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Lessons from the Danish Ban on Feed-Grade Antibiotics

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In June of 2003, McDonald's Corporation announced that it would prohibit its direct suppliers from using antibiotics that are important in human medicine as growth promotants in food animals after 2004. The company also created a purchasing preference for companies that work to minimize antibiotic use. This announcement, coupled with recent Food and Drug Administration guidance on the same issue, will put pressure on the US livestock industry to consider alternatives to feed-grade antibiotics. Denmark recently banned the use of feed-grade antibiotics in pork production and has been joined in this action by countries in the European Union (EU). The ban was implemented first at the finishing stage and then at the weaning stage. Denmark's recent experiences with the withdrawal of antibiotics from feed can help us to better understand and anticipate the consequences of a similar action in the United States.

Background

Current EU regulations restrict the use of antimicrobials—derived from either human or veterinary therapeutic medicine—as feed-additive growth promoters in livestock. The European Union currently restricts the list of approved feed additives to include only avilamycin, bambermycin, salinomycin, and monensin, and these antibiotic growth promotants (AGPs) are scheduled to be banned by 2006.

In 1998, the Danish government instituted a voluntary ban on the use of AGPs in pork production at the finishing stage (accompanied by a penalty tax for use). On January 1, 2000, Denmark banned AGPs at both the weaning and finishing stages. Denmark provides a suitable market for evaluating the cost impact of a ban of AGPs: it is an export-oriented and market-driven production system; it maintains excellent records on production costs and on antibiotic use; and its pork industry is at least as sophisticated as that of the United States.

Antibiotic Use

As shown in Figure 1 (based on data from DANMAP 2001; see Danish Veterinary Institute [DVI], 2002), Denmark's total consumption of antibiotics in pork production was 154 metric tons (mt) of active ingredient in 1996, 106 mt of AGPs, and 48 mt of therapeutic use as medication. By 1998, when antibiotics were banned from use at the finishing stage, the total use was 106 mt. The use of AGPs fell by about 50% (from 107 mt to 49 mt), and therapeutic use remained about constant. By 1999, overall antibiotic use fell to a low of 74 mt.

The effective ban of AGPs at the finishing stage in 1998 was accomplished through a tax and some pressure to discontinue the use of subtherapeutic antibiotics. Danish farm management experts cal-

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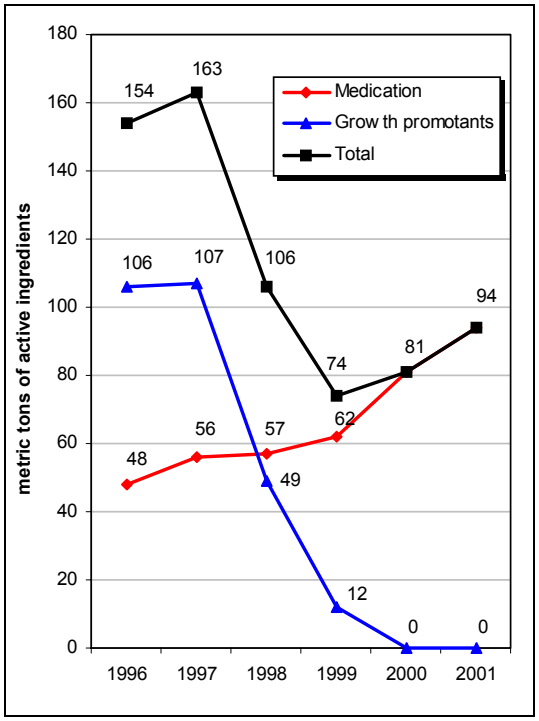

Figure 1. Total consumption of antibiotics in Denmark.
Source: DVI, 2001, 2002.

culated the economic value of the subtherapeutic antibiotics at the finishing stage. Based on their estimates, farmers were required either to pay a tax of $2.00 per head on animals for which the products were used or to agree to discontinue use. Policymakers considered this level of tax "about right." Faced with this tax, most producers stopped using the products at the finishing stage. Farmers reported very few health problems in their herds—a result that indicates that most of the benefits of AGP use at the finishing stage were driven by a growth-promoting effect plus a small reduction in mortality. National mortality did increase from 3% to 3.6% in 1999, but it is not clear that any of this was due to the ban. The Danes viewed the ban at the finishing stage as a resounding success. Total antibiotic use was cut by more than 50%, and few health problems were encountered.

