United States Department of Agriculture

Animal and Plant Health Inspection Service

Veterinary Services

National Animal Health Monitoring System

May 2019

Antimicrobial Use and Stewardship on U.S. Swine Operations, 2017

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Cover photo courtesy of the National Pork Board

Items of Note

The USDA's National Animal Health Monitoring System's (NAHMS) Antimicrobial Use and Stewardship on U.S. Swine Operations, 2017 study represents the Nation's first in-depth look at antimicrobial use and stewardship practices on U.S. swine sites. The study was designed to collect information about antimicrobial use and stewardship practices[1] on U.S. swine sites from July 1 through December 31, 2016—before the U.S. Food and Drug Administration (FDA) implemented antimicrobial use policy changes[2] on January 1, 2017. The FDA changes included eliminating the use of medically important antimicrobials[3] for growth promotion purposes in food animals and requiring veterinary oversight for the use of medically important antimicrobials in animal feed or water. Data for the study were collected from swine sites with at least 1,000 market pigs on December 1, 2016. In total, producers from 199 swine sites provided data for this report.

Over 75 percent of all sites gave market pigs antimicrobials in water. Of sites that had nursery-age pigs, about 50 percent gave the pigs antimicrobials in water. Of sites that had grower/finisher-age pigs, about 60 percent gave the pigs antimicrobials in water.

For sites that gave nursery-age and grower/finisher-age pigs antimicrobials in water, the highest percentages gave them for respiratory disease and diarrhea. Gentamicin, penicillin G, and oxytetracycline were the antimicrobials given in water to nursery-age pigs by the highest percentages of sites. Oxytetracycline and lincomycin were the antimicrobials given in water to grower/finisher-age pigs by the highest percentages of sites.

More than 90 percent of all sites gave market pigs antimicrobials in feed. About 90 percent of sites that had nursery-age pigs gave the pigs antimicrobials in feed, and about 83 percent of sites that had grower/finisher-age pigs gave the pigs antimicrobials in feed. As was the case with antimicrobials used in water, the highest percentages of sites gave nursery-age pigs antimicrobials in feed for respiratory disease and diarrhea. About 50 percent of sites that had grower/finisher-age pigs gave the pigs antimicrobials in feed for respiratory disease, and more than one-third of sites gave them for growth promotion.

Chlortetracycline/tiamulin and carbadox were the antimicrobials given in feed to nursery-age pigs by the highest percentages of sites. Chlortetracycline/tiamulin, bambermycin, and chlortetracycline alone were the antimicrobials given in feed to grower/finisher-age pigs by the highest percentages of sites.

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[1] Includes information on decision-making, record-keeping, producer education, quality assurance programs, and the use of veterinarians.

[2] FDA Guidance for Industry #209, #213

[3] Any antimicrobial the FDA deems medically important with respect to the use of that class of antimicrobials for therapeutic use in human medicine.

More than 90 percent of sites that gave antimicrobials in water or feed recorded at least some information about how antimicrobials were administered. About 92 percent of these sites recorded the date that antimicrobials use in water began, and about 94 percent recorded the antimicrobial used. About 97 percent of sites that gave antimicrobials in feed recorded the date treatment began and the antimicrobial used.

Most sites consulted a veterinarian when making decisions on antimicrobial use. For example, on about 88 percent of sites that gave antimicrobials in water, a veterinarian decided when to use antimicrobials in water, and on about 92 percent a veterinarian decided which antimicrobials to use in water. Similarly, on about 87 percent of sites that gave antimicrobials in feed, a veterinarian decided when to use antimicrobials in feed, and on about 91 percent a veterinarian decided which antimicrobials to use in feed. About 65 percent of sites had a veterinarian visit their site from July 1 through December 31, 2016, and almost all sites (98.2 percent) had a veterinarian-client-patient relationship (VCPR).

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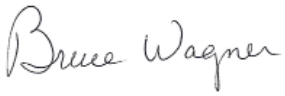
Acknowledgments

This report was a cooperative effort between two U.S. Department of Agriculture (USDA) agencies: the National Agricultural Statistics Service (NASS) and the Animal and Plant Health Inspection Service (APHIS).

We want to thank the NASS enumerators, State and Federal veterinary medical officers (VMOs), and animal health technicians (AHTs) who visited the sites and collected data for the Antimicrobial Use and Stewardship on U.S. Swine Operations, 2017 study. Their hard work and dedication to USDA's National Animal Health Monitoring System (NAHMS) were invaluable. The roles of the producers, NAHMS coordinators, VMOs, AHTs, and NASS enumerators were critical in providing quality data for the report. Recognition also goes to the personnel at USDA–APHIS–Veterinary Services' Center for Epidemiology and Animal Health for their efforts in generating and distributing this report.

All participants are to be commended, particularly the producers whose voluntary efforts made this study possible.



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Suggested bibliographic citation for this report:
USDA. 2019. “Antimicrobial Use and Stewardship on U.S. Swine Operations, 2017”
USDA–APHIS–VS–CEAH–NAHMS. Fort Collins, CO
#752.0419

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Introduction

The USDA's National Animal Health Monitoring System's (NAHMS) Antimicrobial Use and Stewardship on U.S. Swine Operations, 2017 study represents the first nationally representative study focused on antimicrobial use and stewardship practices on U.S. swine sites. In total, 1,725 sites were eligible to participate in the study, of which 388 consented to participate, and 199 completed the questionnaire.

A nonregulatory program of the USDA's Animal and Plant Health Inspection Service, NAHMS is designed to help meet the Nation's animal health information needs. The USDA Antimicrobial Resistance Action Plan, released in 2014, recommended that USDA agencies perform enhanced monitoring of antimicrobial use in food-producing animals. In addition, on January 1, 2017, the U.S. Department of Health and Human Services' FDA completed implementing policy changes regarding the use of antimicrobials in food-producing animals, as specified in the FDA Guidance for the Industry #209. These changes included

- Eliminating the use of medically important antimicrobials for growth promotion purposes in food-producing animals, and
- Requiring veterinary oversight for use of medically important antimicrobials in animal feed or water.

The NAHMS Antimicrobial Use and Stewardship on U.S. Swine Operations, 2017 study represents new data collection and reporting efforts by the USDA and is intended to be repeated over time to monitor changes in antimicrobial use practices. This national study examined antimicrobial use and stewardship practices on swine sites with an inventory of at least 1,000 market pigs on December 1, 2016, before the FDA policy changes were completely implemented.

This study was conducted in 13 top swine-producing States, which represented 92.1 percent of the U.S. swine inventory and 93.8 percent of U.S. swine sites with 1,000 or more pigs in 2016. Using the methodology as described in Section II of this report, the statistical results from this study can be generalized to the population of U.S. swine operations with weaned pigs and an inventory of 1,000 or more market pigs in the 13 participating States.

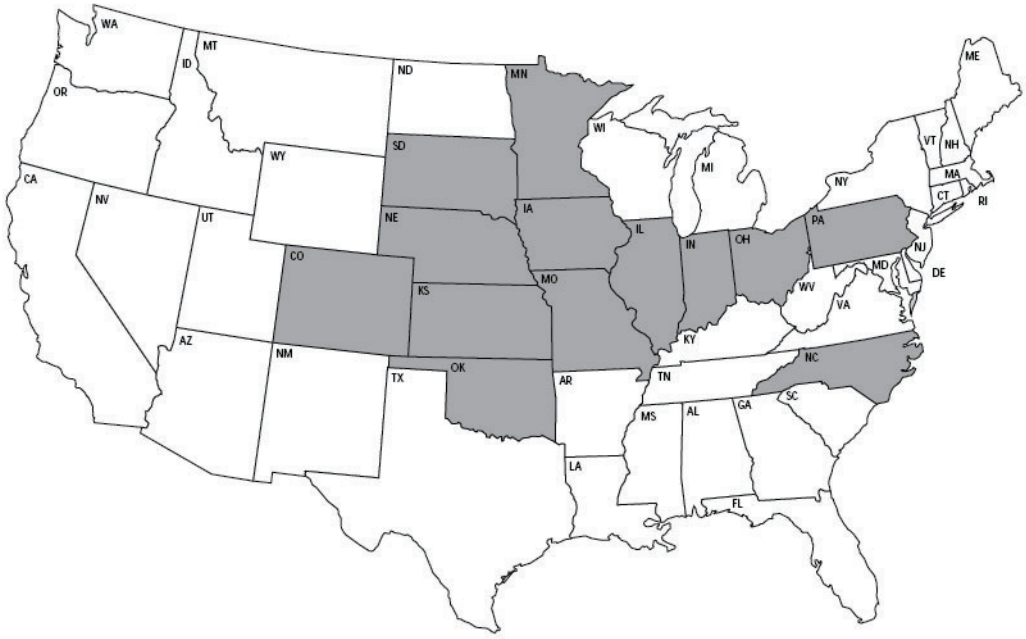
For the study, the USDA's National Agricultural Statistics Service (NASS) randomly selected 1,600 operations and contacted them by phone to request their participation in the study. Interested respondents completed a site-selection form and signed a consent form that gave NASS permission to provide their contact information to USDA-APHIS-Veterinary Services. Personal interviews with study respondents were conducted by State and Federal veterinary medical officers, who collected data on the operations'

antimicrobial use and stewardship practices from July 1 through December 31, 2016. The questionnaire was administered from July through September 2017.

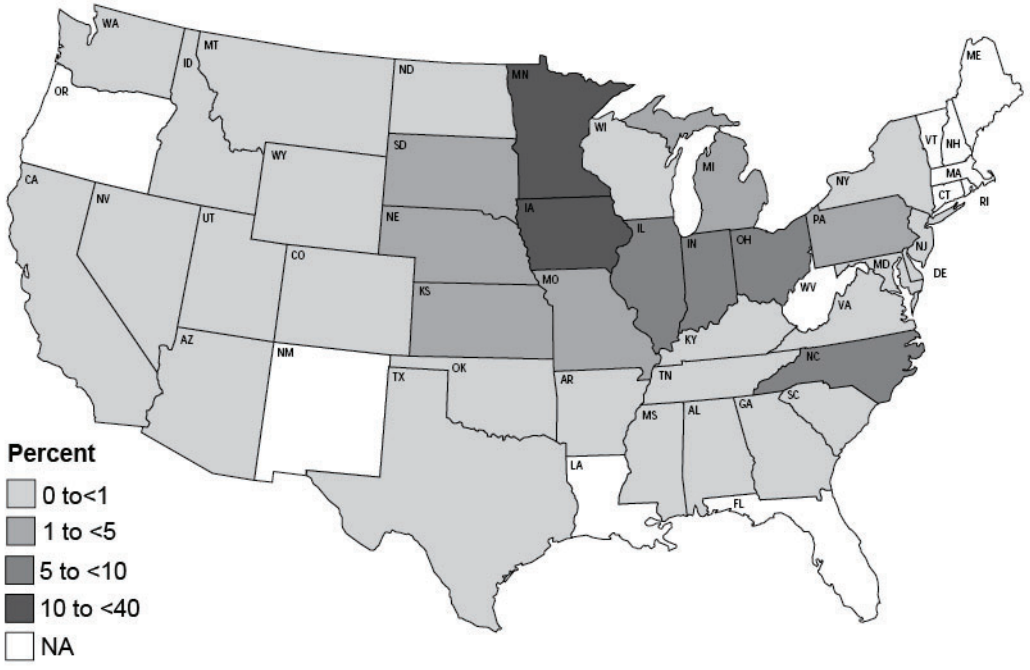
Study objectives were to

- Describe antimicrobial use practices in feed and water;
- Estimate the percentage of production sites using specific antimicrobials in feed and/or water, and the percentage of market pigs receiving specific antimicrobials in feed and/or water, by reasons for using antimicrobials;
- Provide baseline data on antimicrobial use practices in place before FDA policy changes were implemented, which can be used to evaluate trends in antimicrobial use over time; and
- Describe antimicrobial stewardship practices.

States participating in the NAHMS Antimicrobial Use and Stewardship on U.S. Swine Operations, 2017 study



Percentage of U.S. swine operations with 1,000 or more market swine*



*NASS 2012 Agriculture Census

Life Cycle of a Market Pig

Gilts (female pigs) reach maturity and are bred at 170 to 200 days of age. After delivering her first litter, a gilt is called a sow.

Sows and gilts are moved to a farrowing barn when they are ready to give birth, or farrow. Sows nurse piglets until they are weaned at about 21 days of age.

After weaning, piglets are moved to a nursery or a wean-to-finish barn and are housed with piglets from other litters. They are in the nursery phase for about 6 weeks.

The grower/finisher phase begins when pigs are about 9 weeks old and lasts 16 to 17 weeks. In this phase, pigs move to a finishing barn or, if in a wean-to-finish facility, remain in the same barn.

