

PORK SAFETY

Title: Development of Antibiotic Usage Information in Swine - **NPB #05-187**

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Abstract

We evaluated cost accounting-based and in-barn methods of allocation of antibiotics across closeout groups and sow farms within one production system. This encompassed deliveries of antimicrobials to be administered in feed or water, as well as injectable products. Our aim was to validate the accounting records of deliveries, evaluate the amount of carryover of product between closeout groups, and estimate the fluctuation of inventories in sow herds. We also estimated overall antibiotic use by class and delivery methods. Beginning and ending antibiotic and animal inventories were obtained for the sow herds and closed out groups. Antibiotic use was collected by product code and summarized by type. Validation of the usage data was achieved through reconciliation with on-farm inventories and collection of empty antibiotic containers. Additionally, we surveyed farm managers on the likelihood of collating and sharing such information.

Three general observations can be made from this study:

1. For other than antibiotics delivered through feed, there is a systematic underestimation of antibiotic usage in on-farm records. Our estimate is that 42% of antibiotics that are delivered to the farm to be administered through injection or water delivery were recorded.
2. Collection of empty containers can increase the likelihood of recording, though methods of ensuring compliance need to be identified.
3. Cost accounting methods are the most accurate method of identifying and attributing antibiotic use. However, there is some reluctance to sharing that information. It is probable that this can be overcome with further education.

Benefit of Research to Industry:

There exists global concern about the emergence of antibiotic-resistant strains of bacteria and their potential relationship to antimicrobial use in food animal production. Despite this, the U.S. swine industry does yet have a way to describe its antibiotic use in terms of type, quantity and purpose. The objectives of this research are to establish and validate methods to benchmark antibiotic use in the swine industry and to obtain greater understanding of current patterns of antibiotic use in U.S. pork production. The existence of an antibiotic use benchmark will permit the U.S. swine industry to take a proactive position in addressing concerns of customers both in the U.S. and abroad.

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Introduction

The use of antimicrobial compounds in food animal agriculture, especially sub-therapeutic applications, and the emergence of antibiotic-resistant bacterial strains are a growing concern among health organizations in both the United States and abroad^{1,2,3,4}. In June 2000, members of the World Health Organization (WHO) gathered in Geneva, Switzerland and issued *Global Principles for the Containment of Antimicrobial Resistance in Animals Intended for Food*³. The following year, after a meeting in Oslo, Norway, the WHO issued *Monitoring antimicrobial usage in food animals for the protection of human health*⁴. Both publications stress the need for development of systems to monitor antimicrobial use.

Few reports exist of efforts to quantify antimicrobial use in animal agriculture. In countries where antimicrobials are not produced, government records of drug imports can be used for quantification, however, this cannot track antimicrobial use to the site or species level⁵. Dunlop *et al.* used mail surveys to identify “types, frequency, and motives for antimicrobial use” among Ontario swine producers⁶. Denmark has developed the integrated informational database to track antimicrobial sales to food animal production site, species and [when available] production stage^{7,8,9}. The Danish system’s ability to accurately follow the distribution of antimicrobials is further enhanced by the need for veterinary prescription.

Efforts to quantify antimicrobial use in the U.S. have been limited to date. The Animal Health Institute reports annually the pounds of antibiotics produced in the U.S.; however these figures detail neither exports nor species of use¹⁰. In the U.S., food animal producers can also obtain antimicrobials through multiple sources. In addition, U.S. federal law permits veterinarians to prescribe extralabel antibiotic use of non-prohibited antibiotics under the “Animal Medicinal Drug Use Clarification Act of 1994”¹¹. Veterinarians prescribing extralabel antibiotic use are required to maintain prescription records (including product, purpose, species, species age and location) for two years and are subject to FDA (Food and Drug Administration) evaluation¹¹. Several classes and concentrations of antibiotics are also available over-the-counter in injectable, water-soluble and feed inclusion forms.

