Antimicrobial resistance in *E. coli* isolated from pig herds with post-weaning diarrhea in Germany (2019 - 2023)

Adrian Luehrs[1], Rolf Bauerfeind[2], Christa Ewers[2], Ellen Prenger-Berninghoff[2], Pia Münster[1]

[1] Elanco Deutschland GmbH, Rathausplatz 12, 61348 Bad Homburg, Germany

[2] Institute for Hygiene and Infectious Diseases of Animals, Justus Liebig University Giessen, Giessen, Germany

Author contact: adrian.luehrs@elancoah.com

Introduction and Objectives

Post-weaning diarrhea (PWD) due to infection with enterotoxigenic *E. coli*, primarily F4- and F18-ETEC, typically occurs within the first three weeks after weaning and depending on its severity leads to yellowish or grey, watery feces (1, Fig. 1). PWD is a significant contributor to the global use of antibiotics in pig production.

This study aims to explore variations in antimicrobial resistance (AMR) among *E. coli* strains with different pathotypes isolated from PWD outbreaks in Germany.

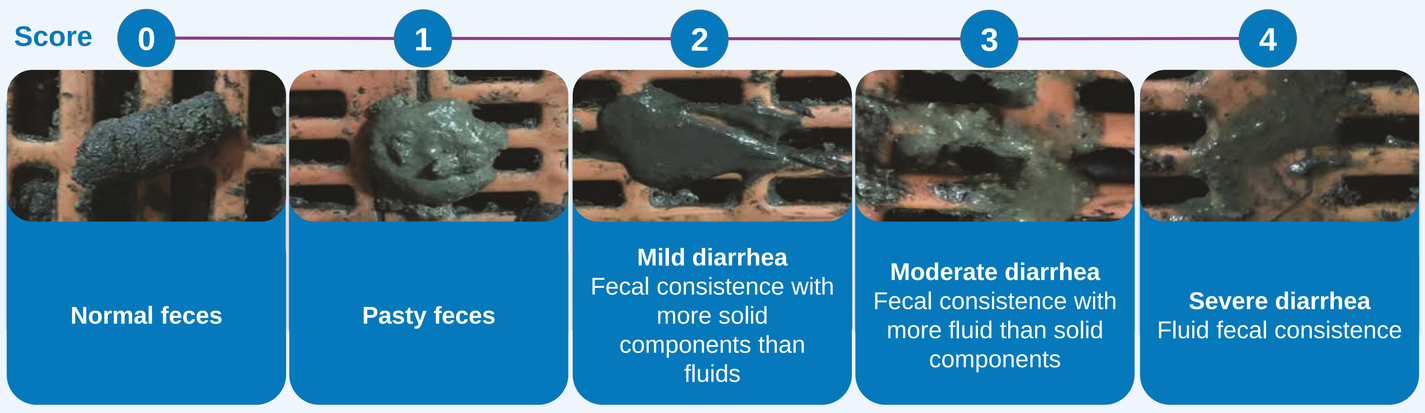

Figure 1: Post-weaning diarrhea fecal score card

Material and Methods

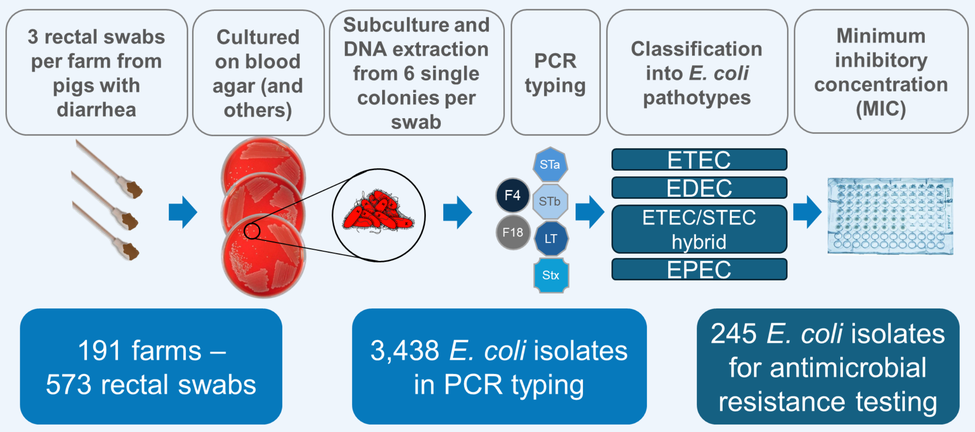

Figure 2: Sample processing workflow

Rectal swabs were collected from 573 piglets with PWD on 191 farms and examined for the presence of *E. coli* by culture methods. Coliform isolates were classified according to their virulence gene patterns into pathotypes ETEC, edema disease *E. coli* (EDEC), enterotoxigenic and Shiga-toxin encoding *E. coli* (ETEC/STEC hybrids), and enteropathogenic *E. coli* (EPEC). Antimicrobial susceptibility testing was carried out for one isolate per farm (n=138) or in cases where two (n=52) or three (n=1) different pathotypes were present, one isolate per pathotype and farm. In total, 245 isolates were assessed for minimum inhibitory concentrations (MICs) of 16 antimicrobials. Susceptibility categories intermediate (I) and resistant (R) were combined for statistical analysis (program JMP 15.0).

