalities
  - ADG
  - Feed conversion rate (FCR)
- Herd characteristics
  - Age / experience farmer
  - Gender
  - Farrowing rhythm
  - Weaning age
  - ....
• Biosecurity

  – Assessed by means of validated risk-based biosecurity scoring system: Biocheck.ugent
  – 109 questions
  – Provides a score for internal and external biosecurity
Results: Biosecurity status

Green = Internal biosecurity
Blue = External biosecurity
Results: Biosecurity status

Postma et al., 2016
Study design

• Antimicrobial use

\[ TI = \frac{\text{Total amount of antimicrobials administered (mg)}}{\text{DDDA (mg/kg) x number of days at risk x kg animal at risk}} \times 1000 \text{ pigs at risk} \]

- TI calculated per age category and for entire production period (200 days)

- \( TI_{200} = 150 \): meaning that over the full production length a pig is treated for 15 % (=150/1000) of its lifetime
Results: AMU
Results: AMU

Graph showing data for Belgium, France, Germany, and Sweden with comparison across different categories.
<table>
<thead>
<tr>
<th>Antimicrobial class</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Belgium</td>
</tr>
<tr>
<td>Aminoglycosides</td>
<td>0.0%</td>
</tr>
<tr>
<td>Aminopenicillins</td>
<td>37.7%</td>
</tr>
<tr>
<td>Amphenicols</td>
<td>0.1%</td>
</tr>
<tr>
<td>Benzylpenicillin</td>
<td>0.4%</td>
</tr>
<tr>
<td>Benzylpenicillin in combination</td>
<td>&lt;0.0%</td>
</tr>
<tr>
<td>3rd &amp; 4th generation Cefalosporins</td>
<td>10.8%</td>
</tr>
<tr>
<td>Fluoroquinolones</td>
<td>5.3%</td>
</tr>
<tr>
<td>Macrolides</td>
<td>14.7%</td>
</tr>
<tr>
<td>Macrolides in combination</td>
<td>1.6%</td>
</tr>
<tr>
<td>Polymixins</td>
<td>17.5%</td>
</tr>
<tr>
<td>Sulfonamides and trimethoprim</td>
<td>5.1%</td>
</tr>
<tr>
<td>Tetracyclines</td>
<td>6.8%</td>
</tr>
<tr>
<td>Tiamulin</td>
<td>0.1%</td>
</tr>
<tr>
<td>Valnemulin</td>
<td>0*</td>
</tr>
</tbody>
</table>
Results: AMU

Country
- Belgium
- France
- Germany
- Sweden
- Belgium
- France
- Germany
- Sweden

Belgium $R^2$ Linear = 0.625
France $R^2$ Linear = 0.033
Germany $R^2$ Linear = 0.037
Sweden $R^2$ Linear = 0.095

Belgium $R^2$ Linear = 0.040
France $R^2$ Linear = 0.004
Germany $R^2$ Linear = 0.159
Sweden $R^2$ Linear = 0.099

Belgium $R^2$ Linear = 0.008
France $R^2$ Linear = 0.082
Germany $R^2$ Linear = 0.053
Sweden $R^2$ Linear = 0.107

Belgium $R^2$ Linear = 0.006
France $R^2$ Linear = 0.003
Germany $R^2$ Linear = 0.514
Sweden $R^2$ Linear = 0.004
Results: Associations

Belgium, France, Germany, Sweden

W/S/Y

Higher TI Breeding
p < 0.01; b = -0.096

Higher WYS
p < 0.05

LOG TI Breeding

HIGHER TI BREEDING
P < 0.01; B = 0.310

LOG TI 200 days

HIGHER TI BREEDING
P < 0.01; B = 0.310

LONGER FARROWING RHYTHM
LOWER TI 200
p < 0.01

FARROWING RHYTHM

HIGHER WEANING AGE
LOWER TI 200
P = 0.06; B = -0.048

WEANING AGE

HIGHER EXTERNAL
LOWER TI 200
P < 0.01; B = -0.024

HIGHER TI BREEDING
P < 0.01; B = -0.096

EXTERNAL BIOSECURITY

HIGHER TI 200
P < 0.01; B = 0.139

PATHOGENS VACCINATED

MORE VACCINATION

14/06/2017
Results: Top farmers
Results: Top farmers

– On average higher internal biosecurity status.
– Located in a more favorable environment (lower pig density and limited contact with wildlife).
– Treated less frequently against respiratory clinical symptoms in weaners and finishers.
Substantial reduction antimicrobial usage without jeopardizing production by coaching?
61 Flemish herds

3 Herd visits

Intervention & follow up
Coaching
<table>
<thead>
<tr>
<th>Biosecurity &amp; Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Registration symptoms &amp; moment mortality for analysis</strong></td>
</tr>
<tr>
<td><strong>Hand hygiene, change coverall and clean boots</strong></td>
</tr>
<tr>
<td><strong>Change needles often</strong></td>
</tr>
<tr>
<td><strong>Hygiene lock per animal/age category</strong></td>
</tr>
<tr>
<td><strong>Use strict euthanasia policy</strong></td>
</tr>
<tr>
<td><strong>Wash sow before farrowing crate</strong></td>
</tr>
<tr>
<td><strong>Analysis drink water 1x/year well/pipes</strong></td>
</tr>
<tr>
<td><strong>Keep dog/cat out of the stable</strong></td>
</tr>
<tr>
<td><strong>AI / AO, do not return to younger age group</strong></td>
</tr>
<tr>
<td><strong>Use dirty road for transport of manure</strong></td>
</tr>
<tr>
<td><strong>Change wooden boards for plastic boards</strong></td>
</tr>
</tbody>
</table>
## Diagnostics & vaccination

