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Antibiotic resistance in E. coli from pigs is associated with their antibiotic treatments and with resistance in E. coli from their dams

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Introduction

A recent European study involving nine countries showed that 88% of pig production batches receive antibiotics during their life, mainly beta-lactams, polymyxins, tetracyclines and macrolides (Sarrazin et al. 2018, JAC).

The purpose of our German longitudinal study was to follow pigs from birth to slaughter and to investigate the association between antibiotic treatment and resistance of fecal *E. coli* from the pigs with a focus on beta-lactams, tetracyclines, polymyxins and macrolides.

We evaluated

a) the antibiotic resistance in different production stages,

b) association between resistance of *E. coli* from these pigs and their dams and

c) potential risk factors (management of housing, feeding, hygiene, animal health, production performance) for antibiotic use at different pig production stages.

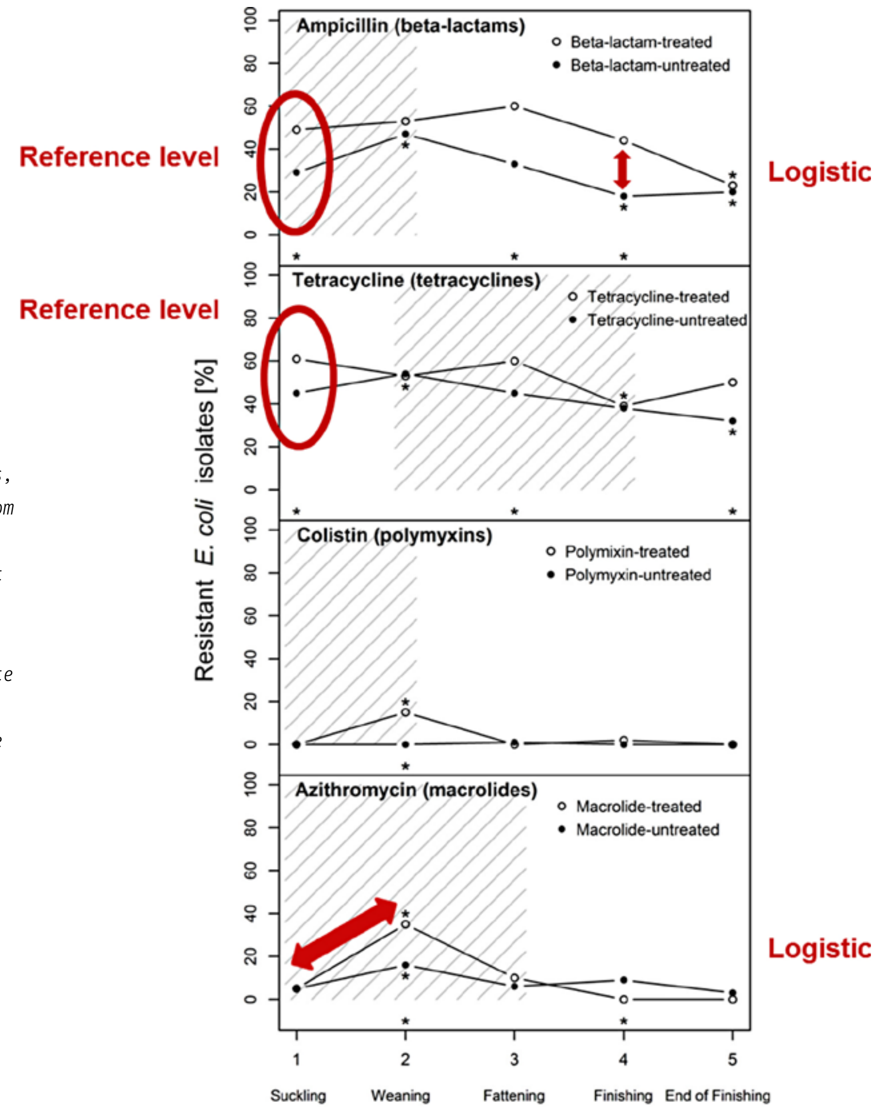

Figure 1: Proportions of E. coli resistant to ampicillin, tetracycline, colistin, azithromycin (representatives for penicillins, tetracyclines, polymyxins and macrolides) from treated and untreated pigs.
Asterisks close to marks indicate significant ($p < 0.05$) differences compared to first sampling in treated or untreated pigs; asterisks at the bottom of each graph indicate significant ($p < 0.05$) differences between isolates of treated and untreated pigs at the same sampling points in chi-squared tests for beta-lactams and tetracyclines, as well as in Fisher's exact test for colistin and macrolides

