Enterococcus on U.S. Sheep and Lamb Operations

Background

Enterococcus is a normal bacterial (commensal) inhabitant of human and animal gastrointestinal tracts. Disease caused by *Enterococcus* in food-producing animals is uncommon, but *Enterococcus* is occasionally associated with mastitis in dairy animals.

In hospital settings, enterococci are a common cause of infections in humans, especially after surgery. Two species of enterococci, *E. faecalis* and *E. faecium,* are responsible for most human disease caused by enterococci. Combined, these two species are responsible for 12 percent of all hospital-acquired infections in the United States and constitute a significant public health risk (Hancock and Gilmore, 2006).

Enterococcus species have natural resistance mechanisms to several classes of antimicrobials. In addition, *Enterococcus* readily acquires resistance to antimicrobials through mutations or acquisition of resistance genes (Hammerum et al., 2010). In both the United States and Europe, research indicates that the patterns of antimicrobial resistance in *Enterococcus* isolates from animals and humans differ (Mannu et al., 2003). This finding suggests that production animals are an uncommon source for human infections. However, there are concerns that resistance components of enterococci in animals could be transferred to other bacteria, including those that cause human illness. The purpose of this information sheet is to describe the species distribution and antimicrobial susceptibility of *Enterococcus* in U.S. sheep and lambs.

Enterococcus on U.S. sheep and lamb operations

For the Sheep 2011 study, the U.S. Department of Agriculture's National Animal Health Monitoring System (NAHMS) collected data on sheep health and management practices from a representative sample of operations in 22 of the Nation's major sheep-producing States.* Collectively, these operations represented 85.5 percent of the ewe inventory and 70.1 percent of U.S. farms with ewes.

During the Sheep 2011 study, 247 operations provided composite fecal samples for *Enterococcus* testing. Composite samples consisted of two pellets from each of up to six animals up to 2 years of age. These samples were combined to make up a single sample. Up to five composite samples were collected on each operation. A total of 1,133 composite samples were collected from March 14 to June 30, 2011. Of the composite samples tested, 1,108 (97.8 percent) were positive for *Enterococcus.*

In addition to composite samples, 95 of the 247 operations provided fecal samples from individual animals up to 2 years of age. Individual-animal samples consisted of up to four fecal pellets collected directly from the rectum of each animal tested. Up to 15 fecal samples from individual animals were submitted per operation. Of the 688 individual samples collected, 646 (93.9 percent) were positive for *Enterococcus*.

Species identification was performed on 1,746 *Enterococcus* isolates. One species was identified per sample. Eight isolates were not typed because of difficulty in regrowing isolates after initial testing. The most common species isolated was *E. hirae*, which accounted for over 60 percent of the positive composite and individual samples (table 1). In total, nine different species of *Enterococcus* were identified. An additional 11 isolates contained *Enterococcus* species not otherwise specified because the PCR methodology used was unable to identify other species. *E. faecium* and *E. faecalis* together made up 9.1 percent of the isolates and were found on 35.2 percent of operations.

* California, Colorado, Idaho, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Montana, New Mexico, New York, Ohio, Oregon, Pennsylvania, South Dakota, Texas, Utah, Virginia, Washington and Wyoming.

Table 1. Percentage of *Enterococcus species* identified in positive samples, by sample type

Species	Percent — Sample Type: Composite (n=1,100)	Individual (n=646)	Any (n=1,746)
E. hirae	69.2	60.4	65.9
E. mundtii	9.3	15.2	11.5
E. casseliflavus	6.5	10.2	7.9
E. faecalis	6.1	4.5	5.5
E. faecium	3.2	4.3	3.6
E. gallinarum	3.5	3.2	3.4
E. durans	1.0	0.9	1.0
Ent. spp.	0.7	0.5	0.6
E. avium	0.4	0.3	0.4
E. porcinus	0.1	0.5	0.2
Total	100.0	100.0	100.0

All 247 operations had at least one composite sample test positive for *Enterococcus*, and all 95 operations from which individual samples were collected had at least one individual-animal sample test positive for *Enterococcus*. At least one *E. hirae* isolate was found on slightly over 95 percent of operations (table 2).

