

Avoiding Antibiotic Resistance: Denmark’s Ban on Growth Promoting Antibiotics in Food Animals

In human medicine, antibiotic use is generally confined to treatment of illness. In contrast, antibiotics and other antimicrobials (drugs that kill microorganisms like bacteria) often are routinely given to food animals in the U.S. in order to grow animals faster and to compensate for unsanitary conditions on many industrial farms. Bacteria exposed to antibiotics at low doses for prolonged periods can develop antibiotic-resistance—a dangerous trait enabling bacteria to survive and grow instead of being inhibited or destroyed by therapeutic doses of a drug.¹ Since many of the classes of antibiotics used in food animal production also are important in human medicine, resistance that begins on the farm can lead to a serious public health problem.

Recognizing the potential for a health crisis, Denmark stopped the administration of antibiotics used for growth promotion (i.e., non-medical uses) in broiler chickens and adult swine (finishers) in 1998, and in young swine (weaners) in 1999. Today in Denmark, all uses of antibiotics in food animals must be accompanied by a prescription in a valid veterinarian-client-patient relationship, and veterinarians cannot profit from the sale of antibiotics. In addition, farmers, veterinarians and pharmacies must report the use and sale of antibiotics, and farm inspections are conducted regularly. Although the U.S. food animal production and animal drug industries often claim that the ban was costly and ineffective, the World Health Organization (WHO) found that the Danish ban reduced human health risk without significantly harming animal health or farmers’ incomes.² In fact, Danish government and industry data show that livestock and poultry production has increased since the ban, while antibiotic resistance has declined on farms and in meat.³

Assessing the Danish Experience

In 2003, the WHO published a study entitled “Impacts of Antimicrobial Growth Promoter Termination in Denmark,”⁴ which culminated their review of Denmark’s elimination of antimicrobial growth promoters (AGPs) in food animal production—a ban that was five years old at the time. The goals set forth by WHO included assessing the impact of the ban on: antibiotic resistance in humans; human health; animal health and welfare; the environment and animal production. The report focused particularly on swine and broiler chickens, and based its study on data from the Danish Antimicrobial Resistance Monitoring and Research Program (DANMAP) and VETSTAT, as well as national experts’ working papers. VETSTAT, a special antimicrobial use monitoring program originating in 2000, is a prescription-based initiative that collects information on veterinary prescriptions from pharmacies, vet practices and feed mills.

Researchers with the Danish Veterinary and Food Administration, the Danish Medicines Agency, the Technical University of Denmark and the State Serum Institute have been compiling, analyzing and publishing data on antibiotic use in food animals since the early 1990s. In addition, they have studied antibiotic resistance in animals and food since the mid-1990s and in humans since the early 2000s. DANMAP publishes this data in an annual report available online.⁵ Many of the report writers and their colleagues also have published findings of the Denmark ban in independent scientific literature.⁶ Additional journal articles have been published comparing the impacts of the AGP ban in Denmark to similar bans in Sweden and Norway, which also were successful in reducing antibiotic use and antibiotic resistance.⁷

Impacts on Human Health, Animal Welfare and the Environment

From 1992, the peak of AGP usage in pigs, to 2008, overall antibiotic use in swine production declined substantially—by over 50 percent—as a result of the ban on growth promoters in Denmark.⁸ In addition, there were no serious long-term effects on swine health.

U.S. industry has expressed alarm over increased treatment of diarrhea and a rise in mortality in weaner pigs in the few years immediately after the ban. The WHO found that diarrhea in young pigs did increase following the ban, creating a short-term need to increase therapeutic antibiotic use. However, levels of diarrhea treatment began to decline after seven months and were back to the pre-ban levels after one year, and weaner mortality has improved considerably in recent years.⁹

According to Danish industry representatives, minor changes in animal husbandry, such as more frequent cleaning of housing, improved ventilation, later weaning, additional space for animal movement, as well as experimenting with feed quality and additives made up for the lack of routine antibiotics on most farms. Today, Danish industry considers farmers to be “adapted” to the ban.¹⁰

The WHO determined that Denmark’s AGP ban achieved its public health goal of reducing resistance in food animals in order to prevent related human resistance from emerging. Extensive data showed that the ban drastically reduced the antibiotic-resistant *enterococci* in animals, a bacterium that can lead to human illnesses such as urinary tract infections, intra-abdominal infections and surgical wound infections.¹¹ However, in 2003 the WHO could not determine the ban’s direct and total effect on antimicrobial resistance in humans because of limited data. Newer monitoring data, however, shows that human resistance trends appear to be mirroring the decline in on-farm use of antibiotics—a positive indicator for public health.¹² Today, the Danish Ministry of Food, Agriculture and Fisheries reports, “The stop for use of different non-therapeutic antibiotic growth promoters...has resulted in a major reduction in antimicrobial resistance as measured among several different bacterial species in food animals and food.”¹³



Economic Impacts and Production Trends

According to the Danish Ministry of Food, Agriculture and Fisheries:

In Denmark the termination of non-therapeutic use of antibiotics for growth promotion has not caused any negative impact on the animal production. The Danish animal food industry has continued to improve its productivity and to increase its output.¹⁴

Following the ban in Denmark, swine production has increased by nearly 50 percent since 1992. In addition, the average number of pigs born per sow has increased (a key indicator of swine health), and the average daily gain of weaners and finishers has increased since the ban. While weaner mortality increased for a few years after the ban (by less than one percent, according to the WHO), it was already increasing for several years before the ban, and has been dramatically decreasing in recent years, indicating “no effect of the termination.”¹⁵ Broiler production rates and mortality were not affected by the ban.