GESTATION → **FARROWING** → **NURSERY** → **GROWER & FINISHER**

WEAN-TO-FINISH

114 days (3 months, 3 weeks, and 3 days)

0 to 3 weeks

3 to 9 weeks

9 to 25 weeks

Terms Used in This Report

Antibiotic: A chemical compound, generally produced by molds, that inhibits and/or kills certain bacteria. Antibiotics are very effective against illnesses caused by bacteria.

Antimicrobial: Any substance of natural, semisynthetic, or synthetic origin that kills or inhibits the growth of microorganisms but causes little or no damage to the host. All antibiotics are antimicrobials, but not all antimicrobials are antibiotics. This report uses the term "antimicrobial."

Antimicrobial stewardship and judicious use: Includes keeping records of antimicrobial use, providing antimicrobial use training for employees, conducting periodic facility audits or assessments, using a veterinarian and having a valid veterinarian-client-patient-relationship, taking steps to prevent disease, and using antimicrobials responsibly.

> **Antimicrobial stewardship:** Refers to the actions veterinarians and producers take individually to preserve the effectiveness and availability of antimicrobial drugs through conscientious oversight and responsible medical decision-making, while safeguarding animal, public, and environmental health.[4]
>
> **Judicious use of antimicrobials:** When the decision is reached to use antimicrobials for treatment, control, or prevention of disease, veterinarians should strive to optimize therapeutic efficacy and minimize resistance to antimicrobials to protect public and animal health and welfare.[5]

Common Swine Industry Audit: An audit that standardizes third-party audits, such as those required by packers or other stakeholders. The audit is based on Pork Quality Assurance-Plus and Transport Quality Assurance educational programs.

Medically important antimicrobial: Any antimicrobial the FDA deems medically important with respect to the use of that class of antimicrobials for therapeutic use in human medicine. As of January 1, 2017, medically important antimicrobials are no longer approved by the FDA to promote growth in food-producing animals, and medically important antimicrobials in animal feed or water require veterinary oversight. See appendix II for more information.

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[4]As defined by the American Veterinary Medical Association (AVMA), https://www.avma.org/KB/Policies/Pages/Antimicrobial-Stewardship-Definition-and-Core-Principles.aspx

[5]As defined by the AVMA, https://www.avma.org/KB/Policies/Pages/Judicious-Therapeutic-Use-of-Antimicrobials.aspx

Medicated feed:

Type A medicated article—Intended solely for manufacturing another Type A medicated article or a Type B or C medicated feed. It consists of a new drug(s) for use in animals, with or without carrier (e.g., calcium carbonate, rice hull, corn, gluten) and with or without inactive ingredients.

Type B medicated feed—Less concentrated than Type A medicated articles but more concentrated than Type C medicated feeds. Type B medicated feeds are used to make other Type B medicated feeds or Type C medicated feeds. Type B medicated feeds are never fed directly to animals. Type B medicated feeds could be a premix designed to be mixed with other feedstuffs to make a finished feed.

Type C medicated feed—The least concentrated medicated feeds. Type C feeds can be fed to animals without further mixing and can be fed as the sole ration, top dressed, or fed free choice.

Operation: The overall business and top-level management unit for a swine farm, which might consist of one or more sites. An operation can encompass all production phases of swine rearing (e.g., gestation, farrowing, nursery, and grower/finisher) on one or more sites (geographic locations), each devoted to a different production phase or combination of phases (see Site).

Percent animals: The number of animals with a certain attribute divided by the total number of animals in the given phase from July 1 through December 31, 2016. The particular phase referred to (i.e., percent nursery-age pigs or percent grower/finisher-age pigs) is identified in each table. For example, in table C.1.b, “Percent Nursery-age Pigs” refers to the number of nursery-age pigs given any (one or more) antimicrobial(s) in water divided by the total number of nursery-age pigs from July 1 through December 31, 2016.

Percent sites: The number of sites that had a certain attribute divided by the total number of sites. Percentages will sum to 100 when the attributes are mutually exclusive (e.g., percentage of sites categorized by size of site). Percentages will not sum to 100 when the attributes are not mutually exclusive (e.g., the percentage of sites using treatment methods in which sites might have used more than one method).

Population estimates: Point estimates in this report (percentages or averages) are provided with a measure of precision called the standard error. A 95-percent confidence interval can be created with bounds equal to the estimate, plus or minus two standard errors. If the only error is sampling error, the confidence intervals created in this manner will contain the true population mean 95 out of 100 times. An estimate of 7.5 with a standard error of 1.0 results in limits of 5.5 to 9.5 (two times the standard error above and below the estimate). When estimates are reported as being “higher” or “lower,” a

statistical difference is implied but not tested. Not all statistically different estimates are mentioned in the text of this report. All estimates in this report are rounded to the nearest tenth. If the estimate rounded to 0, the standard error was reported (0.0). If there were no reports of the event (0.0 percent) or if all operations reported the event (100.0 percent), no standard error was reported (—).

Pork Quality Assurance-Plus (PQA-Plus): An education program overseen by the National Pork Board that addresses food safety, animal well-being, environmental stewardship, worker safety, public health, and community engagement. Individuals can become certified and sites can receive PQA-Plus status through an on-farm site assessment with a PQA-Plus advisor. PQA-Plus certification can be completed through either face-to-face training with an advisor or by asking an advisor to grant access to an online course and exam. Certification lasts 3 years.

Production phases:

Grower/finisher—Production phase in which pigs are fed-out for slaughter. Pigs enter the grower/finisher phase at about 9 weeks old and weighing about 60 lb; they leave the phase at about 25 weeks old and approximately 280 lb (final market weight).

Nursery—Production phase in which newly weaned pigs are managed, fed, and housed until they go into the grower/finisher phase. Nursery-age pigs enter the nursery at about 3 weeks of age and weighing about 13 lb; they leave the nursery at about 9 weeks of age and weighing about 60 lb.

Wean-to-finish—Specialized production method in which newly weaned pigs are managed, fed, and housed until they reach final market weight. Pigs enter the wean-to-finish phase at about 3 weeks of age and weighing about 13 lb; they leave the phase at about 25 weeks old and weighing about 280 lb (final market weight).

Market pigs: Refers to all nursery-age and grower/finisher-age pigs.

Reason for use: Respondents were provided a list of approved antimicrobials and asked to identify which ones they used and the reason(s) for using them. The reasons for using antimicrobials in market pigs included therapeutic purposes (e.g., prevention, control, or treatment of different diseases or conditions), or for growth promotion.

Growth promotion—Includes increased rate of gain (weight) or improved feed efficiency. Prior to January 1, 2017, antimicrobial products could include label claims for growth promotion, but as of January 1, 2017, using medically important antimicrobials for growth promotion in food-producing animals is no longer an approved use.

Respondents were not asked to specify one of the three therapeutic purposes for each antimicrobial, as doing so would have required nonveterinary respondents to make a clinical decision or diagnosis. In addition, many FDA labels for veterinary antimicrobial drugs do not distinguish among therapeutic purposes, and some antimicrobials have labels with more than one purpose or indication.

Sample profile: Information that describes characteristics of the sites from which data were collected.

Site: One geographic location or address that functions as a unit to house one or more production phases in swine rearing, such as a gestation/farrowing site or a nursery site. A site can encompass more than one production phase, such as a farrow-to-finish site, which has gestation, farrowing, nursery, and grower/finisher pigs all at one location. A site can be a part of an operation or it can be the whole operation, if the operation has only one site (see Operation).

Site average: The value for each site summed over all sites reporting and divided by the number of sites reporting.

Size of site: Size groupings were based on the total number of market pigs present on December 1, 2016. Size of site was categorized as small (1,000 to 1,999 pigs), medium (2,000 to 4,999), and large (5,000 or more).

Total inventory: All market pigs present on a site on December 1, 2016.

Veterinarian-client-patient relationship (VCPR): The basis for interaction among veterinarians, their clients, and their patients. Maintaining a good VCPR is critical to animal health. According to the FDA, a valid VCPR[6] includes the following elements:

1. The veterinarian is responsible for making medical judgments regarding the health of animals and the need for medical treatment, and the client (the owner of the animals or other caretaker) has agreed to follow the instructions of the veterinarian.

2. The veterinarian has a sufficient knowledge of the animals, which allows the veterinarian to initiate at least a general or preliminary diagnosis of the animals' medical condition.

3. The veterinarian is readily available for a follow-up visit if animals develop adverse reactions to treatment or if the therapy regimen fails. It is important that the veterinarian has recently seen and is personally acquainted with the keeping and care of the animals by conducting examinations, and/or by making medically appropriate and timely visits to the animals' premises.

[6]https://www.ecfr.gov/cgi-bin/text-idx?SID=99550a83c97103df1503d4e34b99b26b&mc=true&node=pt21.6.530&rgn=div5#se21.6.530_13

Section I: Population Estimates

Where applicable, column or row totals are shown as 100.0 to aid in interpretation; however, estimates may not always sum to 100.0 due to rounding. Table columns or rows that do not sum to 100.0 percent indicate that the options were not mutually exclusive.

Note: Unless otherwise specified, the time period for all tables is July 1 through December 31, 2016, prior to FDA policy changes that took effect January 1, 2017 (see Introduction on p 1).

A. Site Demographics

1. Site inventory

Nursery-age pigs could be in a nursery-phase or a wean-to-finish phase. Overall, 27.5 percent of sites had a nursery phase and 35.5 percent had a wean-to-finish phase. A lower percentage of small and medium sites (58.7 and 57.7 percent, respectively) had nursery-age pigs in either phase compared with 71.9 percent of large sites. Overall, 78.6 percent of sites had grower/finisher-age pigs and 61.0 percent had nursery-age pigs.

A.1.a. Percentage of sites by age of pigs and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Age of pigs	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Nursery age	58.7	(9.6)	57.7	(11.3)	71.9	(10.2)	61.0	(6.5)
Nursery	26.9	(8.4)	19.1	(7.5)	49.6	(11.7)	27.5	(7.3)
Wean-to-finish	31.8	(12.0)	40.0	(12.7)	27.9	(12.6)	35.5	(9.4)
Grower/finisher age*	77.6	(9.8)	84.3	(7.9)	65.1	(11.1)	78.6	(7.6)

*Grower/finisher-age pigs could be in a grower/finisher or a wean-to-finish phase, though this information was not collected.

The percentages of sites by size category reported in this study did not differ from the percentages reported in the NASS 2012 Census of Agriculture. Medium sites accounted for the highest percentages of sites in both the NAHMS study and the Census (54.7 and 45.7 percent, respectively).

A.1.b. Percentage of sites by NAHMS study, NASS 2012 Census of Agriculture, and size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**Total**
Study/census	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**
NAHMS study*	23.8	(3.7)	54.7	(7.8)	21.4	(8.2)	100.0
NASS 2012 Census of Agriculture	25.3	NA	45.7	NA	29.0	NA	100.0

*As of December 1, 2016.

In the NAHMS study, 55.4 percent of pigs were on large sites.

A.1.c. Percentage of pigs by NAHMS study, NASS 2012 Census of Agriculture, and size of site:

Percent Pigs

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**Total**
Study/census	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**
NAHMS study*	5.7	(1.5)	38.9	(11.2)	55.4	(12.4)	100.0
NASS 2012 Census of Agriculture	5.8	NA	24.1	NA	70.1	NA	100.0

*As of December 1, 2016.

2. Site demographics and mortality for nursery-age pigs

Tables A.2.a and A.2.b refer to nursery-age pigs that entered a nursery phase from July 1 through December 31, 2016. In a nursery phase, newly weaned pigs (weighing approximately 13 lb) are managed, fed, and housed until they move into the grower/finisher phase at about 60 lb. Overall, 27.5 percent of sites had a nursery phase (table A.1.a), and 3.3 percent of pigs died on these sites while in the nursery phase.

A.2.a. For the 27.5 percent of sites that had a nursery phase (table A.1.a), percentage of pigs that died while in the nursery phase, by size of site:

Percent Pigs

Size of Site (number of market pigs)

Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
3.1	(0.7)	2.7	(0.2)	3.5	(0.6)	3.3	(0.5)

On average, pigs spent 46.7 days in the nursery phase, arriving at 21.3 days of age and leaving at 68.0 days of age.

A.2.b. Average age of pigs (in days) when entering and leaving the nursery phase, by size of site:

Site Average Age (days)

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Age when . . .	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**
Entering nursery phase	22.4	(1.2)	21.7	(1.2)	20.3	(0.3)	21.3	(0.6)
Leaving nursery phase	68.4	(3.1)	71.5	(3.0)	64.2	(2.6)	68.0	(1.8)

Tables A.2.c and A.2.d refer to nursery-age pigs that entered a wean-to-finish phase. A wean-to-finish phase is a specialized production site in which newly weaned pigs (weighing approximately 13 lb) are managed, fed, and housed until reaching market weight (approximately 280 lb). Overall 35.5 percent of sites had a wean-to-finish phase (table A.1.a). On average, 2.9 percent of nursery-age pigs that entered a wean-to-finish phase died while still of nursery age.