The aim of this project is to develop a benchmark for antibiotic use in the U.S. swine industry. Webster’s defines a benchmark as, “a standard or point of reference in measuring or judging quality, value, etc.”¹². Benchmarks of antibiotic use in the swine industry can be made at several different levels. In a recent report to the National Pork Board entitled “Evaluation of Drug Usage Tracking Systems for Animal Production”, we identified opportunities and limitations to comprehensive benchmarks of antibiotic use on swine farms. These are particularly evident if a further requirement is to relate antibiotic use to decision-making processes for treatments on the farm. To reiterate previous recommendations:

“In the absence of either regulatory requirements or financial incentives, effective systems to track antimicrobial use are unlikely to be widely implemented if they place additional demands on producers. The following are three potential approaches to achieving regular, accurate and consistent antimicrobial use data in swine production that do not rely on regulatory intervention to mandate the collection of such information:

1. *Examine existing practices at farm level in more detail to define a common data set that could be used across producers by, as much as possible, utilizing their current data collection requirements. This approach would yield the largest number of participating farms on a continual basis, but it would lack the granularity to understand changes in usage, and potential implications, at levels below the farm or system level. It is apparent that production records rarely contain the treatment details, nor is there a discipline or validation of current entry systems. Accounting records have been refined with the emphasis on cost accounting so that the itemized records of purchases and allocations to sow herds and close-out groups are predominant. If purchase and delivery provides adequate detail, antibiotic use data is in place, but uncompiled and would be a first step in defining a usable, common data set.*
2. *Build off existing systems to develop a common electronic system that could be used on a periodic basis by a representative number of producers that provides more detailed data on antimicrobial usage. Coming up with a system that would allow this over a large number of farms is a far greater challenge than the first strategy. It would also require more effort at farm level, although the total amount of effort would be driven by the technologies employed. The advantage, however, is that this*

approach would yield much more detailed information on antimicrobial usage throughout the swine production cycle. If only done periodically to identify changes over time (producers use it for a set time period every year or other year), producers may be willing to do so with limited or no financial support.

3. *a) Intermittently conduct standardized surveys on a representative basis to estimate trends in usage patterns in industry over time; or b) pay sentinel production systems (and possibly veterinarians) to supply continual data on antimicrobial use. Both these approaches have shortcomings but recognize the realities that some cost is unavoidable if reliable data are to be obtained."*

These three scenarios provide the framework for further research described in this proposal. The initial questions must address the feasibility of these approaches. More detailed methodologies for data collection in each scenario must be developed and pilot projects will be conducted to evaluate feasibility under practical conditions. Partners in the pilot development phase will include farm supply distribution warehouses, including their accountants, farm managers, record keeping system designers, and farm managers.

Objectives

1. To evaluate cost-based accounting systems as a method to measure antibiotic use in sow, nursery, and grow-finish production at the group, barn or site levels.
2. To evaluate the feasibility of detailed group-level antibiotic use in nursery and grow-finish production sites to attribute antibiotic use to group records in a central computerized database.
3. To assess the feasibility and potential participation rate of collection of antibiotic use by surveys.

Materials and methods

Accounting Records

We evaluated cost accounting-based methods of allocation of antibiotics across closeout groups and sow farms within two production companies. We evaluated recorded deliveries to 41 nursery groups, 26 grow-finish groups, 25 wean to finish groups and 18 sow herds. We estimated overall antibiotic use by delivery methods. Beginning and ending antibiotic and animal inventories were obtained for the sow herds and closed out groups.

Farm-based records

Preset forms were used by each farm, allowing the recording of water and injectable antibiotic use by day, these are the same groups also analyzed using the accounting records. In concert, data of feed antibiotic use was collected from the mill at time of delivery. Validation of the usage data was compared with on-farm inventories, collection of all empty antibiotic containers.