Table 2. Percentage of operations by *Enterococcus* species identified and by sample type

Species	Percent — Sample type: Composite (n=247)	Individual (n=95)	Any (n=247)
E. hirae	95.1	93.7	95.5
E. mundtii	27.9	58.9	41.7
E. casseliflavus	22.3	38.9	32.0
E. faecalis	19.8	23.2	24.3
E. faecium	11.3	20.0	15.7
E. gallinarum	12.6	16.8	16.6
E. durans	4.0	6.3	6.5
Ent. spp.	3.2	3.2	4.5
E. avium	2.0	2.1	2.4
E. porcinus	0.4	3.2	1.6
Any enterococci	100.0	100.0	100.0

Isolates showed somewhat high levels of resistance to tetracycline: depending on the species of *Enterococcus,* 30.2 to 47.6 percent of isolates were resistant to tetracycline. Ciprofloxacin resistance was present in over one-third of *E. faecium* isolates (36.5 percent). Vancomycin resistance is of particular interest because it is commonly used to treat humans with enterococcal infections. None of the isolates demonstrated resistance to vancomycin. Resistance to quinupristin/dalfopristin (Synercid®) is also important because it used to treat humans infected with vancomycin-resistant *E. faecium*. The percentages of Synercid-resistant isolates in *E. faecium* and other enterococci were 14.3 and 4.5 percent, respectively. Most operations (85.4 percent) had at least one tetracycline-resistant isolate, and all operations had at least one lincomycin-resistant isolate.

Table 3. Percentage of resistant *Enterococcus* isolates and percentage of operations with at least one resistant isolate, by antimicrobial and by species

Antimicrobial	*E. faecalis* (n=96)	*E. faecium* (n=63)	Other entero-cocci (n=1585)[3]	Operation level entero-cocci (n=247)[4]
Chlor-amphenicol	1.0	1.6	0.2	1.6
Ciprofloxacin	0.0	36.5	0.9	13.0
Daptomycin	3.1	1.6	28.1	68.4
Erythromycin	7.3	7.9	1.0	7.7
Gentamicin	1.0	0.0	0.1	1.2
Kanamycin	6.3	3.2	0.8	3.6
Lincomycin[1]	99.0	55.6	89.1	100.0
Linezolid	0.0	0.0	0.0	0.0
Nitrofurantoin	0.0	27.0	0.6	9.3
Penicillin	0.0	1.6	0.1	1.2
Quinupristin/ Dalfopristin	93.8[2]	14.3	4.5	36.0
Streptomycin	7.3	3.2	1.1	6.1
Tetracycline	30.2	47.6	46.6	85.4
Tigecycline	1.0	0.0	0.4	2.4
Tylosin	7.3	1.6	1.3	6.9
Vancomycin	0.0	0.0	0.0	0.0

[1] *Enterococcus* exhibits natural resistance to lincosamides such as lincomycin, so a high level of resistance is expected.
[2] *E. faecalis* exhibits natural resistance to quinupristin/dalfopristin (Synercid), so a high level of resistance is expected.
[3] Two "Other enterococci" isolates were not viable at the time of susceptibility testing. Thus, the total of isolates in table 3 (1,744) is not the same as the number of isolates in table 1 (1746).
[4] Percentage of flocks in which at least one *Enterococcus* isolate was resistant (of any *Enterococcus* species).

Conclusions

Nearly all sheep in this study were carrying *Enterococcus*, which was expected since it is a normal inhabitant of the intestinal tract of mammals. *E. hirae* was found in over 60 percent of all samples and was the most commonly identified *Enterococcus* species. The species typically associated with human infections—*E. faecalis* and *E. faecium*—were relatively uncommon and were found in less than 10 percent of all samples. No evidence was found of vancomycin resistance in samples tested. This finding suggests that U.S. sheep are not a significant source of vancomycin-resistant enterococci, which are of concern to human health.

References

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