The ban at the weaning stage in 2000 was much more difficult for farmers; they reported some severe health problems, especially in the early stages of pig production (National Committee for Pig Production, 2002). Producers responded by restricting feed for the first two weeks. As piglet mortality and disease mounted, veterinarians became more dependent on the use of therapeutic antibiotics. Although the use of AGPs fell to nearly zero in 2000, the use of antibiotics as therapeutic medications increased. Therapeutic medications were increasingly substituted for the now-banned AGPs. Thus, the consumption of total antibiotics *increased* from 74 mt in 1999 to 81 mt in 2000 and to 94 mt in 2001. Despite this increase, the overall level of antibiotic use in 2001 was still limited to about 60% of the level used in 1996 before the ban at the finishing stage. On a per-pig basis, the level in 2001 was estimated to be 3.0 grams per pig, down from earlier levels (DVI, 2002).

Most of the pig health problems experienced after the ban were described as problems with post-weaning diarrhea and also some diarrhea at the finishing stage. The Danish producers and veterinarians we spoke with reported that the pigs were weaker and more vulnerable to disease when they were moved to the finishing barns. The Danish experience suggests that reduced use of antibiotics at the weaning stage has had significant animal health effects throughout the production system.

Future Patterns of Antibiotic Use in Denmark

The Danes have implemented a major effort to track antibiotic resistance in animal bacterial isolates through DANMAP, the Danish Integrated Antimicrobial Resistance Monitoring and Research Programme. Through a parallel program called VetStat, the Danes are able to monitor the prescription of antibiotics by type of antibiotic, by farm, and by veterinarian because of unique features of their prescription issuance and reporting system. According to the veterinarians interviewed, this reporting system has enabled the use of prescription information to identify veterinarians and quantify the use of antibiotics in each swine herd.

Through the use of this and other controls, the national authorities believe that they can further reduce the overall use of antibiotics and that they have the tools to do so.

Human Health Impacts and the Law of Unintended Consequences

Although human health impacts were not the focus of our study, the AGP products banned in Denmark have less use in human medicine than do the therapeutic antibiotics that replaced them. Table 1 shows the large increase in the use of human health

Table 1. Trends in the estimated total usage of antimicrobials for treatment of food animals (kg active compound).

Compound	1986	1998	1990	1992	1994	1996	1998	1999	2000	2001[a]
Tetracyclines	3,800	3,600	9,300	22,000	36,500	12,900	12,100	16,200	24,000	27,900
Penicillins with narrow spectrum	3,700	3,800	5,000	6,700	9,400	7,200	14,300	14,700	14,800	17,100
Penicillins with extended spectrum	850	1,000	1,200	2,500	4,400	5,800	6,700	6,600	7,600	9,300
Sulfonamides + trimethoprim	2,500	2,200	3,800	7,900	9,500	4,800	7,700	6,800	7,000	7,400
Sulfonamides	22,300	24,200	8,700	5,900	5,600	2,100	1,000	1,000	1,000	800
Macrolides + lincosamides	10,100	9,300	10,900	12,900	11,400	7,600	7,100	8,700	11,100b	14,300
Aminoglycosides	7,800	7,400	7,700	8,500	8,600	7,100	7,800	7,500	10,400	11,900
Others	13,800	6,900	6,700	6,800	4,400	600	650	350	4,500	5,200
Total	64,800	58,400	53,400	73,200	89,900	48,000	57,300	61,900	80,600	94,200

Source: Data for 1986–94 are from the Federation of Danish Pig Producers and Slaughterhouses: Use of Antibiotics in the Pig Production, edited by N.E. Rønn. Data for 1996–2000 come from DANMAP 2000 (DVI 2001).

[a]Taken from DANMAP 2001 (DVI 2002).

[b]Adjusted from DANMAP 2001 (DVI 2002).

products such as tetracyclines, penicillins, and macrolides in Danish food animal production.

We could reasonably conclude that the use of the human health products in animal production might be more harmful to human health than the products they replaced. This logic is supported by evidence from human health studies in Denmark. Of particular concern is the increase in antimicrobial resistance among *Salmonella typhimurium* and *Campylobacter jejuni* human isolates to tetracycline and other selected antimicrobials in Denmark in 2001 (Figure 2). This evidence is important, because the antibiotics that were phased out were active against gram negative bacteria and could not have created resistance in gram positive bacteria such as salmonella or campylobacter. Because of the health problems, many antimicrobials in use before the ban were replaced with tetracyclines, which are active against gram positive bacteria. Tetracycline use in Denmark went from 12,100 kg in 1998 to 27,900 kg in 2001, and now Denmark has experienced problems with tetracycline resistance in humans. The link between animal use of antibiotics and human resistance has not been proven and is complex, so we cannot conclude that the large increase in the use of human drugs caused a problem. However, it is ironic that the policy resulted in an increase in the use of the products about which humans are most concerned. This is a classic example of how a policy prescription can have consequences that are exactly the opposite of those intended.

