Effect of antimicrobial use on the resistance of *Escherichia coli* in faecal flora of pigs


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Abstract

The antimicrobial use in veterinary medicine is of concern because of possible transmission of resistant bacteria to humans. However the relation between use and occurrence of resistance is poorly documented in the field. Sixteen farrow-to-finish herds were selected and classified on the frequency of antimicrobial administrations (low (LU), medium (MU) and high (HU) users). Indicative *Escherichia coli* strains were isolated from faeces of sows (5 per herd) and young pigs (3 per sow) at several times during animals’ life and tested for resistance to amoxicillin, gentamicin, trimethoprim-sulfamids and tetracyclin. The percentages of resistant strains were compared between herd groups.

The frequency of resistant strains was higher during the lactating and post-weaning periods for sows and young pigs respectively. The level of antimicrobial use was associated with the percentage of resistance although variations were observed depending on antimicrobials. Tetracyclin resistance was very frequent: from 63 to 93.2% in sows and from 65.8 to 99% in young pigs. Similar kinetic although lower frequencies were obtained with trimethoprim-sulfamids: from 37.4 to 74% in sows and from 32.7 to 84.6% in pigs. On the other hand amoxicillin resistance was lower and highly variable depending on the sampling time: from 15.5 to 59% in sows and from 7 to 70.3% in pigs. Lowest frequency values were observed for gentamicin with up to 19.3 and 25.3% in sows and pigs respectively.

Although we demonstrated that low antimicrobial use is associated with less frequent resistance in faecal *E. coli*, both antimicrobial family and administration scheme have to be taken into account when considering the influence of treatments.

Introduction

The antimicrobial use in veterinary medicine is a major concern because of possible selection and transmission to humans of resistant bacteria. However the relation between use and the occurrence of resistance is poorly documented in the field. Such data could thus help to identify treatment schemes associated with less frequent resistant strains.

In swine production the antimicrobial use is rather standardized between herds since major part of the administrations occur during the lactation period for sows and the post-weaning period for piglets. Methods for the quantification of antimicrobial use have been developed in human medicine but are not available for treatments administered to food animals (Chauvin, 2001).

For this study we selected farrow-to-finish commercial herds in which antimicrobial use was representative of the French swine production. Occurrence of resistance was monitored by faecal sampling several times during sows’ and pigs’ life. Indicative *Escherichia coli* strains were isolated from faecal content and tested for antimicrobial susceptibility.

Materials and Methods

Sixteen herds located in west of France were selected and classified depending on the number of systematic collective antimicrobial treatments administered to sows and pigs. In each herd five sows and three piglets per sow were selected and piglets were ear tagged. Faecal samples were collected from sows before farrowing (D0) and then 7, 30 and 60 days after farrowing. Piglets were sampled once during the lactating period (D7), twice during the post weaning period (D30 and D60) and at the end of the fattening period (D150). After plating of faeces on selective medium, four *E. coli* strains were selected per faecal sample and tested for antimicrobial susceptibility using
the standard disk diffusion method. Tested antimicrobials were the following: amoxicillin, gentamicin, trimethoprim-sulfamid and tetracyclin. Herds were scored (s) depending on both the number of antimicrobials used (x) and the number of administrations of each antimicrobial (n) with s=\(\sum n_x\). Depending on the s value herds were classified as low users (LU) if s\leq2, medium users (MU) if it was equal to 3 or 4 or high users (HU) if s\geq4. Statistical analysis was carried out to compare percentages of resistant strains in the groups (LU, MU and HU) using logistic regression (macro GLIMMIX, SAS Institute Inc, 1999) with p<0.05.