A.2.c. For the 35.5 percent of sites that had a wean-to-finish phase (table A.1.a), percentage of pigs that died in the wean-to-finish phase while still of nursery age, by size of site:

Percent Pigs

Size of Site (number of market pigs)

Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
5.2	(1.6)	2.8	(0.4)	2.3	(0.4)	2.9	(0.5)

On average, pigs spent 154.2 days in the wean-to-finish phase, arriving at 21.8 days of age and leaving at 176.0 days of age. There were no differences by size of site.

A.2.d. For the 35.5 percent of sites that had a wean-to-finish phase (table A.1.a), average age of pigs when entering and leaving the wean-to-finish phase, by size of site:

Site Average Age (days)

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Age when . . .	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**
Entering the wean-to-finish phase	22.5	(0.7)	21.9	(0.7)	20.5	(2.0)	21.8	(0.8)
Leaving the wean-to-finish phase	173.3	(2.6)	176.6	(1.3)	176.1	(3.7)	176.0	(1.3)

3. Site demographics and mortality for grower/finisher-age pigs

Note: All tables in this section refer to sites that marketed grower/finisher pigs from July 1 through December 31, 2016.

Grower/finisher-age pigs weigh approximately 60 lb when they enter the grower/finisher phase. These pigs might be housed in a grower/finisher unit or a wean-to-finish unit until they reach market weight (approximately 280 lb) and are shipped for slaughter. Overall, 3.9 percent of grower/finisher-age pigs died, either in a grower/finisher phase or a wean-to-finish phase.

A.3.a. For the 78.6 percent of sites that had grower/finisher-age pigs (table A.1.a), percentage of grower/finisher-age pigs that died, by size of site:

Percent Pigs

Size of Site (number of market pigs)

Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
4.8	(0.8)	4.4	(0.3)	3.1	(0.3)	3.9	(0.3)

On average, pigs spent 106.2 days in the grower/finisher phase, entering at 66.4 days of age and leaving at 172.6 days of age.

A.3.b. Average age of pigs* when entering and when leaving the grower/finisher phase, by size of site:

Site Average Age (days)

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Age when . . .	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**
Entering the grower/finisher phase	65.0	(2.7)	67.7	(2.3)	64.7	(2.2)	66.4	(1.9)
Leaving the grower/finisher phase	177.0	(2.7)	166.6	(3.6)	183.1	(5.4)	172.6	(3.7)

*For pigs not in a wean-to-finish phase.

B. Overall Antimicrobial Use

Note: This section describes the use of antimicrobials administered to market pigs (all nursery-age and grower/finisher-age pigs) via water, feed, or injection—prior to FDA policy changes that took effect January 1, 2017 (see Introduction on p 1). Antimicrobials used in feed and water are the main focus of this report, although limited information about injectable antimicrobials was also reported in this section.

Overall, 95.5 percent of sites gave any (one or more) antimicrobials to market pigs by any route, while 77.8 percent gave antimicrobials in water, 90.4 percent in feed, and 89.4 percent by injection.

B.1. Percentage of sites that gave market pigs any antimicrobials, by route of administration and by size of site:

	Percent Sites							
	Size of Site (number of market pigs)							
	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Route of administration	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Water	63.3	(12.7)	83.2	(5.1)	79.8	(6.3)	77.8	(5.3)
Feed	81.8	(9.8)	90.8	(3.6)	98.7	(0.9)	90.4	(3.3)
Injection	80.1	(9.7)	92.5	(3.5)	91.8	(3.9)	89.4	(3.5)
Water or feed	84.2	(9.6)	92.3	(3.3)	99.0	(0.8)	92.0	(3.1)
Any of the above	88.2	(9.3)	96.9	(3.0)	100.0	(—)	95.5	(3.0)

Overall, 75.2 percent of sites gave market pigs any (one or more) medically important antimicrobials in water, and 85.4 percent administered medically important antimicrobials in feed. There were no differences by size of site in the percentages of sites that gave market pigs medically important antimicrobials.

B.2. Percentage of sites that gave market pigs any **medically important** antimicrobials,* by route of administration and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Route of administration	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error
Water	63.3	(12.7)	81.6	(5.5)	71.7	(4.8)	75.2	(5.7)
Feed	74.4	(11.0)	85.9	(5.0)	96.1	(1.8)	85.4	(4.4)
Water or feed	82.0	(9.9)	91.4	(3.5)	98.7	(0.9)	90.8	(3.3)

*See appendix II.

C. Nursery-age Pigs

Note: Unless otherwise specified, the time period for all tables is July 1 through December 31, 2016, prior to FDA policy changes that took effect January 1, 2017 (see Introduction on p 1).

1. Antimicrobials given in water to nursery-age pigs

Nursery-age pigs are weaned and weigh from 13 to 60 lb. These pigs could be housed in a nursery unit or a wean-to-finish unit. Overall, 48.7 percent of sites that had nursery-age pigs gave them antimicrobials in water for any of the reasons listed in the following table. The highest percentages of sites gave nursery-age pigs antimicrobials in water to prevent, control, or treat respiratory disease (35.1 percent), diarrhea (29.4 percent), or meningitis/ polyserositis/ arthritis (17.7 percent).

C.1.a. For the 61.0 percent of sites that had nursery-age pigs (table A.1.a), percentage of sites that gave nursery-age pigs any antimicrobials in water, by reason(s) for using antimicrobials and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Reason for use*	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Respiratory disease (bacterial pneumonia)	20.0	(8.1)	36.6	(10.7)	48.0	(9.1)	35.1	(7.3)
Diarrhea (bacterial enteritis, swine dysentery, ileitis, or other enteric diseases)	26.9	(8.8)	31.5	(9.8)	26.7	(4.6)	29.4	(6.6)
Atrophic rhinitis	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Cervical lymphadenitis (jowl abscesses)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Meningitis/ polyserositis/arthritis	23.7	(12.4)	19.9	(10.2)	5.2	(3.0)	17.7	(8.9)
Other disease	0.0	(—)	0.4	(0.3)	0.5	(0.5)	0.3	(0.2)
Any reason	41.3	(10.9)	48.5	(10.1)	57.6	(7.5)	48.7	(6.4)
No use	58.7	(10.9)	51.5	(10.1)	42.4	(7.5)	51.3	(6.4)

*To prevent, control, or treat the listed diseases.

On sites that had nursery-age pigs, 40.7 percent of all nursery-age pigs were given antimicrobials in water to prevent, control, or treat respiratory disease, and 37.1 percent were given antimicrobials in water to prevent, control, or treat diarrhea.

C.1.b. For the 61.0 percent of sites that had nursery-age pigs (table A.1.a), percentage of nursery-age pigs given any antimicrobials in water, by reason(s) for using antimicrobials and by size of site:

Percent Nursery-Age Pigs

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Reason for use*	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Respiratory disease (bacterial pneumonia)	29.2	(10.6)	52.4	(7.6)	34.7	(8.7)	40.7	(6.3)
Diarrhea (bacterial enteritis, swine dysentery, ileitis, or other enteric diseases)	37.4	(9.5)	45.5	(11.8)	31.2	(12.1)	37.1	(8.3)
Atrophic rhinitis	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Cervical lymphadenitis (jowl abscesses)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Meningitis/ polyserositis/arthritis	32.2	(12.6)	26.0	(11.9)	4.7	(2.5)	15.1	(7.7)
Other disease	0.0	(—)	0.7	(0.5)	0.0	(0.0)	0.3	(0.2)

*To prevent, control, or treat the listed diseases.

Overall, 48.7 percent of sites that had nursery-age pigs gave any (one or more) antimicrobials in water. The five antimicrobials used most often in water (by percentage of sites and percentage of nursery-age pigs) were gentamicin, penicillin G, oxytetracycline, tiamulin, and neomycin. The average number of days an antimicrobial was administered in water to nursery-age pigs ranged from 4.5 to 18.5 days. The only two products included in the “other” antimicrobials were amoxicillin and trimethoprim/sulfadiazine, with amoxicillin being the most commonly reported of the two.

C.1.c. For the 61.0 percent of sites that had nursery-age pigs (table A.1.a), percentage of sites that gave nursery-age pigs antimicrobials in water, percentage of nursery-age pigs given antimicrobials in water, and average number of days antimicrobials were given, by antimicrobial:

Antimicrobial	Percent sites	Std. error	Percent nursery-age pigs	Std. error	Site average number of days	Std. error
Bacitracin methylene disalicylate	0.0	(—)	0.0	(—)	NA	
Bacitracin zinc	0.0	(—)	0.0	(—)	NA	
Chlortetracycline	1.7	(0.8)	2.1	(1.2)	*	
Chlortetracycline/ sulfamethazine	0.2	(0.1)	0.2	(0.1)	*	
Florfenicol	0.1	(0.1)	0.6	(0.6)	*	
Gentamicin	21.5	(3.4)	28.7	(7.1)	5.0	(0.7)
Lincomycin	3.0	(1.4)	2.5	(1.4)	*	
Lincomycin/ spectinomycin	0.4	(0.4)	0.1	(0.1)	*	
Neomycin	14.9	(6.8)	15.7	(7.3)	4.9	(0.2)
Oxytetracycline	19.6	(7.5)	17.7	(7.4)	5.7	(0.4)
Penicillin G	20.0	(8.9)	21.2	(8.4)	8.1	(0.6)
Spectinomycin	0.0	(—)	0.0	(—)	NA	
Sulfachlorpyridazine	0.0	(—)	0.0	(—)	NA	
Sulfadimethazine	0.1	(0.1)	0.0	(0.0)	*	
Sulfadimethoxine	3.4	(3.1)	2.4	(2.2)	*	
Sulfaquinoxaline	0.5	(0.5)	1.3	(1.3)	*	
Tetracycline	2.0	(1.4)	8.4	(7.0)	*	
Tiamulin	15.2	(6.8)	13.3	(6.1)	18.5	(12.3)
Tilmicosin	1.4	(0.8)	0.9	(0.5)	*	
Tylosin	0.9	(0.8)	0.5	(0.5)	*	
Tylvalosin	0.0	(—)	0.0	(—)	NA	
Other	11.1	(5.4)	11.5	(5.4)	4.5	(0.4)
Any medically important antimicrobial[1]	45.5	(6.7)	**		**	
Any antimicrobial	48.7	(6.4)	**		**	

*Too few to report.
**Unable to estimate because pigs could have been treated with more than one antimicrobial.
[1]See appendix II.

The following table refers to antimicrobial use in nursery-age pigs from July 1 to December 31, 2016. In addition, the table primarily represents the use of individual antimicrobials in water because combination products such as chlortetracycline/sulfamethazine were rarely used.

More than 80 percent of sites that gave nursery-age pigs antimicrobials in water used three or fewer individual antimicrobials. Almost one-third of sites (31.2 percent) used only one individual antimicrobial.

C.1.d. For the 48.7 percent of sites that gave nursery-age pigs any antimicrobials in water for any reason (table C.1.a), percentage of sites by number of individual antimicrobials given, and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Number of individual antimicrobials given*	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
1	39.4	(20.1)	20.8	(10.7)	47.2	(16.1)	31.2	(11.4)
2	26.7	(8.8)	22.9	(10.8)	33.9	(13.0)	26.5	(7.4)
3	20.6	(7.7)	32.7	(8.9)	13.7	(6.0)	25.5	(7.1)
4 or more	13.3	(8.6)	23.6	(11.7)	5.2	(3.5)	16.9	(9.0)
Total	100.0		100.0		100.0		100.0	

*Combination products chlortetracycline/sulfamethazine and lincomycin/spectinomycin were counted as two individual antimicrobials (see table C.1.c).

For sites that gave nursery-age pigs tiamulin or "other" antimicrobials in water, the highest percentages gave these antimicrobials for respiratory disease. All sites that gave oxytetracycline in water gave it for respiratory disease. For sites that gave gentamicin and neomycin, the highest percentages gave these antimicrobials for diarrhea. For sites that gave penicillin G, the highest percentage gave it for meningitis/polyserositis/arthritis. The only two products included in the "other" antimicrobials were amoxicillin and trimethoprim/sulfadiazine, with amoxicillin being the most commonly reported of the two.

C.1.e. For the 61.0 percent of sites that had nursery-age pigs (table A.1.a), percentage of sites that gave nursery-age pigs antimicrobials in water, percentage of sites by antimicrobial given, and reason for using antimicrobial:

	Percent Sites										
			Reason for Use[1]								
	Percent sites that gave antimicrobials in water		**Respiratory disease** (bacterial pneumonia)		**Diarrhea** (bacterial enteritis)		**Meningitis/ polyserositis/ arthritis**		**Other disease**		
Antimicrobial[2]	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Total**
Gentamicin	21.5	(3.4)	9.0	(7.7)	91.0	(7.7)	0.0	(0.0)	0.0	(0.0)	100.0
Neomycin	14.9	(6.8)	2.8	(2.9)	87.0	(12.7)	10.3	(11.7)	0.0	(0.0)	100.0
Oxytetracycline	19.6	(7.5)	100.0	(—)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	100.0
Penicillin G	20.0	(8.9)	20.7	(15.6)	4.4	(3.7)	74.3	(17.9)	0.7	(0.8)	100.0
Tiamulin	15.2	(6.8)	83.6	(15.3)	2.9	(2.8)	13.0	(13.7)	0.5	(0.6)	100.0
Other	11.1	(5.4)	85.4	(9.8)	5.1	(5.1)	9.5	(6.6)	0.0	(0.0)	100.0

[1]To prevent, control, or treat the listed disease.
[2]Antimicrobials listed in table C.1.c. but not shown here were used by no sites or too few sites to break out by reason for use.