<table>
<thead>
<tr>
<th>Request slaughter findings for analysis</th>
<th>% ADVISED</th>
<th>% FEASIBLE</th>
<th>% IMPLEMENTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>59</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Additional vaccinations in general</td>
<td>51</td>
<td>94</td>
<td>81</td>
</tr>
<tr>
<td>Additional specific vaccinations: PCV2</td>
<td>16</td>
<td>100</td>
<td>62</td>
</tr>
<tr>
<td>Check serology titres in general</td>
<td>33</td>
<td>95</td>
<td>90</td>
</tr>
<tr>
<td>Adjustment of vaccination scheme: Atrofic rhinitis</td>
<td>8</td>
<td>100</td>
<td>80</td>
</tr>
</tbody>
</table>
## Prudent antimicrobial usage

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>% Advised</th>
<th>% Feasible</th>
<th>% Implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restrictive use of potent AM</td>
<td>92</td>
<td>72</td>
<td>45</td>
</tr>
<tr>
<td>Stop (routine) prophylactic treatment birth until slaughter</td>
<td>88</td>
<td>69</td>
<td>59</td>
</tr>
<tr>
<td>Stop prophylactic treatment in sows</td>
<td>24</td>
<td>90</td>
<td>83</td>
</tr>
<tr>
<td>Ask for resistance profile/sensitivity testing</td>
<td>7</td>
<td>79</td>
<td>0</td>
</tr>
</tbody>
</table>
Herd specific advice
- 45.8%

- 52.0%

- 31.7%

- 81.6%

Treatment incidence

Piglets

Finishers

Birth-slaughter 205 days

Sows

Average TI DDDA routine visit 1

Average TI DDDA curative visit 1

Average TI DDDA routine visit 3

Average TI DDDA curative visit 3
## Production parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Visit</th>
<th>Mean</th>
<th>Difference</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of weaned piglets per sow per year</td>
<td>Initial</td>
<td>26.4</td>
<td>+1.1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Follow up</td>
<td>27.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily weight gain (g/day) finishers</td>
<td>Initial</td>
<td>667.5</td>
<td>+7.7</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>Follow up</td>
<td>675.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality in finisher period (%)</td>
<td>Initial</td>
<td>3.2</td>
<td>-0.6</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>Follow up</td>
<td>2.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Net benefit

€ 42,99 per sow/year

€ 2,67 per finisher/year

(Rojo-Gimeno C. and Postma M. et al., 2016)
Coaching of farmers & team work

52% Reduction AMU possible

Important reduction critically important antimicrobials

Improved technical results & economically beneficial
Prospective intervention study to explore measures to reduce antimicrobial usage in pig production
• Multi country: Belgium; France; Germany; Sweden
• Interventions
  • Improved internal / external biosecurity
  • Vaccination
  • Changes water / feed schemes
  • Herd management
Across the 4 countries
Median $T_{1200d}$ before: 247.3
Median $T_{1200d}$ after: 160.2
$P < 0.001$ ***

-35.2%
Intervention study

- Herds with high usage can reduce more
- No single intervention can be recommended for all herds
Assigning defined daily doses animal: a European multi-country experience for antimicrobial products authorized for usage in pigs

Merel Postma1, Marie Sjölund2, Lucie Collineau3, Svenja Löskens4, Katharina D. C. Stärk4 and Jeroen Dewulf1 on behalf of the MINAPIG consortium

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The biosecurity status and its associations with production and management characteristics in farrow-to-finish pig herds

M. Postma4, A. Backhans3, L. Collineau4, S. Loesken6, M. Sjölund2, C. Belloc1, U. Emanuelson5, E. Grosse Beilage1, K. D. C. Stärk4 and J. Dewulf1 on behalf of the MINAPIG consortium

Evaluation of the relationship between the biosecurity status, production parameters, herd characteristics and antimicrobial usage in farrow-to-finish pig production in four EU countries

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Opinions of veterinarians on antimicrobial use in farm animals in Flanders and the Netherlands

M. Postma, DVM, PhD1, D. C. Speksnijder, DVM2, A. D. C. Jaarsma, DVM, PhD4, T. J. M. Verheij, MD, PhD5, J. A. Wagenaar, DVM, PhD, DipECVPH4 and J. J. Dewulf, DVM, PhD, DipECVPH1

Farm-economic analysis of reducing antimicrobial use whilst adopting improved management strategies on farrow-to-finish pig farms

Cristina Rojo-Gilmeño6, 1, 5, 6, 7, 8, Merel Postma1, Jeroen Dewulf1, Henk Hogeveen1, Ludwig Lauwers5, 6, Erwin Wauters5, 8

Reducing Antimicrobial Usage in Pig Production without Jeopardizing Production Parameters

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For reduced antimicrobial use

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