Veterinary Practices of Infectious Disease Treatment and Control: Food Animal

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The direction of infectious disease treatment and control in food animal medicine is best described by the term Production Medicine. In the past, veterinarians dealt primarily with individual animals, often referred to as "fire engine" practice. This client service was usually rendered as needed to intervene in crisis situations or perform skilled procedures, such as pregnancy examination. Production medicine evolved as veterinarians started to spend more time preventing, as opposed to treating, left-displaced abomasums in dairy cattle, high respiratory morbidity in feeder cattle, and pre-weaning enteric disease in swine, to use a few examples. Production medicine promotes individual animal health by addressing the entire population through husbandry practices and preventive medicine.

The advent of computer-based record systems has dramatically increased the ability of veterinarians to utilize epidemiological principles to evaluate the disease status of a herd and response to preventive measures. For example, feedlot record systems allow instant access to cause-specific morbidity and case fatality updated on a daily basis. These data may be categorized by days on feed and source of the cattle.

Preventive measures focuses on active and passive immunity, biosecurity, and biocontainment. Biosecurity is a focus on preventing exposure in a susceptible group of animals. Biocontainment recognizes that a pathogen is present in a population and attempts to control the spread and impact.

Genetic selection for disease resistance is being utilized to minimize the need for antimicrobial use. Advances in record capabilities are being utilized to track genetic lines in the vertical integration present in today's swine and poultry industries. Alliances in the beef industry are moving in the same direction, especially as the potential of individual animal electronic identification is explored.

Biosecurity of breeding herds minimizes disease pressure on neonates. Additions to the breeding herd are tested and quarantined. "Transient" populations are isolated from the breeding animals (biosecurity).

The importance of nutrition during the gestational period has been underscored by recent occurrences of "weak calf" syndrome. Although bovine viral diarrhea virus (BVD) has been isolated from some cases, the primary link has been to under-nutrition of the dam. The vigor of the neonate is also linked to the ability to obtain passive immunity through the colostrum. Colostrum quality is assured by exposing the heifer or gilt to the common pathogens in the herd as well as utilizing strategic vaccinations prior to parturition.

Environmental hygiene in the neonatal period is extremely important. *E. coli* and *Cryptosporidium parvum* may cause severe problems in calves living in confined, contaminated environments. Rotavirus in swine and cattle may also infect neonates housed in unsanitary environments. Evaluation of the time period for maintenance of passive immunity combined with the epidemiology of neonatal diseases led to segregated early weaning in swine (SEW). This strategy removes pigs from the sow while their passive immunity to pathogens shed by the sow is still intact.

We are also learning more about how early vaccination can be effective in the face of maternal immunity during the neonatal period. Vaccines are administered to give the maximum time for response prior to high-stress events such as weaning or combining animals with other production groups. In cattle, these systems have evolved into preconditioning programs organized by state veterinary and producer organizations. The best programs involve pre-weaning vaccinations coupled with at least a 30 day post-weaning period during which the calves stay on the farm of origin. In Iowa, approximately 400,000 calves go through some version of this program on a yearly basis.

Another advance in vaccine technology is the development of marker vaccines. Current vaccines for pseudorabies in swine and brucellosis in cattle (RB51) allow separation of titers between natural exposure and vaccination. These vaccines allow vaccination in combination with eradication programs. Conventional vaccine technology also continues to advance. Examples of vaccines which have had major impacts on production are *Mycoplasma*, *E. coli*, *Salmonella*, and pseudorabies vaccines in swine. In cattle, vaccines against *E. coli*, Clostridial diseases, and viral respiratory pathogens are extremely valuable. Vaccines for *Salmonella*, *Pasteurella,* and *Haemophilus* are also becoming more effective.

