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Antimicrobial Resistance
a Food Safety Perspective

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Many food-borne pathogens and opportunistic bacteria such as enterococci can have natural habitats in food animals. They can contaminate meat and milk products during slaughter and milking or contaminate raw vegetables when the soil is fertilised with animal manure. The molecular analysis of antibiotic resistance genes, plasmids and transposons has demonstrated that identical elements are found in animals and humans. The phenomenon applies to pathogenic, opportunistic and commensal bacteria: the use of antibiotics in veterinary medicine, similar to its use in agriculture and aquaculture, selects resistant bacteria, which are released into the environment. Specific food items, water and direct contact can spread these bacteria from animal microfloras to human microfloras (Teuber, 2004).

The development of antimicrobial resistance in pathogenic bacteria is a matter of increasing concern. There is growing scientific evidence that the use of antimicrobials in food animals leads to the development of resistant pathogenic bacteria that can reach humans through the food chain (Van Looveren et al., 2001). These human food safety concerns have been influential in prompting the European Union to ban the use of antimicrobials as growth promoters in food production and to increase their surveillance for bacterial resistance in food-borne pathogens and indicator organisms (Smith et al., 2007). In farm environments, commensal and environmental bacteria may be a reservoir for the transfer of antimicrobial resistance genes to pathogenic bacteria. Bacteria acquire most resistance genes through horizontal transfer, while conjugative genetic elements such as plasmids and transposons are common vectors for the dissemination of antimicrobial resistance genes to diverse microorganisms (Smith et al., 2007). Many scientists and public health specialists expect this resistance problem to worsen unless we act decisively.

Estonian antimicrobial susceptibility studies (Roasto et al., 2007) of *Campylobacter* strains revealed high resistance patterns for several antimicrobials. A high proportion of multidrug-resistant isolates (27.5%) was found. All of these isolates were resistant to enrofloxacin and all except one were resistant to nalidixic acid. Hakanen et al. (2003) noted that 20% of the human isolates associated with travelling were resistant to three or more antimicrobials. Multiresistant isolates reported in the Roasto et al. (2007) study consisted of a combination of all tested antimicrobials. The results showed that multidrug resistance was significantly associated with enrofloxacin and nalidixic acid resistance (correlation coefficient 0.372 and 0.310, $P<0.01$). These findings suggest that the use of fluoroquinolones may select multiresistant strains, since resistance to erythromycin, gentamicin or oxytetracycline was rare without simultaneous resistance to fluoroquinolones. A recent study on antimicrobial resistance of *Escherichia coli* at a farm where no antimicrobial treatment of the birds was performed during one year before

Table 26.1. Antimicrobial susceptibility of *C. jejuni* isolates (n = 131) from broiler chickens in Estonia, 2005-2006.

Antimicrobial agent[a]	Antimicrobial concentration range (µg/ml) VetMIC™Camp	Breakpoint (µg/ml)	No. of resistant strains (%)
Am	0.5-64	32	10 (7.6)
Ef	0.03-4	1	96 (73.3)
Em	0.12-16	16	26 (19.8)
Gm	0.25-8	8	25 (19.1)
Nal	1-128	32	99 (75.6)
Tc	0.25-32	4	42 (32.1)

a Antimicrobial agents: Am, Ampicillin; Ef, Enrofloxacin; Em, Erythromycin; Gm, Gentamicin; Nal, Nalidixic acid; Tc, Oxytetracycline.

the sampling showed that the resistance to tetracycline, gentamicin and streptomycin persisted but all isolates were susceptible to enrofloxacin (Smith et al., 2007). Thus multiresistant strains may reflect the past history of antimicrobial usage during a longer period. This phenomenon may partly explain the rather high number of multiresistant strains in the Estonian study (Roasto et al., 2007). Antimicrobial susceptibility patterns of *C. jejuni* isolates from broiler chickens in Estonia in 2005-2006 are shown in Table 26.1.