The WHO found that the AGP ban had several minor impacts on the hog life cycle that in turn affected production. It took close to an extra day and a half to reach slaughter weight, while it took almost three days for weaners to reach their goal weight. However, Danish Pig Production (an industry group) suspects that the total effect of the ban may have been more like 1.6 days of added growth time over a pig’s lifetime, with most impact felt during the weaner period.¹⁶ Overall, the WHO agreed with Danish government and industry findings that the ban did not have a direct impact on the growth rate and increased mortality of finishers. The study likewise found no impacts on broiler chicken mortality or weight gain changes in broilers attributable to the ban.

Tied closely to the reduced growth rate in hogs are the economic costs associated with the ban. In general, the WHO report found that overall economic impacts were minimal. Costs varied among farmers, but may have included the costs associated with modifying the production system;¹⁷ decreased feed efficiency; reduced growth/increased mortality in weaners and increased use of therapeutic antimicrobials or the purchase of alternatives to AGPs. The WHO panel found that each pig produced cost the producer 7.75 DKK (\$1.09 in 2003) more than before the ban, translating to a comprehensive production cost increase of just over one percent. The WHO found no net increase in costs to poultry production.



Overall, the combination of production impacts on hogs and poultry farmers caused very minimal loss (0.03 percent) to Denmark’s economy.

Considering a Phase Out on Antibiotic Growth Promoters in the U.S.

In Denmark, like in the U.S., the trend in food animal production favors an industrial model with fewer farms producing more food animals per farm.¹⁸ The WHO report has clearly concluded that eliminating AGPs in such a system does not have significantly adverse economic consequences.

Other recent studies agree with such findings. A peer-reviewed economic report produced for the Pew Commission on Industrial Farm Production by the University of Tennessee’s Agricultural Policy Analysis Center found that when accounting for societal and environmental costs, industrial swine farming methods are usually more expensive than alternative methods such as hoop barns, which typically do not involve the use of antibiotics for growth promotion.¹⁹ An economic analysis conducted on the U.S. poultry industry by researchers from Johns Hopkins University also was consistent with the WHO’s findings.²⁰ The researchers concluded that the costs of production are reduced when AGPs are not used. In their research, the increased cost of feed containing antibiotics

outweighed the costs associated with the alternative, i.e., the increased amount of feed needed combined with the slightly increased mortality, variability in weight gain and increased condemnation rates (chickens rejected at slaughter due to illness or disease).

There is current legislation that would address the routine use of antibiotics on industrial farms. The Preservation of Antibiotics for Medical Treatment Act (PAMTA, H.R. 1549, S. 619) would withdraw the use of seven classes of antibiotics vitally important to human health from food animal production unless animals or herds are sick or unless drug companies can prove that their non-therapeutic use does not harm human health by contributing to antibiotic resistance.

Conclusions

The WHO's report on the termination of AGPs in food animals in Denmark concludes with final remarks summarizing their findings: the use of antimicrobials for the sole purpose of growth promotion can be discontinued in countries with "similar animal production conditions," and the routine non-therapeutic use of antimicrobials should never be a substitute for good animal health management. The ban in Denmark led to fewer animals being given antimicrobials and those who are given them for disease treatment have a shortened exposure time. The termination of AGPs affected weaner pigs more than finishers but had small overall negative economic impact in the swine industry, while there was no negative impact on broilers. Overall, the ban phasing out the non-therapeutic use of antibiotics for growth promotion has not caused any negative impact on food animal production in Denmark. In fact, the industry's productivity has increased as well as its output.²¹

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¹ World Health Organization, 2000. "Report on Infectious Diseases," Chapter 3, available at: <http://www.who.int/infectious-disease-report/2000/index.html>.

² World Health Organization, 2003. "Impacts of antimicrobial growth promoter termination in Denmark: The WHO international review panel's evaluation of the termination of the use of antimicrobial growth promoters in Denmark," available at: http://whqlibdoc.who.int/hq/2003/WHO_CDS_CPE_ZFK_2003.1.pdf.