Records included:

- i. Group where treatment occurred
- ii. Product used
- iii. Number of animals treated
- iv. Reason for treatment

Records were made of partially used antibiotic inventory at the beginning and end of each close-out group and at the beginning and end of study periods for the sow unit. Labeled refuse containers were placed in sites. Site personnel were instructed to dispose of all empty antibiotic containers (bottles, jars, bags, etc.) in a labeled refuse container and container contents were tabulated and attributed to each group. Estimates of antibiotic use obtained through barn inventory and refuse containers will be compared to antibiotic use records in PigCHAMP.

Survey methods

We also conducted a survey on the feasibility of surveys of antibiotic use information. We surveyed farm managers on the likelihood of sharing such information. This is purposeful as we feel that the response rate

would be higher on such a survey, though it may overestimate the actual level of cooperation. The availability and likelihood of cooperation on the following variables will be ascertained:

- Antibiotic purchases
- Farm or group-level deliveries
- Purposes of use
- Current methods of recording antibiotic use
- Antibiotic use tracking level (i.e., animal, pen, group, site, operation)
- Operation type (i.e., sow unit, farrow-to-finish, farrow-to-feeder, nursery-finish, etc.)
- Quantity of pigs marketed or supervised annually
- Willingness to share antibiotic use information
- Likelihood of collecting antibiotics use information by day and production group.
- Perceived value of antibiotic use information

The survey was conducted in accordance with the methods described by Dillman¹⁵. Surveys were sent to 400 randomly selected pork producers who participated in the Pork Check-off in 2004. Non-respondents were evaluated as to size of herd and geographic location in comparison to respondents.

Results and Discussion

Accounting Records

Consumption by group (nursery, grow/finish or wean to finish) or by site (sow unit) covered all assignments of antibiotics assigned by the cost accounting system. Additional product types were not found on the farm, nor was there additional product found, suggesting no deliveries outside that described by the accounting system. Double entry accounting made it unlikely that product was lost in the system. Additionally, central stores and the feed mill performed monthly inventories that validated the accuracy of the records. On interview, one company did have inventory errors that were reconciled by interviewing the veterinarian, owing to undocumented withdrawals by that person. The only potential entry point on interview was free product provided directly to a site for experimental studies – this did not occur in the realm of this study.

Two real mechanical deficiencies in this method of monitoring antibiotic intake were identified. The first is the occasion where more than one group of pigs was located on one site, and the storage of antibiotics was in a central facility. Injectable and water compounds were allocated equally to groups, in spite of probable different levels of usage, as implied by on-site records. Feed level antibiotic allocation by group may also be affected when deliveries to a group are limited by bin capacity and the extra feed is put in a second bin, though unrecorded.

The second deficiency is in the variation of ending on-farm inventory between groups or time periods. The mean variation in inventory, expressed as a function of overall intake for the group was 2.5%. This is relatively small and appears to not be a major contributor to recording error.

From the data, without implying representation of the industry, we estimate that the mean allocation per growing pig was 8.04 grams of active compound per pig sold. Of this, 83% was delivered through feed, 13% through water and 3% through injection. This included all allocations from birth through market. Use of antibiotics in sows in this study was limited to injections in this study and amounted to 0.77 grams per sow per year.

Farm-based records

Farm-based records focus on the use of injectable and water-based medicines. Feed-based allocations were not recorded on farm and instead we were referred to printouts of the feed delivery. Records on paper were inconsistently used, even with a potential study bias. Total recorded use of accounted delivery of active ingredient varied from 0 to 104%, with a mean proportion of 42%. The collection of containers resulted in a similar range of 0 to 99%, with a mean of 57%. Sow farms recorded a higher proportion of product used, approximately 81%, though container collection was poorer, at 50%. Injectable therapies were less likely to be recorded (33%) but containers were more likely to be collected (65%). Approximately 22% of recorded

treatments did not include a reason. In neither system was there any attempt to reconcile on-farm treatment records and accounting records.