Large production units are especially attuned to management of the animal environment. For example, most swine consultants are extremely well versed in the mechanics of airflow and ventilation, which have a dramatic impact on the occurrence of respiratory disease in a hog confinement facility. The temperature maintained on the floor of a swine nursery facility is also very critical. Environmental management in dairy facilities is crucial to milk production (cow comfort) and control of environmental mastitis pathogens.
One Iowa dairy realized a 6-pound/day/cow increase in milk production when the herd moved to a new free-stall barn on the same premises. This barn was designed in cooperation with the consulting veterinarian. "All in/all out" facilities in swine production allow cleaning and sanitation of facilities prior to introducing another group of animals. This production strategy has had a tremendous impact in decreasing morbidity due to swine dysentery and other pathogens.

Colleges of veterinary medicine are responding to changing technology in food animal production by establishing production medicine programs. For example, veterinary students at Iowa State University are exposed to production medicine concepts during the third-year medicine course. They may sign up for species-specific production medicine electives in the senior year that include in-house didactic and problem-based courses as well as field-based courses. Field experience with practicing veterinarians is a crucial part of this program. Efforts are under way to move basic production medicine courses further back into the curriculum and to identify interested students early in their career.

Areas of emphasis in production medicine education include epidemiology, economics of production, immunology, environmental management, client relation skills, and prudent use of vaccines and antimicrobials. The analysis of production records to evaluate programs in these areas is a major emphasis. At Iowa State University, a focus on clinical pharmacology includes developing an appropriate regimen (selection, dose, route, duration, withdrawal time) and utilizing susceptibility results combined with clinical observations to evaluate this regimen.

How are antimicrobials used in production medicine? The attached charts include labeled indications for food animal diseases and/or specific pathogens as found in the Compendium of Veterinary Products and the Feed Additive Compendium. Note that there are areas with no labeled products. A label for an indication should not necessarily be equated to efficacy. Rather, these tables should be recognized as illustrating the complexity of food animal antimicrobial use. An example is *E. coli* in calves. Labeled antimicrobials include sulfachlorpyridazine, sulfamethazine, neomycin, oxytetracycline, and chlortetracycline. These antimicrobials would be expected to meet with limited success in many field cases. In these situations, extralabel use would be considered, such as ceftiofur, spectinomycin, or an aminoglycoside. Several veterinary and producer groups have discouraged the extralabel use of aminoglycosides in food animals. It is in the best interest of producers to use all available preventive strategies so that the need for antimicrobial use is avoided.

There is the need for further research to define antimicrobial/pathogen interactions through susceptibility testing combined with pharmacokinetic parameters in the target species. An example of an antimicrobial with excellent pharmacokinetic information and efficacy based break-point information is ceftiofur (Naxcel®, Excenel®, Pharmacia & Upjohn). Incorporation of pharmacokinetic and minimal inhibitory concentration (MIC) summary information on product labels has been very helpful to practitioners.
Diagnosticians at the Iowa State University Diagnostic Lab are seeing a trend by veterinary practitioners towards an increased use of diagnostic microbiology, including susceptibility testing, in field disease cases.

It would be inaccurate to present the opportunities and techniques discussed above as uniformly practiced across the veterinary profession. However, aggressive education and quality assurance programs on the part of veterinary and producer groups are having significant impacts. Veterinarians and producers not taking advantage of current technology and production techniques will not be able to compete in today's markets.