## Results

### Tetracyclin

<table>
<thead>
<tr>
<th>Sows</th>
<th>Amoxicillin</th>
<th>Pigs</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>D0</td>
<td>D7</td>
</tr>
<tr>
<td>PU</td>
<td>15.5</td>
<td>24.3</td>
</tr>
<tr>
<td>MU</td>
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<td>58.9</td>
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<td>33.9</td>
</tr>
<tr>
<td>p</td>
<td>0.01</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

### Gentamicin

<table>
<thead>
<tr>
<th>Sows</th>
<th>Gentamicin</th>
<th>Pigs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D0</td>
<td>D7</td>
</tr>
<tr>
<td>PU</td>
<td>32.2</td>
<td>49.3</td>
</tr>
<tr>
<td>MU</td>
<td>65.4</td>
<td>68.5</td>
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<tr>
<td>HU</td>
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<td>0.06</td>
</tr>
<tr>
<td>p</td>
<td>0.006</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Table 1 Percentage of antimicrobial resistant strains in sows and young pigs at different sampling times

The number of herds classified as LU, MU and HU were six, four and six respectively.

Antimicrobial susceptibility results were available for 1200 strains from sows and 3099 strains from young pigs and resistance levels at the different sampling times are presented in Table 1.

In sows the percentage of amoxicillin resistant strains varied from 15.5% (LU herds at D0) to 58.9% (MU, D7) and tended to increase when sows were in the farrowing unit and to decrease thereafter. In young pigs it ranged from 7% (LU, D150) to 70.3% (MU, D60) with maximal resistance during the post-weaning period. The effect of level of antimicrobial use was always statistically significant. Tetracyclin resistance levels were high (from 63% to 93.2% in sows and from 65.8% to 99% in young pigs) with a significant effect of the level of antimicrobial use except for sows at D30. Trimethoprim-sulfamid resistance was also frequent with values ranging from 37.4% (PU, D30) to 74% (MU, D60) in sows and from 32.7% (LU, D7) to 84.6% (MU, D60) in pigs. Statistically significant differences were constantly observed for pigs and for sows at D30 and D60. Gentamicin resistance was less frequently observed. Highest percentages were 19.3% at D30 and 25.3% at D60 for HU herds in sows and pigs respectively. The difference was statistically significant except for the following sampling times: sows at D60 and for pigs at D150.

For some antimicrobials the relationship between antimicrobial use and resistance was not linear between groups of herds. Indeed at some sampling times the percentages were higher in herds with lower antimicrobial use (for example amoxicillin resistance in sows at D0).

### Discussion

Our results describe the kinetic evolution of antimicrobial resistance during sows' production cycle and pigs' life. In sows whatever the level of antimicrobial use the highest percentages of resistant strains were observed during the lactating period (D7 and D30) and decreased thereafter. In pigs the highest values were found during the post-weaning period (D30 and D60) and were lower at the end of the fattening period (D150). These differences between sampling times were more noticeable for antimicrobials with less frequent occurrence of resistant strains such as amoxicillin and gentamicin. These periods are those during which antimicrobial administrations occur most
frequently in the field. However previous studies have shown that other factors such as farrowing or weaning stress can induce the occurrence of resistance (Moro et al, 2000).

Levels of resistance observed were different depending on the antimicrobial. Tetracyclin resistance was very common as demonstrated previously by others even in herds that did not use this antimicrobial class (Dunlop et al, 1998).

In our study the level of antimicrobial use estimated using a score value was frequently associated with the percentage of antimicrobial resistant E.coli in the faecal content of pigs since in most cases the low user herds exhibited the lowest levels of resistance. However some discrepancies were noticed. For example amoxicillin resistance in young pigs at D7 and D60 was higher for the MU group than for the HU one. This is probably due to the fact that using our scoring method, beta-lactam using herds were included in both the MU and the HU groups. Consequently the resulting amoxicillin resistant strains were observed independently of the use of other antimicrobials.

Our scoring method did not take into account several parameters such as administration moment in animal’s life, duration or route of administration. However it consisted in a rapid and easy approach of antimicrobial use. These observations emphasize the need for further studies on the association between antimicrobial use and resistance.

References