Survey results

Of the 400 surveys sent, 14 were returned as undelivered. Of the remaining 386, 51 were completed and returned, and a further 18 were return as out of business or uninterested. No significant differences were found between the non-respondents and respondents in terms of size or number of pigs marketed.

Of the respondents, 88% felt they were capable of reporting the types of antibiotics purchased, and 87 % reported they could report the quantity of each type of antibiotic purchased. Beyond this, the capabilities dropped. 32% reported an ability to report individual antibiotic usage at the level of the farm (site) and 29% at the level of the production group, and 21% with the reason for use of each antibiotic and 20% with the specific level of antibiotic application. When asked about production type, capabilities were much higher for sows (75%) and litters (74%) than production group (18%).

91% used accounting records of antibiotic use, while 82% used computerized records, while only 47% used written records. Willingness to share these records anonymously, when rated on a 1-5 scale for never to absolutely had a median score of 3.3 for one's packer, 2.1 for the state extension service, 2.6 for the National Pork Board and 1.7 for the FDA. The willingness to participate was low and may be lower in those that did not respond.

Lay interpretation

There exists global concern about the emergence of antibiotic-resistant strains of bacteria and their potential relationship to antimicrobial use in food animal production. Despite this, the U.S. swine industry struggles with ways to describe its antibiotic use in terms of type, quantity and purpose. The best method to record and monitor antibiotic use at this time is through cost accounting records. On farm recording has real potential biases in under-reporting of usage that makes its utility questionable. Accounting records are questioned as to their accuracy, but for consumption estimates, they provide the best indicators. Much more effort must be placed in improving compliance in recording water and injectable therapies on farm to reflect accounting records.

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Appendix 1: letter sent to producers

Dear Pork Producer:

You are receiving this letter because you have been selected to participate in a survey funded by the National Pork Board.

The World Health Organization has called for each country to develop a method to account for use of antimicrobial compounds (antibiotics) in production animal agriculture. We at the University of Minnesota are conducting a survey among U.S. pork producers to determine both their willingness and ability to report antibiotic use in their animals.

Please take a moment to complete the enclosed survey and return it in the self-addressed, stamped envelope provided. All responses will remain anonymous.

Respectfully,

A handwritten signature in cursive script, appearing to read "Stephen Kettle-Rand".

To help us understand your perspective, please provide some information about the type and size of your operation.

How would you best describe your operation (circle the most appropriate)?	Farrow-to-wean	Farrow-to-finish	Farrow-to-feeder	Nursery	Grow-finish	Other (please describe)
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How many pigs does your operation market annually?	≤1,000	1,001-10,000	10,000-50,000	51,000-250,000	>250,000
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If you were required to provide information on your operation's antibiotic usage, what information would you be able to provide today (circle the most appropriate)?

Type(s) of antibiotics purchased	Yes	No	
Quantity of each type of antibiotic purchased	Yes	No	
Individual antibiotic usage at the level of the farm (site)	Yes	No	
Individual antibiotic usage at the level of the production group	Yes	No	
Reason for use of each antibiotic	Yes	No	
Specific level of antibiotic application			
Sow	Yes	No	N/A
Litter	Yes	No	N/A
Production group	Yes	No	N/A

How do you maintain your records of antibiotic use (circle all that apply)?

Written records	Computerized records	Accounting records
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Please rate your willingness to, if asked, anonymously share your operation's antibiotic usage with the following entities (circle the most appropriate):

	Never				Absolutely
Your Packer	1	2	3	4	5
State Extension Service	1	2	3	4	5
National Pork Board	1	2	3	4	5
U.S. Food and Drug Administration	1	2	3	4	5

Lastly, please rate how valuable you perceive antibiotic use information to be to your own management (circle the most appropriate).

Not at all valuable				Highly valuable
1	2	3	4	5

Thank you for your participation!