2. Antimicrobials given in feed to nursery-age pigs

Overall, 89.9 percent of sites that had nursery-age pigs gave them any (one or more) antimicrobials in feed for one or more of the reasons listed in the following table. The highest percentages of operations gave antimicrobials in feed to prevent, control, or treat respiratory disease or diarrhea (60.5 and 56.5 percent, respectively). The most commonly reported "other" reason for using antimicrobials was a combination of respiratory disease and diarrhea.

C.2.a. For the 61.0 percent of sites that had nursery-age pigs (table A.1.a), percentage of sites that gave nursery-age pigs any antimicrobials in feed, by reason(s) for using antimicrobials and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Reason for use	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Respiratory disease (bacterial pneumonia)*	56.5	(8.8)	61.4	(10.8)	62.0	(11.6)	60.5	(7.5)
Diarrhea (bacterial enteritis, swine dysentery, ileitis, or other enteric diseases)*	43.6	(10.6)	59.2	(13.8)	62.1	(8.7)	56.5	(8.6)
Atrophic rhinitis*	0.0	(—)	4.7	(4.7)	0.0	(—)	2.4	(2.5)
Cervical lymphadenitis (jowl abscesses)*	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Other disease*	9.9	(5.6)	6.0	(3.3)	25.5	(14.8)	11.9	(5.4)
Growth promotion	19.8	(11.8)	15.2	(8.6)	3.1	(3.1)	13.1	(5.4)
Any reason	96.3	(3.1)	86.1	(5.5)	92.1	(3.6)	89.9	(3.0)
No use	3.7	(3.1)	13.9	(5.5)	7.9	(3.6)	10.1	(3.0)

*To prevent, control, or treat the listed disease.

The highest percentages of nursery-age pigs were given antimicrobials in feed for respiratory disease and diarrhea (60.4 and 57.8 percent, respectively). The most commonly reported “other” reason for using antimicrobials was a combination of respiratory disease and diarrhea.

C.2.b. For the 61.0 percent of sites that had nursery-age pigs (table A.1.a), percentage of nursery-age pigs given any antimicrobials in feed, by reason(s) for using antimicrobials and by size of site:

Percent Nursery-Age Pigs

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Reason for use	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Respiratory disease (bacterial pneumonia)*	48.1	(8.3)	66.1	(8.6)	58.6	(15.0)	60.4	(9.3)
Diarrhea (bacterial enteritis, swine dysentery, ileitis, or other enteric diseases)*	48.5	(8.3)	56.0	(15.0)	60.7	(10.8)	57.8	(8.1)
Atrophic rhinitis*	0.0	(—)	2.9	(2.9)	0.0	(—)	1.1	(1.1)
Cervical lymphadenitis (jowl abscesses)*	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Other disease*	7.4	(4.5)	5.9	(3.1)	30.4	(17.3)	19.2	(10.7)
Growth promotion	17.3	(10.1)	11.6	(5.6)	4.3	(4.3)	8.2	(3.4)

*To prevent, control, or treat the listed disease.

Overall, 89.9 percent of sites that had nursery-age pigs gave any (one or more) antimicrobials in feed. The two antimicrobials given in feed to nursery-age pigs by the highest percentages of sites were chlortetracycline/tiamulin and carbadox; chlortetracycline/tiamulin was fed for an average of 16.1 days, starting when pigs were an average of 23.1 days of age, and carbadox was fed for an average of 24.7 days, starting when pigs were an average of 33.3 days of age.

Overall, 50.3 percent of sites gave nursery-age pigs medically important antimicrobials in feed.

C.2.c. For the 61.0 percent of sites that had nursery-age pigs (table A.1.a), percentage of sites that gave nursery-age pigs antimicrobials in feed, percentage of nursery-age pigs given antimicrobials in feed, average age of pigs (in days) when antimicrobial was first added to feed, and average number of days antimicrobial was given, by antimicrobial:

Antimicrobial	Percent sites	Std. error	Percent nursery-age pigs	Std. error	Site avg. age of pigs (days) when first given	Std. error	Site average number of days given	Std. error
Avilamycin	1.1	(0.8)	1.0	(0.9)	*		*	
Bacitracin methylene disalicylate	3.7	(1.7)	2.2	(1.4)	*		*	
Bacitracin methylene disalicylate/ chlortetracycline	0.1	(0.1)	0.0	0.0)	*		*	
Bacitracin zinc	0.0	(—)	0.0	(—)	NA		NA	
Bambermycin	0.0	(—)	0.0	(—)	NA		NA	
Carbadox	50.2	(10.2)	49.2	(9.7)	33.3	(2.5)	24.7	(2.6)
Carbadox/ oxytetracycline	10.8	(6.1)	10.5	(5.6)	23.0	(4.3)	31.1	(5.8)
Chlortetracycline	19.0	(7.3)	25.9	(10.0)	27.1	(2.4)	13.1	(1.4)
Chlortetracycline/ sulfamethazine	0.7	(0.6)	0.5	(0.4)	*		*	

continued→

C.2.c. (cont'd.) For the 61.0 percent of sites that had nursery-age pigs (table A.1.a), percentage of sites that gave nursery-age pigs antimicrobials in feed, percentage of nursery-age pigs given antimicrobials in feed, average age of pigs (in days) when an antimicrobial was first added to feed, and average number of days antimicrobial was given, by antimicrobial:

Chlortetracycline/ tiamulin	59.7	(8.0)	63.2	(9.5)	23.1	(1.6)	16.1	(1.4)
Chlortetracycline/ sulfathiazole/ penicillin	1.2	(0.9)	0.2	(0.2)	*		*	
Chlortetracycline/ sulfamethazine/ penicillin	0.4	(0.4)	0.5	(0.5)	*		*	
Florfenicol	0.0	(—)	0.0	(—)	NA		NA	
Lincomycin	2.6	(1.9)	1.7	(1.3)	*		*	
Narasin	0.7	(0.6)	0.3	(0.3)	*		*	
Neomycin/ terramycin	3.4	(2.6)	1.8	(1.3)	*		*	
Oxytetracycline	0.6	(0.4)	2.6	(1.7)	*		*	
Tiamulin	20.0	(5.2)	21.5	(7.7)	25.1	(2.2)	10.6	(1.3)
Tilmicosin	1.3	(0.8)	0.6	(0.4)	*		*	
Tylosin	0.6	(0.6)	0.7	(0.7)	*		*	
Tylosin/ sulfamethazine	0.0	(—)	0.0	(—)	NA		NA	
Tylvalosin	0.0	(—)	0.0	(—)	NA		NA	
Virginiamycin	0.0	(—)	0.0	(—)	NA		NA	
Any medically important antimicrobial[1]	50.3	(5.0)	**		**		**	
Any antimicrobial	89.9	(3.0)	**		**		**	

*Too few to report.
**Unable to estimate because pigs could have been treated with more than one antimicrobial.
[1]See appendix II.

For sites that gave nursery-age pigs antimicrobials in feed, 37.4 percent gave one or two individual antimicrobials, and 62.7 percent gave three or more individual antimicrobials.

C.2.d. For the 89.9 percent of sites that gave nursery-age pigs any antimicrobials in feed for any reason (table C.2.a), percentage of sites by number of individual antimicrobials given, and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Number of individual antimicrobials given*	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
1	20.0	(7.2)	22.8	(5.2)	2.0	(1.7)	13.1	(3.6)
2	36.9	(8.5)	20.1	(9.9)	20.7	(9.9)	24.3	(6.3)
3	30.0	(9.9)	48.0	(12.7)	52.4	(11.9)	44.9	(7.6)
4 or more	13.1	(6.5)	16.1	(7.6)	24.9	(9.3)	17.8	(6.2)
Total	100.0		100.0		100.0		100.0	

*Combination products, e.g., carbadox/oxytetracycline, were counted as two individual antimicrobials.

For sites that gave nursery-age pigs chlortetracycline, chlortetracycline/tiamulin, or tiamulin in feed, the highest percentage gave them for respiratory disease. For sites that gave carbadox or carbadox/oxytetracycline, the highest percentage gave them for diarrhea.

C.2.e. For the 61.0 percent of sites that had nursery-age pigs (table A.1.a), percentage of sites that gave nursery-age pigs antimicrobials in feed, percentage of sites by antimicrobial given, and reason for using antimicrobial:

Percent Sites

Reason for Use[1]

	Percent sites that gave antimicrobials in water		**Respiratory disease** (bacterial pneumonia)[1]		**Diarrhea** (bacterial enteritis)[1]		**Atrophic rhinitis**[1]		**Other disease**[1]		**Growth promotion**		
Antimicrobial[2]	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Total**
Carbadox	50.2	(10.2)	2.2	(1.8)	80.0	(12.4)	0.0	(0.0)	1.4	(1.2)	16.4	(11.7)	100.0
Carbadox/ oxytetracycline	10.8	(6.1)	10.0	(9.0)	79.1	(15.6)	0.0	(0.0)	3.4	(3.8)	7.5	(8.2)	100.0
Chlortetracycline	19.0	(7.3)	78.5	(8.8)	5.2	(4.3)	0.0	(0.0)	11.3	(6.1)	5.0	(4.0)	100.0
Chlortetracycline/ tiamulin	59.7	(8.0)	76.1	(10.9)	9.4	(4.4)	0.0	(0.0)	12.7	(7.9)	1.8	(1.5)	100.0
Tiamulin	20.0	(5.2)	68.0	(13.9)	19.7	(9.4)	0.0	(0.0)	12.3	(7.5)	0.0	(0.0)	100.0

[1]To prevent, control, or treat the listed disease.

[2]Antimicrobials listed in table C.2.c but not shown here were used by no sites or too few sites to break out by reason.

D. Grower/ finisher-age Pigs

Note: Unless otherwise specified, the time period for all tables is July 1 through December 31, 2016, prior to FDA policy changes that took effect January 1, 2017 (see Introduction on p 1).

Grower/finisher-age pigs are about 9 weeks old and weigh approximately 60 lb when they enter the grower/finisher phase. These pigs might be housed in a grower/finisher unit or a wean-to-finish unit until they reach market weight (approximately 280 lb) and are shipped for slaughter at about 25 weeks of age.

1. Antimicrobials given in water to grower/finisher-age pigs

Overall, 60.2 percent of sites that had grower/finisher-age pigs gave them any (one or more) antimicrobials in water for one or more of the reasons listed in the following table. The highest percentage of sites (53.5 percent) gave grower/finisher pigs any antimicrobials for respiratory disease. The most commonly reported “other” reason for using antimicrobials in water was a combination of respiratory disease and diarrhea.

D.1.a. For the 78.6 percent of sites that had grower/finisher-age pigs (table A.1.a), percentage of sites that gave grower/finisher-age pigs any antimicrobials in water, by reason(s) for using antimicrobials and by size of site:

	Percent Sites							
	Size of Site (number of market pigs)							
	Small (1,000–1,999)		Medium (2,000–4,999)		Large (5,000 or more)		All sites	
Reason for use*	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error
Respiratory disease (bacterial pneumonia)	54.3	(10.4)	51.9	(7.9)	58.1	(13.5)	53.5	(6.7)
Diarrhea (bacterial enteritis, swine dysentery, ileitis, or other enteric diseases)	19.6	(8.1)	18.7	(4.7)	12.0	(6.8)	17.7	(3.3)
Atrophic rhinitis	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Cervical lymphadenitis (jowl abscesses)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Meningitis/ polyserositis/arthritis	0.0	(—)	2.0	(1.7)	13.2	(11.4)	3.5	(2.5)
Other disease	2.4	(2.4)	0.5	(0.4)	0.8	(0.8)	1.0	(0.7)
Any reason	56.7	(10.1)	59.8	(6.5)	66.4	(9.9)	60.2	(5.3)
No use	43.3	(10.1)	40.2	(6.5)	33.6	(9.9)	39.8	(5.3)

*To prevent, control, or treat the listed diseases.

Overall, 26.4 percent of grower/finisher-age pigs were given antimicrobials in water for respiratory disease. About one-half of all grower/finisher-age pigs on small sites (52.3 percent) were given antimicrobials in water for respiratory disease compared with about one-eighth of grower/finisher-age pigs on large sites (12.7 percent).