Methods

In each of 29 German breeding herds, two sows were selected. From each sow, seven piglets (in total 406) were followed from birth to slaughter. Antibiotic treatments were documented and fecal samples were collected from the sows around farrowing and from their progeny while suckling, after weaning, and three times during fattening. *Escherichia coli* were tested for their susceptibility to ampicillin (beta-lactam), tetracycline, colistin (polymyxin) and azithromycin (macrolide) by determination of the minimum inhibitory concentration (MIC; broth microdilution, Clinical and Laboratory Standards Institute 2012, commercial testplates Sensititre, TREK Diagnostic Systems, UK) in accordance with Decision 2013/652/EU (European Commission 2013). The MIC were evaluated against the epidemiological cut-off-values provided by EUCAST (2015). The owners/managers of the herds answered a questionnaire on relevant farm and animal related factors leading to 121 variables concerning the production stage of piglets, 123 variables concerning weaners and 133 for fattening. All factors were tested on herd-level for their significant effect on antimicrobial use in univariate (decision criterion $p<0.2$) and multivariate ($p<0.02$ as the threshold) logistic regression using SAS 9.4 (North Carolina).

Results

a) Resistance to ampicillin and tetracycline was already frequent before pigs were treated with beta-lactams or tetracyclines. Isolates were more likely to be ampicillin resistant in the fattening period if the pig was treated with a beta-lactam during suckling or weaning compared to not been treated (logistic analysis). After administration of macrolides, the risk for *E. coli* to be resistant to azithromycin increased (logistic analysis; Figure 1).
b) Isolates from piglets were more likely to be resistant to ampicillin or azithromycin if those from the dam were so as well (Figure 2).
c) Farm management factors identified for decreasing the risk for antibiotic use at specific production stages were professional rodent control at suckling stage, cleaning of the feeding system after weaning and cleaning of the water pipes with chlorine during fattening (in logistic regressions on herd-level).

Conclusions

The results hint towards the potential of improved hygienic measures to reduce antimicrobial resistance. Reducing antibiotic resistance in sows might also have a positive impact on the progeny. More longitudinal research is necessary.
Hatched area = period in which at least individual pigs received antibiotics.
Number of sampled piglets/*E. coli*: 403 at suckling, 386 at weaning, 339 at fattening, 313 at finishing, 258 at slaughter.

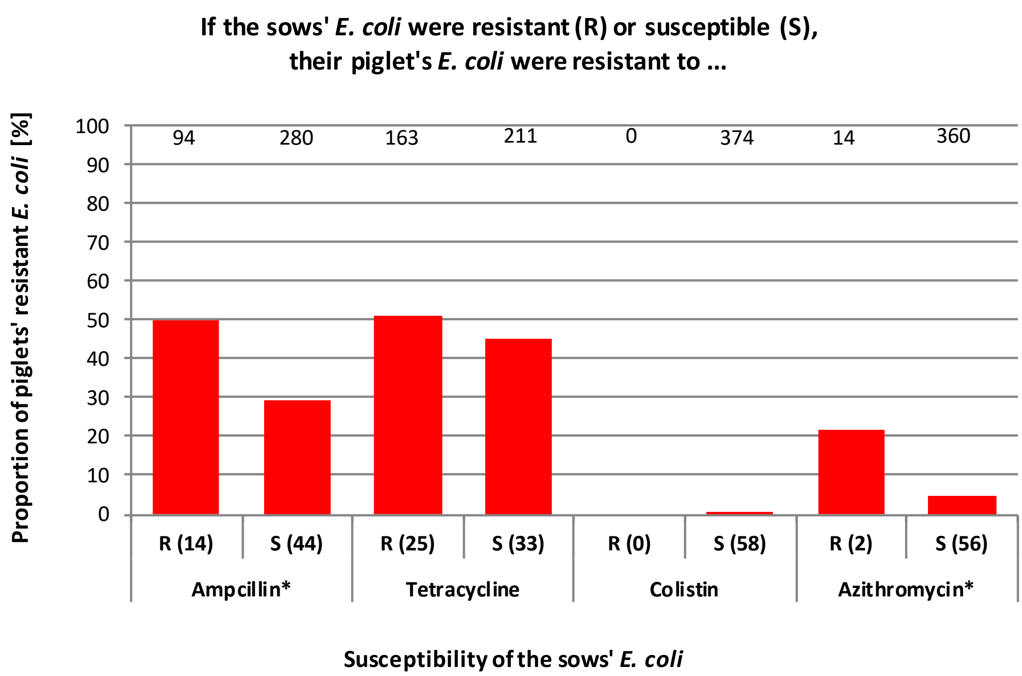

Figure 2: Proportion of resistant E. coli in the intestine of pigs originating from sows with resistant or susceptible fecal E. coli (numbers below bars are total numbers of E. coli isolates from sows; numbers above bars are total numbers of E. coli isolates from piglets; asterisk behind antibiotic indicates significant, p<0.05, association in fisher's exact test)