Cost Impacts

Based on what we learned in Denmark and on an earlier publication that measured the costs associated with a previous Swedish ban, we calculated the components of the cost of the ban, as shown in Table 2. (Details on these cost estimates are available from the authors.)

Greater variability in weight at slaughter A ban at the finishing stage in the United States would create few animal health concerns, but it would reduce feed efficiency slightly and increase the weight spread of finished animals.

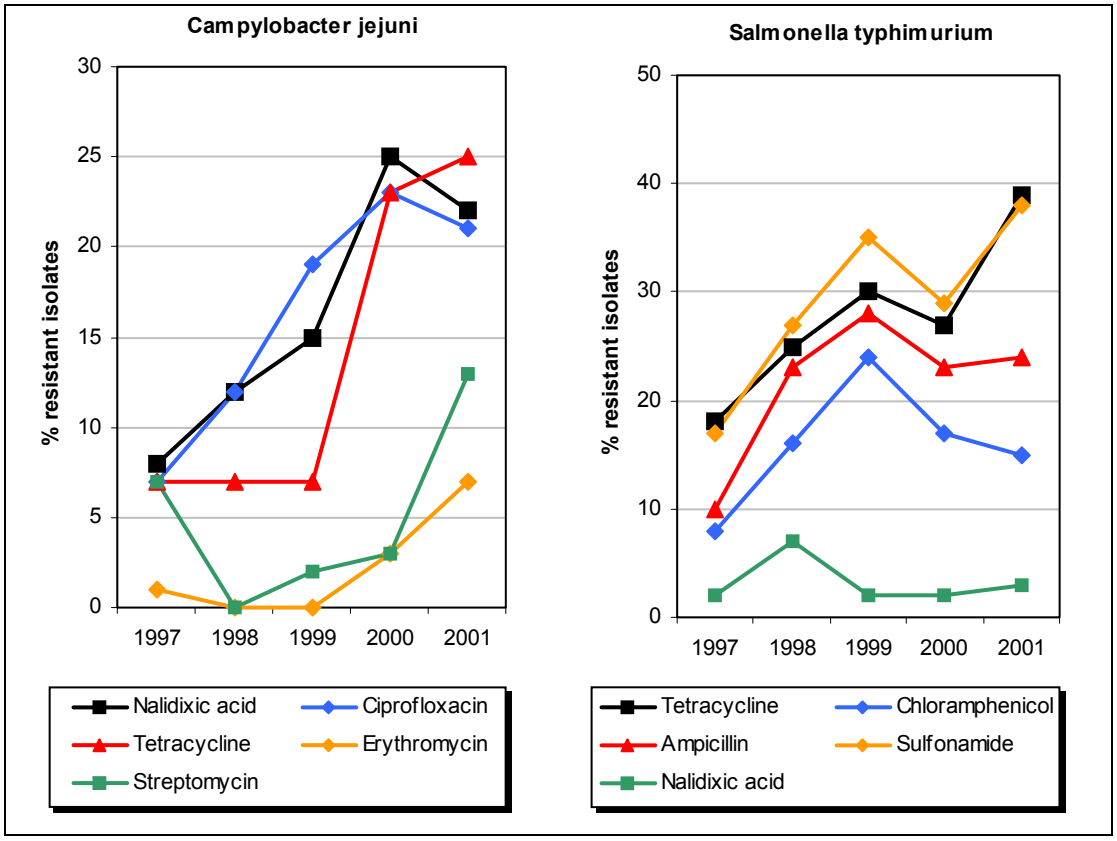

Figure 2. Trends in resistance to selected antimicrobials among isolates from domestically acquired human cases.
Source: DVI, 2001, 2002.

In addition, we included sort-loss costs of $0.64 per animal. The Swedish and Danish producers did not have a problem with sort loss, because the producers convinced the packers to accept more lightweight pigs. We included the sort loss in the costs expected in the United States because of increased variability of weights expected with the move away from AGPs and the penalty packers place on the lighter-weight pigs. We also included capital costs of $63 million for the additional space needed for the extra five days post-weaning and $166 million for the additional sow space.