D.1.b. For the 78.6 percent of sites that had grower/finisher pigs (table A.1.a), percentage of grower/finisher-age pigs given any antimicrobials in water, by reason(s) for using antimicrobials and by size of site:

Percent Grower/finisher-Age Pigs

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Reason for use*	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Respiratory disease (bacterial pneumonia)	52.3	(7.6)	33.6	(7.0)	12.7	(6.6)	26.4	(5.9)
Diarrhea (bacterial enteritis, swine dysentery, ileitis, or other enteric diseases)	18.5	(8.5)	15.6	(3.8)	4.9	(3.1)	11.2	(12.8)
Atrophic rhinitis	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Cervical lymphadenitis (jowl abscesses)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Meningitis/ polyserositis/arthritis	0.0	(—)	1.5	(1.3)	1.9	(1.1)	1.5	(0.8)
Other disease	1.6	(1.7)	0.5	(0.4)	0.0	(0.0)	0.4	(0.3)

*To prevent, control, or treat the listed disease.

Overall, 60.2 percent of sites that had grower/finisher-age pigs gave the pigs any (one or more) antimicrobials in water. Oxytetracycline and lincomycin were the antimicrobials given in water to grower/finisher-age pigs by the highest percentages of sites (27.1 and 14.0 percent, respectively). Less than 10 percent of sites gave any of the other listed antimicrobials in water to grower/finisher-age pigs. Oxytetracycline was given in water to 12.7 percent of grower/finisher-age pigs. The most commonly reported “other” antimicrobial used was amoxicillin. Over one-half of sites (56.7 percent) gave grower/finisher-age pigs medically important antimicrobials in water.

D.1.c. For the 78.6 percent of sites that had grower/finisher-age pigs (table A.1.a), percentage of sites that gave grower/finisher-age pigs antimicrobials in water, percentage of grower/finisher-age pigs given antimicrobials, and average number of days antimicrobial was given, by antimicrobial:

Antimicrobial	Percent sites	Std. error	Percent grower/ finisher-age pigs	Std. error	Site Average number of days given	Std. error
Bacitracin methylene disalicylate	0.0	(—)	0.0	(0.0)	NA	
Bacitracin zinc	0.0	(—)	0.0	(—)	NA	
Chlortetracycline	8.9	(4.1)	5.2	(2.1)	5.0	(0.7)
Chlortetracycline/ sulphamethazine	1.2	(0.7)	0.5	(0.3)	*	
Florfenicol	2.1	(2.1)	0.4	(0.4)	*	
Gentamicin	5.0	(2.7)	3.0	(1.7)	*	
Lincomycin	14.0	(4.1)	7.6	(2.4)	5.7	(0.5)
Lincomycin/ spectinomycin	0.6	(0.5)	0.5	(0.5)	*	
Neomycin	4.0	(1.4)	1.7	(0.6)	*	
Oxytetracycline	27.1	(9.0)	12.7	(5.4)	5.4	(0.3)
Penicillin G	1.1	(0.8)	0.7	(0.5)	*	
Spectinomycin	0.0	(—)	0.0	(—)	NA	
Sulfachlorpyridazine	0.4	(0.4)	0.2	(0.2)	*	
Sulfadimethoxine	4.8	(2.7)	1.9	(1.2)	*	
Sulfadimethazine	3.2	(2.2)	0.8	(0.6)	*	
Sulfaquinoxaline	0.0	(—)	0.0	(—)	NA	
Tetracycline	4.2	(2.6)	2.4	(1.7)	*	
Tiamulin	8.9	(2.7)	3.9	(1.4)	5.0	(0.1)
Tilmicosin	3.4	(2.5)	2.3	(1.8)	*	
Tylosin	4.2	(3.7)	1.9	(1.8)	*	
Tylvalosin	0.9	(0.6)	0.8	(0.5)	*	

continued→

D.1.c. (cont'd.) For the 78.6 percent of sites that had grower/finisher-age pigs (table A.1.a), percentage of sites that gave grower/finisher-age pigs antimicrobials in water, percentage of grower/finisher-age pigs given antimicrobials, and average number of days antimicrobial was given, by antimicrobial:

Other	4.9	(3.6)	3.2	(2.8)	*
Any medically important antimicrobial[1]	56.7	(5.4)	**		**
Any antimicrobial	60.2	(5.3)	**		**

*Too few to report.
**Unable to estimate because pigs could have been treated with more than one antimicrobial.
[1]See appendix II.

For sites that gave grower/finisher-age pigs antimicrobials in water, 53.1 percent of all sites gave only one antimicrobial in water; 32.4 percent of small sites gave three or more antimicrobials in water compared with only 1.2 percent of large sites.

D.1.d. For the 60.2 percent of sites that gave grower/finisher-age pigs any antimicrobials in water for any reason (table D.1.a), percentage of sites by number of individual antimicrobials given, and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Number of individual antimicrobials*	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
1	36.1	(14.4)	57.8	(8.6)	57.9	(13.2)	53.1	(6.0)
2	31.6	(15.9)	22.6	(4.3)	40.9	(13.3)	28.0	(6.3)
3 or more	32.4	(12.2)	19.6	(8.2)	1.2	(1.3)	18.9	(4.4)
Total	100.0		100.0		100.0		100.0	

*Combination products, e.g., lincomycin/spectinomycin, were counted as two individual antimicrobials.

For sites that gave grower/finisher-age pigs chlortetracycline, oxytetracycline, lincomycin, or tiamulin, the highest percentages gave these antimicrobials for respiratory disease. Chlortetracycline and lincomycin were the only antimicrobials used in water for meningitis/polyserositis/arthritis.

D.1.e. For the 78.6 percent of sites that had grower/finisher-age pigs (table A.1.a), percentage of sites that gave grower/finisher pigs antimicrobials in water, percentage of sites by antimicrobial given, and reason for using antimicrobial:

			Percent Sites								
			Reason for Use[1]								
	Percent sites that gave anti-microbials in water		**Respiratory disease** (bacterial pneumonia)		**Diarrhea** (bacterial enteritis)		**Meningitis/ polyserositis/ arthritis**		**Other disease**		
Antimicrobial[2]	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Total**
Chlortetracycline	8.9	(4.1)	71.7	(19.1)	4.8	(3.8)	23.5	(19.4)	0.0	(0.0)	100.0
Lincomycin	14.0	(4.1)	71.7	(18.2)	17.5	(15.0)	9.8	(8.0)	1.0	(1.1)	100.0
Oxytetracycline	27.1	(9.0)	90.0	(6.6)	10.0	(6.6)	0.0	(0.0)	0.0	(0.0)	100.0
Tiamulin	8.9	(2.7)	83.4	(9.9)	15.6	(9.6)	0.0	(0.0)	1.0	(1.0)	100.0

[1]To prevent, control, or treat the listed disease.

[2]Antimicrobials listed in table D.1.c but not shown here were used by no sites or by too few sites to break-out by reason.

2. Antimicrobials given in feed to grower/finisher-age pigs

Note: Estimates reflecting the use of antimicrobials for growth promotion were established before the implementation of FDA policy changes on January 1, 2017, after which medically important antimicrobials such as chlortetracycline could no longer be used for growth promotion.

Overall, 82.9 percent of sites that had grower/finisher-age pigs gave them any (one or more) antimicrobials in feed for one or more reasons listed in the following table. About two-fifths of sites gave antimicrobials in feed for respiratory disease or for growth promotion (43.4 and 36.0 percent of sites, respectively). About one-sixth of small and medium sites (16.9 and 15.6 percent, respectively) administered antimicrobials in feed for diarrhea compared with 65.5 percent of large sites. The most commonly reported “other” disease reason for using antimicrobials in water was a combination of respiratory disease and diarrhea.

D.2.a. For the 78.6 percent of sites that had grower/finisher pigs (table A.1.a), percentage of sites that gave grower/finisher-age pigs any antimicrobials in feed, by reason(s) for using antimicrobials and by size of site:

	Percent Sites							
	Size of Site (number of market pigs)							
	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Reason for use	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Respiratory disease (bacterial pneumonia)*	45.8	(10.9)	47.0	(17.2)	28.3	(13.0)	43.4	(12.7)
Diarrhea (bacterial enteritis, swine dysentery, ileitis, or other enteric diseases)*	16.9	(5.1)	15.6	(3.0)	65.5	(10.7)	24.7	(5.0)
Atrophic rhinitis*	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Cervical lymphadenitis (jowl abscesses)*	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Other disease*	25.1	(14.9)	22.1	(11.3)	41.4	(14.2)	26.2	(10.0)
Growth promotion	49.2	(16.4)	31.7	(17.0)	33.4	(19.4)	36.0	(14.3)
Any reason	87.5	(5.8)	78.5	(7.2)	91.5	(4.1)	82.9	(4.6)
No use	12.5	(5.8)	21.5	(7.2)	8.5	(4.1)	17.1	(4.6)

*To prevent, control, or treat the listed disease.

Over one-third of all grower/finisher-age pigs (35.2 percent) were given antimicrobials in feed for respiratory disease, and over one-fourth (26.2 percent) were given antimicrobials in feed for diarrhea. The most commonly reported “other” reason for using antimicrobials was a combination of respiratory disease and diarrhea.

D.2.b. For the 78.6 percent of sites that had grower/finisher-age pigs (table A.1.a), percentage of grower/finisher-age pigs given any antimicrobials in feed, by reason(s) for using antimicrobials and by size of site:

Percent Grower/finisher-Age Pigs

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Reason for use	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Respiratory disease (bacterial pneumonia)*	37.9	(9.9)	50.2	(17.1)	19.2	(12.1)	35.2	(11.5)
Diarrhea (bacterial enteritis, swine dysentery, ileitis, or other enteric diseases)*	18.0	(5.2)	12.5	(3.3)	42.2	(11.8)	26.2	(6.5)
Atrophic rhinitis*	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Cervical lymphadenitis (jowl abscesses)*	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Other disease*	29.5	(15.2)	18.2	(7.6)	21.4	(9.2)	20.8	(6.6)
Growth promotion	56.3	(15.5)	27.4	(13.7)	17.3	(12.7)	26.0	(11.1)

*To prevent, control, or treat the listed disease.

Overall, 82.9 percent of sites gave grower/finisher-age pigs any (one or more) antimicrobials in feed. The highest percentages of sites gave grower/finisher-age pigs chlortetracycline/tiamulin, bambermycin, and chlortetracycline in feed (55.4, 21.7, and 18.4, respectively). The average age of pigs when antimicrobials were first added to feed ranged from 75.4 days for chlortetracycline/tiamulin to 95.8 days for bambermycin. The average number of days antimicrobials were administered in feed to grower/finisher-age pigs ranged from 12.6 days for chlortetracycline to 54.6 days for bacitracin methylene disalicylate.

Overall, 77.8 percent of all sites with grower/finisher-age pigs gave the pigs medically important antimicrobials in feed.

D.2.c. For the 78.6 percent of sites that had grower/finisher-age pigs (table A.1.a), percentage of sites that gave grower/finisher-age pigs antimicrobials in feed, percentage of grower/finisher-age pigs given antimicrobials in feed, average age of pigs (days) when antimicrobials were first added to feed, and average number of days antimicrobials were given, by antimicrobial:

Antimicrobial	Percent sites	Std. error	Percent grower/ finisher-age pigs	Std. error	Site average age of pigs (days)	Std. error	Site average number of days given	Std. error
Avilamycin	0.0	(—)	0.0	(—)	NA		NA	
Bacitracin methylene disalicylate	10.3	(3.5)	6.5	(3.1)	84.6	(1.8)	54.6	(5.5)
Bacitracin methylene disalicylate/ chlortetracycline	2.3	(1.7)	1.0	(0.7)	*		*	
Bacitracin zinc	0.0	(—)	0.0	(—)	NA		NA	
Bambermycin	21.7	(12.4)	16.2	(9.0)	95.8	(3.3)	40.2	(18.4)
Carbadox	2.2	(1.3)	2.0	(1.1)	*		*	
Carbadox/ oxytetracycline	0.0	(—)	0.0	(—)	NA		NA	
Chlortetracycline	18.4	(6.0)	18.0	(6.5)	85.1	(3.9)	12.6	(1.2)
Chlortetracycline/ sulfamethazine	0.0	(—)	0.0	(—)	NA		NA	

continued→

D.2.c. (cont'd.) For the 78.6 percent of sites that had grower/finisher-age pigs (table A.1.a), percentage of sites that gave grower/finisher-age pigs antimicrobials in feed, percentage of grower/finisher-age pigs given antimicrobials in feed, average age of pigs (days) when antimicrobials were first added to feed, and average number of days antimicrobials were given, by antimicrobial:

Chlortetracycline/ tiamulin	55.4	(10.0)	44.2	(10.6)	75.4	(2.5)	19.3	(3.3)
Chlortetracycline/ sulfathiazole/ penicillin	0.0	(—)	0.0	(—)	NA		NA	
Chlortetracycline/ sulfamethazine/ penicillin	0.4	(0.4)	0.3	(0.3)	*		*	
Florfenicol	0.0	(—)	0.0	(—)	NA		NA	
Lincomycin	7.6	(4.3)	8.8	(5.6)	86.7	(7.6)	17.1	(1.3)
Narasin	3.8	(1.8)	2.7	(1.2)	*		*	
Neomycin/ terramycin	0.1	(0.1)	0.0	(0.0)	*		*	
Oxytetracycline	0.5	(0.3)	0.2	(0.2)	*		*	
Tiamulin	7.9	(3.7)	11.0	(6.2)	84.0	(5.2)	14.0	(2.0)
Tilmicosin	0.7	(0.6)	0.3	(0.3)	*		*	
Tylosin	11.0	(4.3)	11.5	(3.9)	91.1	(5.8)	23.4	(5.2)
Tylosin/ sulfamethazine	0.1	(0.1)	0.4	(0.4)	*		*	
Tylvalosin	0.1	(0.1)	0.1	(0.1)	*		*	
Virginiamycin	0.9	(0.5)	1.0	(0.6)	*		*	
Any medically important antimicrobial[1]	77.8	(5.6)	**		**		**	
Any antimicrobial	82.9	(4.6)	**		**		**	

*Too few to report.