Main results

Of the 245 isolates tested, the predominant pathotype was F4-ETEC (38.4%), followed by F18-ETEC (12.7%), F18-ETEC/STEC hybrids (11.0%), EDEC (7.3%), EPEC (5.3%) and F5-ETEC (4.5%). 20.8% of the isolates could not be assigned to a pathotype (no specific pathotype). **F4-ETEC isolates proved resistant on average to 63.4% of the antibiotics tested and showed a significantly higher level of AMR ($p < 0.001$) than all other pathotypes** (mean of all other pathotypes: 52%, Fig. 3). **F4-ETEC was the pathotype with the highest resistance rates for eight antibiotics:** ampicillin, tetracycline, trimethoprim/sulfonamide, spectinomycin, cephalothin, enrofloxacin, amoxicillin/clavulanic acid and gentamicin (Table 1). Ceftiofur resistance was highest in EPEC, while **colistin resistance rate was highest in F18-ETEC/STEC hybrids (40.7%).**

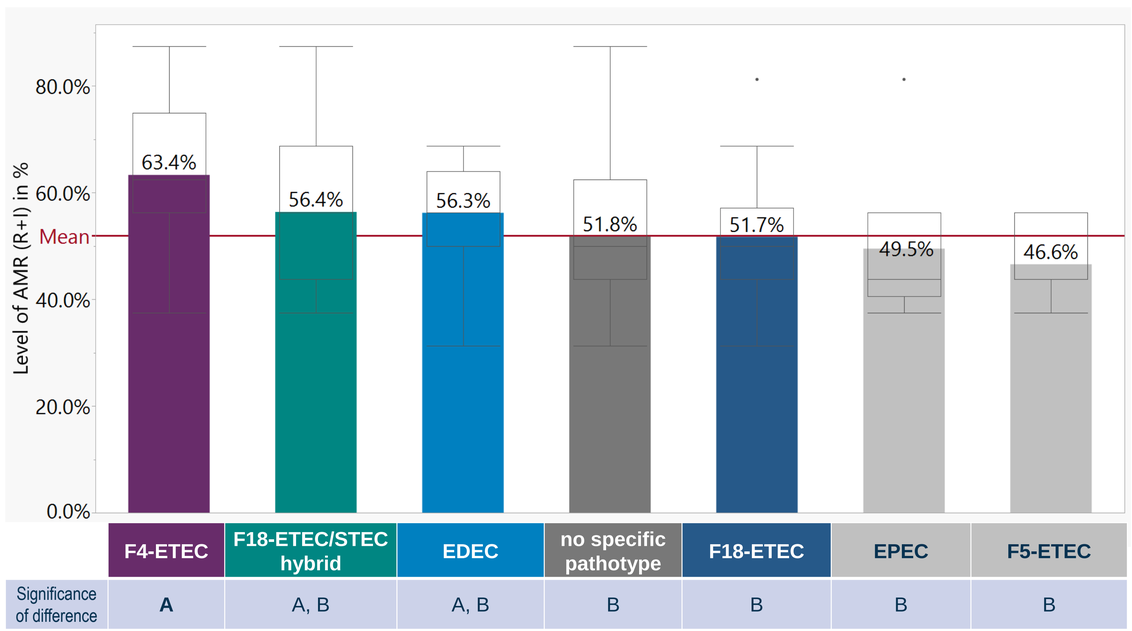

Figure 3: Level of AMR for all 16 tested antibiotics per *E. coli* pathotype - Levels not connected by same letter are significantly different ($p < 0.001$).

Table 1: Overview about resistance rates of all *E. coli* isolates and pathotypes with the highest resistance rates for tested antibiotics

Antibiotic tested (n = 16)	Resistance rate (R+I) [%]	Pathotype with highest resistance rate	Resist. rate of this pathotype [%]
Amoxicillin/clavulanic acid	8.2	F4-ETEC	11.7
Ampicillin	67.3	F4-ETEC	85.1
Ceftiofur	3.7	EPEC	7.7
Cephalothin	42.3	F4-ETEC	58.8
Colistin	21.2	F18-ETEC/STEC hybrid	40.7
Enrofloxacin	13.9	F4-ETEC	28.7
Erythromycin	100.0	N/A	
Florfenicol	86.5	EPEC, F5-ETEC	100.0
Gentamicin	4.9	F4-ETEC	8.5
Penicillin	99.6	N/A	
Spectinomycin	48.5	F4-ETEC	65.9
Tetracycline	58.0	F4-ETEC	72.3
Tiamulin	99.2	N/A	
Tilmicosin	100.0	N/A	
Trimethoprim/sulfonamide	52.2	F4-ETEC	67.0
Tulathromycin	99.2	N/A	

Discussion

This study demonstrated substantial AMR in various *E. coli* pathotypes associated with PWD. To reduce selective pressure, fewer antibiotics should be used, while promoting alternative control strategies, such as administering live oral *E. coli* vaccinations to piglets. We also detected significant differences of AMR frequencies between distinct *E. coli* pathotypes. These findings may indicate that pathotypes are differentially exposed to antimicrobials and/or go through different processes of selection for AMR in their habitats. Elucidating the underlying mechanisms may help to develop new strategies of prudent antimicrobial use.

References

1. Fairbrother JM et al. 2012. Colibacillosis, Diseases of Swine 10th Edition, Chapter 53, pp.723-749

IPVS & ESPHM, Leipzig, Germany, 4-7June-2024

Signature Page for PM-DE-24-0152 v1.0

PMO Approval	Adrian Luehrs Material Owner 30-Apr-2024 10:55:33 GMT+0000

Regulatory Approval	Sonja Reitinger Regulatory 02-May-2024 14:53:54 GMT+0000

Signature Page for PM-DE-24-0152 v1.0