In addition, the costs of treating antimicrobial-resistant infections place a significant burden on society. For example, it has been estimated that the in-hospital costs of hospital-acquired infections caused by just six common kind of resistant bacteria were at least 1.3 billion USD (1 billion euros) in 1992 (http://www.hhs.gov/news/press/2001pres/20010118b.html; accessed 24 May 2007). Multiresistance to antimicrobials (resistance to three or more unrelated antimicrobials) is a major public health problem because it limits chemotherapeutic options. The concept of Critically Important Antimicrobials, both for humans and animals, should be used by EU member states for setting priorities in improved management of antimicrobials in animal production.

Kaden, V., Steyer, H., Schnabel, J. and Bruer, W. 2005. Classical swine fever (CSF) in wild boar: the role of the transplacental infection in the perpetuation of CSF. In: *J. Vet. Med. B Infect. Dis. Vet. Public Health*, 52 (4), pp 161-164

Markestad, A. and Grave, K. 1997. Reduction in antibacterial drug use in Norwegian fish farming due to vaccinion. In: Gudding, R., Lillehaug, A., Midtlyng, P.J. and Brown, F. (eds.) In: *Fish vacciniology*. Basel: Kager, pp 365- 369

Michel, A., Venter, L., Espie, I.W. and Coetzee M.L. 2003. Mycobacterium tuberculosis in eight species at the national zoological gardens of South Africa, 1991–2001. In: *Journal of Zoo and Wildlife Medicine*; 34, pp 364–370

Mortensen, S. 1998. PRRS-infection through semen (Danish) In: *Veterinärinformation*, 2 pp. 3-9

Nielsen, N.C., Bille, N. and Svendsen, J. et al. 1976. *Sygdomsbekempelse i svinebesaetninger (Control of diseases in swineherds)*. Kobenhavn: DSR Forlag ISBN: 87 7432 104 8

OIE, 2005.; Animal welfare: global issues, trends and challenges. In: *Rev.sci.tech. Off.int.Epiz*.Vol. 24 (2) ISSN 0253-1933

Slate, D., Rupprecht, C.E., Rooney, J.A., Donovan, D., Lein, D.H. and Chipman, R.B. 2005. Status of oral rabies vaccination in wild carnivores in the United States. In: *Virus Res*. Jul;111(1), pp 68-76

Stärk, K.D.C., Regula, G., Hernandez, J., Knopf, L., Fuchs, K., Morris, R.S. and Davies, P. 2006. Concepts for risk-based surveillance in the field of veterinary medicine and veterinary public health: Review of current approaches. In: *BMC Health Services Research*, 6-20 (doi:10.1186/1472-6963-6-20)

Söderlind, O., Olsson, E. and Smyth, C.J. et al. 1982. Effect of parenteral vaccination of dams on intestinal Escherichia coli in piglets with diarrhoea. In: *Infect. Immun*. 36 pp 900-906

Valle, P.S., Skjerve, E., Martin, S.W., Larssen, R.B., Osteras, O. and Nyberg, O. 2005. Ten years of bovine virus diarrhoea virus (BVDV) control in Norway: a cost-benefit analysis. In: *Prev Vet Med*. 72. pp 189-207

Von Rüden, S., Staubach, C., Kaden, K., Hess, R.G., Blicke, J., Kuehne, S., Sonnenburg, S., Froehlich, A., Teuffert, J. and Moennig, V. 2008. Retrospective analysis of the oral immunisation of wild boar populations against classical swine fever virus (CSFV) in region Eifel of Rhineland-Palatinate. In: *Vet. Microbiol*. 132 pp 29-38

Wallgren, P.T. 1994. The importance of diseases for daily growth of pigs. In: *Proc.Nord Vet Congr.17* (2) pp. 106-110

Wathes, C.M., Miller, B.G., Bourne, F.J. 1989. Cold stress and post-weaning diarrhoea in piglets inoculated orally or by aerosol. In: *Anim. Prod*., 49 pp 483-496

Wierup, M. 1983. *The influence of antibiotics on the excreation of salmonella*, Allmänt Veterinärmöte, Uppsala, Sveriges Veterinärförbund, Stockholm, pp 115-122