**Unable to estimate because pigs could have been treated with more than one antimicrobial.

[1]See appendix II.

For sites that gave grower/finisher-age pigs antimicrobials in feed for any reason, 62.1 percent of sites administered only one or two individual antimicrobials in feed. More than one-third of all sites (37.9 percent) gave three or more individual antimicrobials in feed.

D.2.d. For the 82.9 percent of sites that gave grower/finisher-age pigs any antimicrobials in feed for any reason (table D.2.a), percentage of sites by number of individual antimicrobials given and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Number of individual antimicrobials*	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
1	22.4	(10.8)	10.1	(4.8)	21.3	(9.3)	15.3	(5.6)
2	33.7	(15.2)	53.4	(21.2)	44.3	(15.1)	46.8	(16.1)
3 or more	43.8	(20.4)	36.4	(22.7)	34.4	(15.0)	37.9	(17.9)
Total	100.0		100.0		100.0		100.0	

*Combination products, e.g., carbadox/oxytetracycline, were counted as two individual antimicrobials.

For sites that gave grower/finisher-age pigs chlortetracycline in feed, 79.0 percent used it for respiratory disease. For diarrhea, 70.8 and 88.1 percent of sites gave lincomycin or tylosin, respectively. For sites that gave bacitracin methylene disalicylate or bambermycin, the highest percentages (92.7, and 100.0 percent, respectively) gave these antimicrobials for growth promotion. About one-half of sites that used tiamulin used it for respiratory disease and about one-half used it for diarrhea.

D.2.e. For the 78.6 percent of sites that had grower/finisher-age pigs (table A.1.a), percentage of sites that gave grower/finisher-age pigs antimicrobials in feed, percentage of sites by antimicrobial given, and by reason for using antimicrobial:

	Percent Sites										
			Reason for Use								
	Percent sites that gave anti-microbials in feed		**Respiratory disease** (bacterial pneumonia)[1]		**Diarrhea** (bacterial enteritis)[1]		**Other disease**[1]		**Growth promotion**		
Antimicrobial[2]	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Total**
Bacitracin methylene disalicylate	10.3	(3.5)	0.0	0.0	5.5	(4.6)	1.8	(1.9)	92.7	(5.4)	100.0
Bambermycin	21.7	(12.4)	0.0	0.0	0.0	0.0	0.0	0.0	100.0	(—)	100.0
Chlortetracycline	18.4	(6.0)	79.0	(11.4)	2.3	(2.3)	15.7	(11.0)	3.0	(3.0)	100.0
Chlortetracycline/ tiamulin	55.4	(10.0)	53.8	(19.3)	7.9	(3.7)	38.3	(16.1)	0.0	0.0	100.0
Lincomycin	7.6	(4.3)	16.3	(10.6)	70.8	(16.5)	13.0	(8.8)	0.0	0.0	100.0
Tiamulin	7.9	(3.7)	49.9	(24.9)	47.9	(24.7)	2.1	(2.3)	0.0	0.0	100.0
Tylosin	11.0	(4.3)	2.8	(2.8)	88.1	(6.5)	5.2	(4.2)	3.8	(3.8)	100.0

[1]To prevent, control, or treat the listed disease.

[2]Antimicrobials listed in table D.2.c but not shown here were used by no sites or too few sites to break out by reason

E. Stewardship

Antimicrobial stewardship and judicious use practices include keeping records of antimicrobial use, offering antimicrobial training for employees, periodically undergoing facility audits or assessments, using a veterinarian, having a valid veterinarian-client-patient-relationship, and taking steps to prevent disease.

1. Decision-making and record-keeping

For sites that gave market pigs any (one or more) antimicrobials in water, 87.5 percent had a veterinarian decide when to use antimicrobials in water. Multiple people were often involved in the decision-making process regarding antimicrobial use in water.

E.1.a. For the 77.8 percent of sites that gave market pigs any antimicrobials in **water** (table B.1), percentage of sites by person(s) who decided **when** to use antimicrobials, by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Decision-maker	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Owner of site	41.7	(17.9)	22.2	(9.7)	16.6	(11.2)	24.7	(8.6)
Farm manager on site, but not the owner	2.4	(2.5)	12.3	(9.5)	34.1	(21.1)	15.3	(10.4)
Local veterinary practitioner	31.7	(14.1)	25.3	(12.1)	35.3	(20.8)	28.8	(11.7)
Consulting or second-opinion veterinarian	3.3	(3.4)	16.5	(10.4)	41.3	(21.3)	19.6	(10.7)
Company veterinarian	48.2	(20.7)	60.0	(15.9)	40.2	(23.7)	53.3	(14.7)
Company nutritionist or other nutritionist	5.8	(6.1)	0.8	(0.6)	0.0	(—)	1.6	(1.3)
Service manager who oversees more than one site	14.7	(11.4)	36.5	(17.3)	63.7	(16.1)	38.4	(14.7)
Other	2.4	(2.5)	0.0	(—)	0.0	(—)	0.5	(0.5)
Any veterinarian*	83.3	(9.9)	87.9	(5.7)	90.2	(7.4)	87.5	(4.9)

*Local practitioner, consulting or second opinion veterinarian, and company veterinarian.

On 91.6 percent of sites that gave market pigs any (one or more) antimicrobials in water, a veterinarian decided what antimicrobials to use in water.

E.1.b. For the 77.8 percent of sites that gave market pigs any antimicrobials in **water** (table B.1), percentage of sites by person(s) who decided **what** antimicrobials to use, by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Decision-maker	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Owner of site	38.4	(18.3)	22.7	(11.0)	6.4	(3.5)	21.7	(8.3)
Farm manager on site, but not the owner	2.7	(2.8)	0.2	(0.2)	7.2	(4.5)	2.2	(1.2)
Local veterinary practitioner	45.5	(19.6)	21.7	(11.1)	36.6	(20.9)	29.2	(11.7)
Consulting or second-opinion veterinarian	7.7	(6.1)	17.1	(10.3)	49.9	(22.1)	22.9	(11.0)
Company veterinarian	41.5	(24.6)	61.5	(16.3)	39.4	(23.7)	53.1	(15.1)
Company nutritionist or other nutritionist	6.6	(6.9)	0.5	(0.5)	0.0	(—)	1.4	(1.3)
Service manager who oversees more than one site	3.8	(3.9)	36.9	(18.4)	66.2	(16.9)	37.8	(15.0)
Other	2.7	(2.8)	0.0	(—)	0.0	(—)	0.5	(0.5)
Any veterinarian*	90.8	(7.7)	88.9	(7.6)	99.3	(0.7)	91.6	(4.8)

*Local practitioner, consulting or second opinion veterinarian, and company veterinarian.

Overall, 92.0 percent of the sites that gave market pigs antimicrobials in water always recorded the date antimicrobial use began, and 94.1 percent always recorded the antimicrobial used.

E.1.c. For the 77.8 percent of sites that gave market pigs any antimicrobials in **water** (table B.1), percentage of sites by information recorded and by frequency that information was recorded:

Percent Sites

Frequency

	Never		Sometimes		Always		
Information recorded	**Pct**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Total**
Date antimicrobial use began	4.6	(2.4)	3.4	(1.7)	92.0	(3.1)	100.0
Date antimicrobial use ended	17.7	(13.2)	6.7	(3.0)	75.6	(13.2)	100.0
Antimicrobial used	3.1	(2.0)	2.8	(1.6)	94.1	(2.5)	100.0
Treatment withdrawal period	21.4	(10.2)	12.0	(5.6)	66.6	(11.8)	100.0

For sites that gave market pigs any (one or more) antimicrobials in feed, 86.7 percent had a veterinarian decide when to use antimicrobials in feed. Multiple people were often involved in the decision-making process regarding antimicrobial use in feed.

E.1.d. For the 90.4 percent of sites that gave market pigs any antimicrobials in **feed** (table B.1), percentage of sites by person(s) who decided **when** to use antimicrobials, by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Decision-maker	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Owner of site	45.4	(15.4)	24.9	(10.9)	17.7	(9.4)	27.7	(9.0)
Farm manager on site, but not the owner	12.4	(8.7)	10.9	(9.7)	32.6	(21.7)	16.2	(12.3)
Local veterinary practitioner	29.1	(12.0)	20.3	(10.8)	40.6	(21.1)	26.9	(12.3)
Consulting or second-opinion veterinarian	16.2	(9.4)	17.3	(10.5)	54.9	(20.8)	25.7	(12.2)
Company veterinarian	36.8	(18.9)	63.5	(14.5)	40.9	(18.1)	52.6	(13.2)
Company nutritionist or other nutritionist	20.8	(10.5)	28.1	(16.0)	32.8	(21.7)	27.6	(12.0)
Service manager who oversees more than one site	11.6	(8.7)	15.2	(10.3)	30.6	(21.8)	18.0	(12.3)
Other	1.8	(1.8)	0.5	(0.5)	0.0	(—)	0.6	(0.5)
Any veterinarian*	70.4	(11.5)	88.4	(7.2)	97.7	(1.9)	86.7	(5.3)

*Local practitioner, consulting or second opinion veterinarian, and company veterinarian.

On the 90.4 percent of sites that gave market pigs any (one or more) antimicrobials in feed, 90.5 percent had a veterinarian decide what antimicrobials to use in feed.

E.1.e. For the 90.4 percent of sites that gave market pigs any antimicrobials in **feed** (table B.1), percentage of sites by person(s) who decided **what** antimicrobials to use, by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Decision-maker	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Owner of site	37.7	(13.4)	21.9	(8.8)	7.1	(3.8)	21.8	(6.8)
Farm manager on site, but not the owner	3.3	(2.2)	2.1	(17.)	6.5	(3.4)	3.4	(1.8)
Local veterinary practitioner	43.4	(14.3)	21.0	(11.0)	35.2	(18.2)	29.1	(11.7)
Consulting or second-opinion veterinarian	16.0	(9.5)	19.9	(10.1)	49.4	(18.7)	26.0	(10.9)
Company veterinarian	36.8	(18.9)	60.8	(15.6)	34.3	(22.2)	49.5	(14.7)
Company nutritionist or other nutritionist	25.3	(12.5)	28.3	(13.9)	38.5	(20.1)	30.0	(10.5)
Service manager who oversees more than one site	11.6	(8.7)	18.7	(10.1)	25.8	(18.6)	18.8	(11.2)
Other	1.8	(1.8)	5.9	(4.7)	0.0	(—)	3.6	(2.8)
Any veterinarian*	82.7	(8.2)	92.3	(4.1)	93.4	(3.5)	90.5	(3.3)

*Local practitioner, consulting or second opinion veterinarian, and company veterinarian.

Almost all sites that gave market pigs antimicrobials in feed always recorded the date antimicrobial use began (97.1 percent) and the antimicrobial used (97.2 percent). Overall, 82.0 percent of sites always recorded the date antimicrobial use ended. Almost three-fourths of sites (72.7 percent) always recorded the treatment withdrawal period.

E.1.f. For the 90.4 percent of sites that gave market pigs any antimicrobials in **feed** (table B.1), percentage of sites by information recorded and by frequency that information was recorded:

	Percent Sites						
	Frequency						
	Never		Sometimes		Always		
Information recorded	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error	Total
Date antimicrobial use began	0.6	(0.5)	2.4	(1.3)	97.1	(1.4)	100.0
Date antimicrobial use ended	14.7	(11.5)	3.3	(1.6)	82.0	(11.5)	100.0
Antimicrobial used	0.7	(0.5)	2.1	(1.2)	97.2	(1.4)	100.0
Treatment withdrawal period	22.2	(12.2)	5.2	(2.4)	72.7	(12.4)	100.0

About two-thirds of sites that gave market pigs antimicrobials in feed (66.7 percent) obtained medicated feed from a feed mill. About one-half of sites (53.9 percent) obtained type B or C medicated feeds to be fed or mixed in a ration on the site.