³ Letter from Dr. Jan Mousing, Chief Veterinary Officer of Denmark, to Congress, August 12, 2009, and "FACT sheet – Effects of Danish restrictions on non-therapeutic use of antibiotics," available at: http://www.uk.foedevarestyrelsen.dk/NR/rdonlyres/63497AA7-8E8A-4C6A-9C74-E56C3383F26A/0/Info_om_vaekstfremmerforbud_samt_oevrige_riskmanagement_str_UK.pdf; letter to House Speaker Nancy Pelosi from Dr. Frank Aarestrup, Denmark Technical University, including copy of presentation given to congressional delegation, September, 2009, available at: http://www.louise.house.gov/index.php?option=com_content&view=article&id=1314:rep-slaughter-releases-letter-from-denmark-on-non-therapeutic-use-of-antimicrobials&catid=41:press-releases&Itemid=109; Niels J. Kjeldsen, "Consequences of the removal of antibiotic growth promoters in the Danish pig industry," Danish Pig Production; and Danish Integrated Antimicrobial Resistance Monitoring and Research Program (DANMAP) 2007 report, pp. 81-83, available at: http://www.danmap.org/pdfFiles/Danmap_2007.pdf.

⁴ *Ibid.*

⁵ See www.danmap.org for a list of reports. See also: F. Bager, H.D. Emborg, F.M. Aarestrup, and H.C. Wegener. 2007. "DANMAP: The Danish experience following the ban on antimicrobial growth promoters: trends in microbial resistance and antimicrobial use," Danish Veterinary Institute, available at: http://en.engormix.com/MA-pig-industry/nutrition/articles/danmap-danish-experience-following_330.htm.

⁶ See, for example: F.M. Aarestrup, A.M. Seyfarth, H.D. Emborg, K. Pedersen, R.S. Hendriksen, and F. Bager, 2001. "Effect of Abolishment of the Use of Antimicrobial Agents for Growth Promotion on Occurrence of Antimicrobial

Resistance in Fecal Enterococci from Food Animals in Denmark,” *Antimicrobial Agents and Chemotherapy* 45(7): 2054-2059; and M.C. Evans and H.C. Wegener. 2003. “Antimicrobial Growth Promoters and *Salmonella* spp., *Campylobacter* spp. in Poultry and Swine, Denmark,” *Emerging Infectious Diseases* 9(4): 489-492, available at: <http://www.cdc.gov/ncidod/eid/vol9no4/pdfs/02-0325.pdf>.

⁷ See, for example: B. Bengtsson and M. Wierup. 2006. “Antimicrobial Resistance in Scandinavia after Ban of Antimicrobial Growth Promoters,” *Animal Biotechnology* 17(2): 147-156, available at: http://pdfserve.informaworld.com/203907__768446439.pdf; and K. Gravea, V.F. Jensen, K. Odensvik, M. Wierup, and M. Bangen. 2006. “Usage of veterinary therapeutic antimicrobials in Denmark, Norway and Sweden following termination of antimicrobial growth promoter use,” *Preventive Veterinary Medicine* 75(1-2): 123-132. More on Sweden’s ban in: M. Wierup. 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,” *Microbial Drug Resistance* 7(2): 183-90, available at: <http://www.ncbi.nlm.nih.gov/pubmed/11442345>.

⁸ Aarestrup letter, *Op. cit.* See also: Mousing letter, *Op. cit.* These letters summarize trends through 2008 from the DANMAP reports, available at www.danmap.org.

⁹ See also: Aarestrup letter, *Op. cit.*

¹⁰ Danish Agriculture and Food Council, meeting with Pew staff, Copenhagen, Denmark, September 14, 2009.

¹¹ Fasser, MD, Susan L., “Enterococcal Infections,” eMedicine from WebMD, 25 Aug. 2008, www.emedicine.com/med/TOPIC680.htm.

¹² DANMAP 2007, see, for example, pp. 81-83, available at: http://www.danmap.org/pdfFiles/Danmap_2007.pdf.

¹³ Fact sheet accompanying Mousing letter, *op. cit.*

¹⁴ Mousing letter, *Op. cit.*

¹⁵ *Ibid.*

¹⁶ Kjeldsen, *Op. cit.*

¹⁷ See WHO 2003, *op. cit.*, page 39: Some farmers “altered production systems with such changes as adoption of other feed ingredients, tightening biosecurity, improving sanitation, increasing weaning weights, adopting all-in-all-out pig flow, reducing stocking density, or others. Such changes in production systems would be especially important to producers because many of the changes would require capital investment that in some cases could be substantial.”

¹⁸ McBride, William D. and Nigel Key, “Characteristics and Production Costs of U.S. Hog Farms, 2004,” United States Department of Agriculture, Bulletin No. 32, Dec. 2007, 15.

¹⁹ Schaffer, H. D., Koonnathamdee, P., & Ray, D. E. (2008). *An economic analysis of the social costs of the industrialized production of pork in the United States*. Institute of Agriculture, Agricultural Policy Analysis Center, Department of Agricultural Economics. Knoxville: University of Tennessee, www.ncifap.org/reports/index.html

²⁰ Graham, J.P., Boland, J.J. and Silbergeld, E. (2007). “Growth promoting antibiotics in food animal production: an economic analysis.” *Public Health Report* 2007; 122(1): 79-87.

²¹ Mousing Letter, *Op. cit.*