Wierup, M. 1999. The Swedish experience of limiting antimicrobial use. *Proc. Agriculture´s role in managing antimicrobial resistance conference, Oct 24-26,Toronto, Canad* , pp 99-109

Wierup, M. 2001. The Swedish experience of the 1986 year ban of antimicrobial Growth – promoters, with special reference to animal health, disease prevention, productivity and usage of antimicrobials. In: *Microbial Drug Resistance*, 7, 2 pp 183- 190

Wierup, M. and Wegener, H.C. 2006. Termination of AGP use and effect on subsequent production of broiler chickens in Sweden and Denmark during a 25 year period. In: Barug, D., de Jong, J., Kies, A.K. and Verstegen, M.W.A. *Antimicrobial growth promoters, Where do we go from here?* , Wageningen Academic Publishers, ISBN: 9076998876, www.wageningenacademic.com; pp 127-135

Wierup, M. 2008. The Swedish experiences of Salmonella control in food animals. In: *International Seminar Nutztiere, BPT-Kongresse, Hannover 14 Nov 2008*, Heraausgeber:bpt Akademie GmbH, Frankfurt am Main, www.bpt-akademie.de, pp. 17-24

Chapter 26

Hakanen, A., Jousimies-Somer, H., Siitonen, A., Huovinen, P., Kotilainen, P. 2003. Fluoroquinolone resistance in Campylobacter jejuni isolates in travelers returning to Finland: association of ciprofloxacin resistance to travel destination. In: *Emerg.Infect.Dis*. 9:267-270.

Roasto, M., Praakle, K., Korkeala, H., Elias, P. and Hänninen, M-L. 2007. Prevalence of Campylobacter in raw chicken meat of Estonian origin. In: *Archiv für Lebensmittelhygiene* 56, (49-72). 61-62.

Smith, J.L., Drum, D.J.V., Dai, Y., Kim, J.M., Sanchez, S., Maurer, J.J., Hofacre, C.L. and Lee, M.D. 2007. Impact of antimicrobial usage on antimicrobial resistance in commensal Escherichia coli strains colonizing broiler chickens. In: *Applied Environmental Microbiology* 73:1404-1414.

Teuber, M. 2004. Veterinary use and antibiotic resistance. In: Smulders, F.J.M. and Collins, J.D. (eds.) *Food safety assurance and veterinary public health*. Volume 2, Safety aasurance during food processing, Wageningen Academic Publishers, The Netherlands, pp. 229-241.

US Department of Health and Human Services http://www.hhs.gov/news/press/2001pres/20010118b.html; accessed 24 May 2007

Van Looveren, M., Daube, G., De Zutter, L., Dumont, J-M., Lammens, C., Wijdooghe, M., Jouret, M., Cornelis, M. and Goossens, H. 2001. Antimicrobial susceptibilities of Campylobacter strains isolated from food animals in Belgium. In: *Journal of Antimicrobial Chemotherapy*, 48, 235-240.

Chapter 27

Baker, R. 2006 Health management with reduced antibiotic use – the U.S. experience. In: *Anim. Biotec*. 17:195-205.

Bosi, P., Han, I.K., Jung, H.J., Heo, K.N., Perini, S., Castellazzi, A.M., Casini, L., Creston, D. and Gremokolini, C. 2001. Effect of different spray dried plasmas on growth, ileal digestibility, nutrient deposition, immunity and health of early-weaned pigs challenged with E. coli K88. In: *Asian-Aust. J. Anim. Sci*. 14:1138-1143.

Chernysheva, L.V., Friendship, R.M., Gyles, C.L. and Dewey, C.E. 2003. Field trial assessment of the efficacy of specific egg-yolk antibody product for control of postweaning E. coli diarrhea. In: *Veterinary Therapeutics* 4:279-284.

Coffey, R.D., and Cromwell, G.L. 2001. Use of spray-dried animal plasma in diets for weanling pigs. In: *Pig News and Information* 22:39-48.