E.1.g. For the 90.4 percent of sites that gave market pigs antimicrobials in **feed** (table B.1), percentage of sites by source of medicated feed and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Source of feed	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Company supplied and delivered medicated feed	27.0	(8.8)	49.0	(14.4)	48.6	(21.8)	44.1	(10.9)
From an off-site, privately owned or cooperatively owned feed mill that delivered feed with antimicrobials mixed in	81.0	(5.8)	71.4	(11.6)	42.9	(21.1)	66.7	(9.1)
Type A medicated articles were delivered or brought to this site to be mixed into feed on-site	14.8	(6.9)	14.4	(8.6)	7.4	(4.1)	12.8	(5.7)
Type B or C medicated feeds were delivered or brought to this site to be fed or mixed in a ration on-site	58.1	(14.2)	50.8	(18.7)	42.7	(21.7)	53.9	(14.3)

For sites that gave market pigs injectable antimicrobials, 85.8 percent always recorded the date pigs were treated and 87.0 percent always recorded the antimicrobial used. About two-thirds of sites (66.4 percent) always recorded the treatment withdrawal period.

E.1.h. For the 89.4 percent of sites that treated market pigs with **injectable antimicrobials** (table B.1), percentage of sites by information recorded and by frequency that information was recorded:

	Percent Sites						
	Frequency						
	Never		Sometimes		Always		
Information recorded	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error	Total
Date treated	4.9	(2.0)	9.3	(4.5)	85.8	(5.5)	100.0
Antimicrobial given	4.4	(1.8)	8.6	(4.4)	87.0	(5.3)	100.0
Treatment withdrawal period	24.8	(12.0)	8.8	(3.4)	66.4	(12.4)	100.0

2. Quality assurance

Pork Quality Assurance-Plus (PQA-Plus) is an education program overseen by the National Pork Board that addresses food safety, animal well-being, environmental stewardship, worker safety, public health, and community engagement. Individuals can become certified and sites can receive PQA-Plus status through an on-farm site assessment with a PQA-Plus advisor. PQA-Plus certification can be completed through either face-to-face training with an advisor or by asking an advisor to grant access to an online course and exam. Certification lasts 3 years.

Almost all sites (96.9 percent) had workers who were PQA-Plus certified.

E.2.a. Percentage of sites that had any workers who were PQA-Plus certified, by size of site:

Percent Sites

Size of Site (number of market pigs)

Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
100.0	(—)	94.3	(4.9)	100.0	(—)	96.9	(2.8)

Almost all medium and large sites had ever had a PQA-Plus site assessment (95.8 and 99.5 percent, respectively) compared with 67.0 percent of small sites.

E.2.b. Percentage of sites that had ever had a PQA-Plus site assessment, by size of site:

Percent Sites

Size of Site (number of market pigs)

Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
67.0	(11.6)	95.8	(2.1)	99.5	(0.5)	89.8	(3.9)

On average, sites that had ever had a PQA-Plus site assessment last had an assessment 21 months before being surveyed, regardless of size of site.

E.2.c. For the 89.8 percent of sites that had ever had a PQA-Plus site assessment (table E.2.b), average number of months since the last assessment, by size of site:

Site Average Number of Months*							
Size of Site (number of market pigs)							
Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Avg.	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**
20.9	(1.6)	21.1	(2.6)	21.0	(1.8)	21.0	(1.7)

*As of September 1, 2017.

The Common Swine Industry Audit standardizes third-party audits, such as those required by packers or other stakeholders. The audit is based on PQA-Plus and Transport Quality Assurance educational programs.

Nearly 10 percent of all sites had ever been audited under the Common Swine Industry Audit. On average, sites that had ever had a Common Swine Industry Audit had not had an audit for 26.3 (std. error 7.7) months (data not shown).

E.2.d. Percentage of sites that had ever been audited under the Common Swine Industry Audit, by size of site:

Percent Sites							
Size of Site (number of market pigs)							
Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
12.7	(5.7)	5.2	(3.4)	16.7	(10.2)	9.5	(3.4)

3. Use of veterinarians

Of all sites surveyed, 64.9 percent were visited by one or more of the veterinarian types listed in the following table, and 41.5 percent were visited by a local veterinary practitioner. More than one-third of sites were not visited by a veterinarian.

E.3.a. Percentage of sites visited by one or more veterinarians for any purpose from July 1 through December 31, 2016, by type of veterinarian and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Type of veterinarian	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Local veterinary practitioner	59.1	(15.6)	32.1	(13.3)	45.9	(20.8)	41.5	(12.7)
Consulting or second-opinion veterinarian	3.5	(2.6)	13.7	(5.9)	27.7	(10.1)	14.3	(4.5)
On-staff or company veterinarian	7.3	(4.3)	23.3	(10.2)	4.5	(3.2)	15.4	(6.9)
State or Federal veterinarian	0.0	(—)	1.6	(1.6)	7.9	(8.1)	2.6	(1.8)
Other	0.0	(—)	0.0	(—)	0.3	(0.3)	0.1	(0.1)
Any of the above veterinarians	67.8	(12.3)	62.0	(13.3)	69.1	(19.1)	64.9	(10.6)

The average number of visits by type of veterinarian ranged from 1.3 visits by on-staff or company veterinarians to 2.7 visits by local veterinary practitioners.

E.3.b. For the 64.9 percent of sites visited by any type of veterinarian for any purpose from July 1 through December 31, 2016 (table E.3.a), average number of visits made, by type of veterinarian visiting:

Type of veterinarian	Site average number of visits	Std. error
Local veterinary practitioner	2.7	(0.6)
Consulting or second-opinion veterinarian	2.6	(0.6)
On-staff or company veterinarian	1.3	(0.2)
State or Federal veterinarian	*	
Other	*	

*Too few to report.

Almost all sites had a veterinarian-client-patient relationship (VCPR), regardless of size of site.

E.3.c. Percentage of sites that had a VCPR, by size of site:

Percent Sites							
Size of Site (number of market pigs)							
Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
93.6	(5.1)	99.6	(0.4)	99.7	(0.3)	98.2	(1.3)

More than one-half of all sites that had a VCPR (58.6 percent) had a written document regarding the relationship signed by the veterinarian and the owner. A higher percentage of large sites had a written VCPR compared with small sites. About 14 percent of small sites reported that their veterinarian has not formally mentioned a VCPR, but they considered that they have a VCPR based on their relationship.

E.3.d. For the 98.2 percent of sites that had a VCPR (table E.3.c), percentage of sites by description of VCPR and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
VCPR description	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
A written document signed by veterinarian and owner	39.4	(14.0)	54.9	(17.9)	84.9	(7.4)	58.6	(14.5)
A verbal agreement between veterinarian and owner	46.4	(16.7)	42.7	(18.2)	11.5	(6.1)	36.3	(15.0)
No formal VCPR, but considered to have one based on relationship with veterinarian	14.2	(6.9)	2.4	(1.5)	3.6	(2.4)	5.1	(2.0)
Total	100.0		100.0		100.0		100.0	

4. Disease and antimicrobial residue prevention

More than 90 percent of sites agreed that biosecurity plans, vaccination plans, all-in/all-out management, and adjusting pigs' diets were very important practices for preventing disease and reducing the need to use antimicrobials in 2016. Antimicrobial alternatives were considered somewhat important on 68.7 percent of all sites. The most commonly reported "other" practice for disease prevention was parity segregation.

E.4.a. Percentage of sites by importance of the following practices for preventing disease and reducing the need to use antimicrobials in pigs:

	Percent Sites						
	Importance						
	Not		Somewhat		Very		
Practice	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error	Total
Adjust diet to meet the nutritional needs of pigs at a particular age	0.0	(—)	2.2	(1.4)	97.8	(1.4)	100.0
Implement a vaccination plan for disease prevention	0.0	(—)	2.2	(1.1)	97.8	(1.1)	100.0
All-in/all-out management of pigs at the room, barn, or site level	1.8	(0.9)	3.5	(1.3)	94.7	(1.9)	100.0
Implement a site biosecurity plan for employees and visitors	1.1	(0.8)	6.7	(2.5)	92.2	(2.8)	100.0
Facility management adjustments (e.g., adding ventilation systems or air filtering systems, etc.)	5.7	(2.9)	12.3	(4.1)	81.9	(6.0)	100.0
Regular visits by herd health veterinarian	28.4	(13.5)	24.4	(9.0)	47.3	(14.3)	100.0
Weaning pigs at older ages (e.g., 21 days or older)	20.6	(11.3)	48.2	(14.3)	31.3	(12.1)	100.0
Use antimicrobial alternatives (e.g., probiotics, prebiotics, etc.)	20.6	(7.9)	68.7	(9.5)	10.7	(4.2)	100.0
Other	71.9	(15.3)	19.0	(15.0)	9.1	(3.6)	100.0

When a food-producing animal is treated with a drug, residues of the drug might remain in or on edible tissues from that animal. Residues include small amounts of leftover drug or parts of the drug that were not completely broken down by an animal's body. The FDA makes sure that any residues that might be present in or on edible tissues from treated animals pose little risk to people. As part of the approval process for a drug for a food-producing animal, the agency sets the drug's tolerance and withdrawal periods. The tolerance is the level of residues allowed to be in or on the edible tissues. Residues higher than this level are called "violative" because they violate (are above) the tolerance set by FDA.

The withdrawal period is the time from when the animal was last treated with the drug to when the animal can be slaughtered for food. The withdrawal period allows for the drug (or parts of the drug) in the edible tissues to get to levels at or below the tolerance.

The following table includes methods that sites used to ensure that they comply with withdrawal times prior to marketing pigs. The table's estimates do not represent compliance with withdrawal periods. A site could have used one method for antimicrobials administered in feed and another for injectable drugs, resulting in using at least one method for 100 percent of pigs on the site.

The highest percentages of sites complied with antimicrobial withdrawal times by not administering antimicrobials for a predetermined period before marketing pigs (89.7 percent), identifying pigs individually treated (85.2 percent), and consulting written treatment records before marketing treated pigs (73.9 percent). The most commonly reported “other” step taken was placing signs on swine housing facilities.

E.4.b. Percentage of sites by steps taken to comply with withdrawal times for any antimicrobials administered to pigs on-site, and by size of site:

Percent Sites

Size of Site (number of market pigs)

	Small (1,000–1,999)		**Medium** (2,000–4,999)		**Large** (5,000 or more)		**All sites**	
Step taken	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Do not administer antimicrobials for a predetermined period prior to marketing	88.8	(4.7)	88.5	(5.9)	98.3	(3.7)	89.7	(4.1)
Identification (e.g., by ear tags, chalk, or paint) of pigs individually treated (e.g., by injection)	79.5	(8.1)	86.1	(6.2)	89.2	(5.8)	85.2	(4.8)
Written treatment records consulted before marketing treated pigs	75.8	(9.3)	77.7	(11.6)	62.3	(20.8)	73.9	(11.6)
Dates signaling the end of the withdrawal period are computer generated	15.3	(9.8)	3.0	(1.5)	18.4	(10.5)	9.2	(3.8)
Individual serum samples tested prior to marketing	8.4	(6.0)	0.7	(0.8)	0.3	(0.3)	2.5	(1.8)
Individual urine samples tested prior to marketing	3.5	(3.4)	0.7	(0.8)	0.0	(—)	1.2	(1.2)
No special steps are taken to comply with withdrawal times	3.1	(2.0)	0.6	(0.5)	0.0	(—)	1.1	(0.6)
Other	2.0	(1.5)	1.5	(1.0)	24.4	(12.9)	6.5	(4.1)

Section II: Methodology

A. Objectives and Population of Interest

The NAHMS Antimicrobial Use and Stewardship on U.S. Swine Operations, 2017 study was initiated as a response to the 2014 USDA Antimicrobial Resistance Action Plan and the January 1, 2017, FDA policy changes regarding the administration of antimicrobials to food-producing animals. The 2014 USDA Antimicrobial Resistance Action Plan recommended that USDA agencies re-evaluate their data collection efforts to monitor antimicrobial use in food-producing animals. The FDA policy changes included requiring veterinary oversight for the use of medically important antimicrobials in animal feed and water and eliminating the use of medically important antimicrobials for growth promotion in food-producing animals.

As a response to these factors, NAHMS started new data collection activities to monitor antimicrobial use in food-producing animals, with the intention of increasing the baseline knowledge of antimicrobial use in U.S. swine populations.

The study's target population included all swine operations with nursery, wean-to-finish and/or grower/finisher phases and with 1,000 or more market pigs. Study objectives follow:

- Describe antimicrobial use practices in feed and water.
- Estimate the percentage of production sites using specific antimicrobials in feed and/or water, and the percentage of market pigs receiving specific antimicrobials in feed and/or water, by reasons for using antimicrobials.
- Provide baseline data on antimicrobial use practices in place before FDA policy changes were implemented, which can be used to evaluate trends in antimicrobial use over time.
- Describe antimicrobial stewardship practices.