Cost Increase Details

The economic impact of a US ban would depend to a large extent on the willingness of US veterinarians to increase therapeutic use. Our best estimate is that costs would increase by approximately $4.50 per animal in the first year. The estimated cost increase includes an increase in costs at the finishing stage of $1.05 per animal; an increase in costs at the weaning stage of $1.25 per animal; an additional veterinary cost of $0.25 per animal; a vaccine cost of $0.75 per animal; an increase in sort loss of $0.65 per animal; and a capital cost of about $0.55 per animal. Industry profits would be lower than would otherwise be the case as US producers adjust to the ban. The total cost of a ban to the US pork industry spread across a ten-year period is estimated to be in excess of $700 million. The expected cost to consumers is an approximate 2% increase in retail prices.

Economic Effects

Adding the effects from estimated changes in productivity (Table 2) to the sort loss and initial construction costs suggests a first-year impact of $4.50 per head due to the effects of a ban on AGPs. The $4.50 figure represents a production cost increase of approximately 4.5%. This cost increases slightly as more buildings are required in subsequent years and there are fewer animals but the same fixed costs. Another comparable estimate for the United States is a cost of $2.76 per hog (Brorsen et al., 2002); and, a recent estimate of the cost in Denmark of the restricted use is $4 per pig (Jensen, 2003). These estimates suggest the costs are likely to range from $3 to $4.50 per pig.

As costs increase, production declines, and some producers likely would be forced out of busi-

Table 2. Productivity impacts in Denmark and Sweden.

	Sweden	Denmark
Age at weaning	+1 week	a
Days from weaning to reach 25 kg	+5 days	a
Feed efficiency from 50 to 250 lbs	-1.5%	-1.5%
Piglet mortality	+1.5% pts	a
Fattening-finish mortality	+0.04%	+0.04
Piglets per sow	-4.82%	-4.82%
Veterinary and therapeutic costs (per pig) net of costs for feed-grade antibiotics		+$0.25
Lawsonia vaccine		$0.75

[a] These costs totaled $1.25 per animal in Denmark and were not broken down into specific productivity impacts.

ness. A lower level of production increases wholesale and retail prices, and higher prices help offset some of the cost increases. The profit impact is greatest in year one. By year two, the consumer is paying for most of the cost increase, and the loss in producer profits would decline. The end result is a slightly smaller US pork industry, as slightly higher retail prices would result in lower consumption. Our estimates show that by adding up the lower profits per animal for all ten years and summing across the entire industry, the total cost of a ban would likely exceed $700 million. The productivity decline associated with the ban would be recovered by normal technological advances, but the income lost to individual producers during the adjustment phase would be not be recovered.

One important lesson from the Danish experience is the wide variation in the effects among producers. Our results show the economic impacts of a ban on an "average" or "representative" farm. These results mask wide differences across farms. With a ban on AGP use, an all-in, all-out system is necessary in order to reduce the pressure of infectious diseases. In the United States today, as much as 20% of production still originates on farms that have not yet adopted all-in, all-out processes. Producers who use a mixed or continuous-flow system might be disinclined to invest in system changes, and thus they would exit the business. A ban would likely increase lightweight pigs. The model accounted for this change as a discount to producers as they sell on the price grid. By contrast, the Swedish and Danish industries own their packers and can better protect the market for smaller animals.

The Danish experience clearly illustrates the differences between the effects of a ban at the weaning and finishing stages. The Danes achieved a large reduction in antibiotic use, and producers encountered few costs when they banned at the finishing stage. However, when they imposed a ban at the weaning stage, they encountered increased post-weaning health problems leading to increased medication and other costs. In general, the Danes achieved 80 percent of the benefits for 20 percent of the costs when they imposed a partial ban, and they encountered 20 percent of the benefits and 80 percent of the costs when they extended the ban.

Our conclusion is that a ban at the finishing stage in the United States would create few animal health concerns, but it would reduce feed efficiency slightly and increase the weight spread of finished animals. A ban at the weaning stage would create serious animal health concerns and a significant increase in mortality. Faced with these problems, US veterinarians likely would resort to more powerful therapeutic antibiotics, and the total use of antibiotics would rise.

The economic impact of a US ban largely would depend on the willingness of US veterinarians to increase therapeutic use. Recent experience in the United Kingdom indicates that the costs and management required in eliminating use of subtherapeutic antibiotics are significant. Under agreements with retailers, UK producers eliminated AGPs in poultry production in 2000. Now, faced with significant problems of disease and diarrhea in their flocks, they are reintroducing antibiotics to *prevent* disease. Currently, total antibiotic use has dropped, but AGP use may increase as one tool in increased management of animal health.

For More Information

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