B. Sampling

1. State selection

A goal of NAHMS national studies is to include States that account for at least 70 percent of the animals and operations in the population being studied. In addition, geographic representation is taken into account during State selection. These factors are balanced, along with the scientific objectives and practical budget constraints, to ensure representativeness of the sample and allow for generalization of results from the sample collected.

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A total of 13 States[1] were selected for inclusion in the study; these States represented 93.8 percent of sites with 1,000 or more pigs and 92.1 percent of pigs on sites with 1,000 or more pigs. The 13 States were chosen based on their contribution to the national percentage of market pigs and swine operations, using information from USDA's National Agricultural Statistics Service's (NASS) list frame, which was updated using data from the NASS 2012 Census of Agriculture and the December 1, 2016, NASS "Hogs and Pigs Report."

2. Operation selection

Swine operations on the NASS list frame are organized by ownership of animals. If an operation owned swine that were housed on multiple sites, the operation would be on the list frame, but the individual sites would not. Thus, sampling first occurred at the operation level, based on animal ownership, from the NASS list frame.

A stratified random sample of 1,600 swine operations with 1,000 or more market pigs in the 13 States was selected with stratification by State and by operation size: small (1,000 to 1,999 pigs); medium (2,000 to 4,999 pigs), and large (5,000 or more pigs).

3. Site selection

For each operation contacted, a number of sites that raised market pigs were chosen within the given State. The number of sites selected from each operation was a function of the number of sites on the operation. Given the number of sites on the operation that had a nursery and/or grower/finisher phase and/or a wean-to-finish phase in a given State, a simple random sample of sites was selected to be contacted for the study.

C. Data Collection

In May 2017, NASS enumerators contacted the selected operations and requested a personal visit. During the visit, operators were familiarized with the study and were invited to participate in a phase I operation-level questionnaire. The purpose of this questionnaire was to identify and randomly select swine sites that operated under the ownership of the selected operation from the NASS list frame.

Once sites were randomly selected, the enumerator visited the individual sites. The enumerator familiarized site managers with the study and invited them to participate in phase II (site-level questionnaire) of the study. If the manager expressed interest, he/she signed a waiver form, and their contact information was released to field veterinarians with the UDSA's Animal and Plant Health Inspection Service's Veterinary Services (USDA–APHIS–VS).

[1]Colorado, Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Carolina, Ohio, Oklahoma, Pennsylvania, South Dakota.

From July through September 2017, USDA–APHIS–VS field veterinarians and State veterinarians recontacted site managers and requested a personal visit to administer the phase II site-level questionnaire. If a manager expressed interest, field veterinarians personally visited managers and administered the phase II questionnaire. The questionnaire can be found at https://www.aphis.usda.gov/animal_health/nahms/amr/downloads/SwineQuestionnaire.pdf.

D. Data Analysis and Estimation

Completed questionnaires were securely delivered to NAHMS headquarters, and hard-copy questionnaires were checked for consistency before being entered into a SAS dataset by NAHMS staff. NAHMS staff then performed a second round of data validation on the complete dataset to evaluate consistency and identify statistical issues.

Issues included logical inconsistencies within a site survey and were identified using summaries of responses to check for invalid responses (e.g., a response of two for a variable that has possible responses of one or three only); threshold checks (e.g., invalid total sums of animal inventory); and “if-then” checks (e.g., if there was no nursery phase, questions pertaining to swine in a nursery phase should not be answered). Statistical issues were identified by investigating summary measures of responses for variables, and extreme outliers were investigated by data analysts and subject-matter experts. Inconsistencies were identified using SAS software and hard copies of surveys, and were addressed using imputation measures.

Summarization and estimation were performed using SUDAAN® software, which accounts for the stratified sampling study design and unequal sampling weights. Survey weights were computed using initial weights, which were equal to the inverse probability of selection, then adjusted for phase II swine site selection using the ratio of total to sampled sites, then adjusted for nonresponse within State and size strata. SUDAAN allows for the proper estimation of complex survey estimate standard errors using Taylor series linearization. Estimates were generated by one analyst and the results and code were reviewed by a second analyst to ensure accurate reporting of estimates.

E. Sample Evaluation

A total of 1,725 swine sites were selected for the survey. Of these sites, 445 were contacted and provided a known response code. Of these 445 sites, 393 provided usable inventory information: 5 were out of business or had no pigs, and 388 had at least one pig, completed the site-level questionnaire, and consented to continue to phase II of the study.

In additional analyses, the unknowns were reassigned to the five nonconsent categories (refusal, no pigs/out of business, out of scope, office hold, and inaccessible) using the same proportions as presented in the following table. Using the reassigned counts, the proportion of in-scope sites (consent, refusal, no pigs/out of business, inaccessible) providing usable information is 456/1,401 (32.5 percent). The proportion of sites that provided complete information is 388/1,401 (27.7 percent).

1. Response codes for the phase I (consent) swine sites:

Collapsed reason codes	Count	Percent	Contacts	Usable	Complete
Consent	388	22.5	x	x	x
Refusal	52	3.0	x		
No pigs/out of business	5	0.3	x	x	
Out of scope	20	1.2			
Office hold	4	0.2			
Inaccessible	18	1.0			
Unknown*	1,238	71.8			
Total	1,725	100.0	445	393	388
Percent of total count			25.8	22.8	22.5

*Response code not recorded.

Response codes for phase II (2017 study questionnaire):

Collapsed reason codes	Count	Percent	Contacts	Usable	Complete
Complete	199	51.3	x	x	x
Refusal	86	22.2	x		
Out of business/ no or too few swine	12	3.1	x	x	
Other	15	3.9	x	x	
Inaccessible	70	18.0			
Unknown[1]	6	1.5			
Total	388[2]	100.0	312	226	199
Percent of total count			80.4	58.2	51.3

[1]Response code not recorded.

[2]For the 388 sites that gave “complete-consent” for phase I.

2. Nonresponse bias analysis

Using information collected for all sampled swine operations by NASS through their ongoing sampling efforts, NAHMS staff performed an analysis to identify potential sources of nonresponse bias in the study results. This analysis was designed to identify whether there were differences in response behaviors based on the factors known for respondents and nonrespondents.

There were two primary response variables of interest: (a) consent at phase I (1=the operation consented to participating in the study and 0=the operation did not consent) and (b) response to phase II (1=the operation was a "complete" response on the phase II questionnaire and 0=the operation was not a "complete" response).

Univariate tests were performed (chi-squared tests for categorical variables and Kolmogrov-Smirnov tests for numeric variables), and multiple logistic regression models were fit for each of the response variables of interest. Consent response was significantly related to the type of pig operations, with "farrow-to-wean" and "other" operations consenting less frequently than other operations (farrow-to-finish, finish only, farrow-to-feeder, and nursery operations). This finding was expected and is not a source of bias because in order to be in scope operations needed to have weaned market pigs. Operations categorized as "farrow-to-wean" and "other" would have typically been labeled out of scope for this study. No variables were significantly related to complete response propensity for phase II of the study.

Based on the NASS list frame data, we cannot conclude that there is a significant source of nonresponse bias. That is, the set of respondents did not differ significantly from the nonrespondents, based on the evaluated factors, so study respondents are expected to represent the population of U.S. swine operations with 1,000 or more pigs and the population of weaned pigs on those sites.

Appendix I: Sample Profile

A. Responding Sites

Independent swine producers/owners and company veterinarians provided most or all information for all sections of this report. In the “other” category for antimicrobial stewardship, the highest percentages of responses included nutritionists and farm service managers (nutritionist was not an option for the stewardship section).

1. Percentage of sites by person(s) who provided most or all information on antimicrobial use in water and feed for nursery-age and grower/finisher-age pigs, and antimicrobial stewardship:

	Percent Sites									
	Section of Report									
	Antimicrobials in water to nursery-age pigs		Antimicrobials in feed to nursery-age pigs		Antimicrobials in water to grower/finisher-age pigs		Antimicrobials in feed to grower/ finisher-age pigs		Antimicrobial stewardship	
Person	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error
Independent producer/owner of operation	36.2	(14.3)	45.0	(15.7)	36.3	(12.5)	30.9	(11.3)	37.5	(11.0)
Farm manager on-site, but not the owner or contractee for the company	10.2	(7.0)	2.4	(1.3)	16.4	(12.3)	1.2	(0.7)	2.8	(1.1)
Company veterinarian	44.9	(19.3)	40.7	(19.4)	59.9	(13.7)	64.2	(12.9)	45.5	(14.4)
Private or other veterinarian	16.4	(8.0)	17.7	(7.9)	11.1	(4.1)	7.5	(3.8)	0.3	(0.3)
Employee of feed mill supplying feed	0.0	--	0.5	(0.5)	1.5	(1.4)	2.1	(1.6)	NA	NA
Company nutritionist or other nutritionist	13.9	(12.3)	14.8	(10.1)	2.8	(2.0)	22.6	(15.0)	NA	NA
Other	5.8	(4.9)	5.8	(4.9)	3.7	(2.1)	2.5	(1.7)	18.1	(11.2)

Appendix I: Sample Profile

2. Size of operations

Number of market pigs	Number of responding sites
1,000–1,999	48
2,000–4,999	97
5,000 or more	54
Total	199

Appendix II: FDA Categories of Antimicrobials Mentioned in This Report

There are four categories of antimicrobials with respect to their use in human medicine, as determined by the FDA and published in Guidance for Industry #152, Appendix A[1]: not medically important, important, highly important, and critically important. The table below shows the current ranking of the drug classes mentioned in this report. According to Guidance for Industry #213, FDA stated that it will periodically reassess and publish updates to GFI #152 Appendix A as necessary.

Antimicrobial by importance to human medicine	Drug/drug class
Not ranked	Ionophores (e.g., narasin)
	Tiamulin
	Bacitracin (e.g., bacitracin zinc, bacitracin methylene disalicylate)
	Bambermycin
	Carbadox
Medically important	
Important	None of the antimicrobials listed in this report were classified as important.
Highly important	Tetracyclines (e.g., oxytetracycline, chlortetracycline, tetracycline)
	Aminoglycosides (e.g., neomycin, spectinomycin, gentamicin)
	Streptogramins (e.g., virginiamycin)
	Phenicols (e.g., florfenicol)
	Beta lactam-natural penicillins (e.g., penicillin G)
	Lincosamides[2] (e.g., lincomycin)
Critically important	Macrolides (e.g., tilmicosin, tylosin, tylvalosin)
	Sulfonamides[3] (e.g., sulfamethazine, sulfadimethoxine, sulfathiazole, sulfachlorpyridazine, sulfaquinoxaline)

[1]https://www.fda.gov/downloads/AnimalVeterinary/GuidanceComplianceEnforcement/GuidanceforIndustry/UCM052519.pdf
[2]In FDA GFI #152, lincosamides are represented by the drug clindamycin.
[3]In FDA GFI #152, sulfonamides are represented by the drug trimethoprim/sulfamethoxazole.

Appendix III: U.S. Swine Inventory and Number of Operations*

	Number of pigs		Number of sites	
	All operations	Sites with 1,000 or more pigs	All operations	Sites with 1,000 or more pigs
Colorado	727,301	714,972	1,001	18
Illinois	4,630,796	4,452,458	2,045	672
Indiana	3,747,352	3,523,874	2,757	632
Iowa	20,455,666	19,733,548	6,266	3,815
Kansas	1,886,197	1,840,103	1,010	118
Minnesota	7,606,785	7,294,150	3,355	1,548
Missouri	2,774,597	2,685,694	2,128	272
Nebraska	2,992,576	2,789,665	1,476	427
North Carolina	8,901,434	8,854,463	2,217	1,011
Ohio	2,058,503	1,916,601	3,494	575
Oklahoma	2,304,740	2,283,159	1,947	81
Pennsylvania	1,122,837	1,013,557	3,097	389
South Dakota	1,187,895	1,129,795	681	199
Total (13 States)	60,396,679	58,232,039	31,474	9,757
Total U.S. (50 States)	66,026,785	63,248,402	63,246	10,401
Percent sites represented by 13 States	91.5	92.1	49.8	93.8

*USDA-NASS 2012 Census of Agriculture

Appendix IV: Acronyms Used in This Report

AHT	Animal Health Technician
APHIS	Animal and Plant Health Inspection Service
AVMA	American Veterinary Medical Association
CEAH	Center for Epidemiology and Animal Health
FDA	U. S. Food and Drug Administration
NA	Not applicable
NAHMS	National Animal Health Monitoring System
NASS	National Agricultural Statistics Service
PQA-Plus	Pork Quality Assurance Plus
SE	Standard error
VCPR	Veterinarian-client-patient relationship
VMO	Veterinary Medical Officer
VS	Veterinary Services