Species	Disease	Primary Pathogens	Labeled
Cattle	Respiratory Disease Complex	Pasteurella haemolytica Pasteurella multocida Haemophilus somnus Mycoplasma bovis? Actinomyces pyogenes (secondary) Staphylococcus spp. (secondary) Streptococcus spp. (secondary)	**Macrolides** – tilmicosin, tylosin, erythromycin (injectable) **Tetracyclines** – oxytetracycline (feed, water, injectable), chlortetracycline (feed) **Beta-lactams** – ampicillin, amoxicillin, penicillin, ceftiofur (all inj.) **Sulfas** – sulfadimethoxine (oral, water, inj.), sulfamethazine (oral, feed) **Florfenicol**
	Enteric	Escherichia coli Salmonella spp. Clostridium perfringens Cryptosporidium parvum	**Sulfachlorpyridazine** (inj., oral, powder for milk) for E. coli **Sulfamethazine** (oral) for colibacillosis **Neomycin** (oral) for colibacillosis, (water) for bacterial enteritis **Tetracyclines** – oxytetracycline (inj, oral, water, feed), chlortetracycline (oral, water, feed) all for E. coli, some for Salmonella
	Mastitis	Staphylococcus aureus Streptococcus agalactiae Mycoplasma bovis Streptococcus spp. (environmental) Klebsiella/E. coli/Pseudomonas Actinomyces pyogenes	**Novobiocin** – (intramammary, dry, Strep. ag/Staph aureus) **Lincosamides** – pirlimycin (Intramammary, lactating, Staph. aureus/Strep. spp.) **Aminoglycosides** – Streptomycin/penicillin (intramammary, dry, Staph. aureus) **Penicillin/novobiocin** – (intramammary, lactating and dry products, Staph. aureus/Strep.) **Beta-lactams** – amoxicillin, (intramammary, lactating, Strep ag/Staph aureus), cephapirin (lactating/dry products, Strep. ag/Staph. aureus), cloxacillin (lactating/dry products, Strep. ag/Staph aureus), hetacillin (intramammary, lactating, Strep./Staph. aureus/E. coli), penicillin (intramammary, lactating/dry products, Strep. ag or Strep. spp.) **Macrolides** – erythromycin (inj., lactating and dry cow intramammary, Strep. spp/Staph aureus)
	Footrot	Fusobacterium necrophorum Bacteroides nodosus	**Tetracyclines** - oxytetracycline (inj.,), chlortetracycline (feed) **Beta-lactams** – ceftiofur, amoxicillin, (inj.), **Macrolides** – tylosin, erythromycin (inj.) **Sulfadimethoxine** (inj., oral, water) **Sulfamethazine** (oral, water)
	Metritis	Actinomyces pyogenes multiple anaerobes and aerobes	**Macrolides** – tylosin, erythromycin (inj.) **Oxytetracycline** (inj.)
	Ocular	Moraxella bovis	**Oxytetracycline** (inj.)
	Other	Actinomyces bovis	**Sodium iodide** (inj.)
		Actinobacillus lignieresii	**Oxytetracycline** (inj.) **Sodium iodide** (inj.)
		Anaplasma marginale	**Oxytetracycline** (inj.)
		Leptospirosis	**Oxytetracycline** (inj.)
		Septicemia (usually E. coli)	
		Listeriosis	
		Clostridial spp.	
		Chlamydia psittaci	

Injectable penicilli n and oxytetracycline may have label indications for "susceptible pathogens".

Swine	Respiratory disease	Streptococcus suis Actinobacillus suis Actinobacillus pleuropneumoniae Haemophilus parasuis Pasteurella multocida Bordetella bronchiseptica Salmonella cholerasuis Mycoplasma hyopneumoniae	**Ceftiofur sodium and hydrochloride** (inj.) – A. pleuropneumoniae, P. mult, S. cholerasuis, Strep. suis type II **Macrolides** – Tylosin (inj.) for Pasteurella spp., Erythromycin (inj.) **Lincomycin** (inj., feed) - Mycoplasma **Oxytetracycline** (inj., feed) – P. mult. **Tetracycline, Chlortetrtacycline** (water) – Pasteurella, Haemophilus **Tilmicosin** (feed) – Actinobacillus pleuropneumoniae, Pasteurella multocida
	Enteric disease	Escherichia coli Salmonella spp. Serpulina hyodysenteriae Serpulina spp. Lawsonia intracellularis Clostridium perfringens	**Sulfachlorpyridazine** (water) for E. coli **Oxytetracycline** (inj.) – E. coli, (feed) E. coli , Salmonella, Vibrionic dysentery **Gentamicin** (inj., oral) – E. coli up to 3 days of age **Tylosin** (inj., feed) – Serpulina hyodysenteriae (vibrionic dysentery) **Bacitracin** (water) - Serpulina **Tetracycline** (water), **Chlortetracycline** (water, feed) – E. coli, Salmonella **Chlortetracycline/Arsanilic acid** (feed) – Serpulina hyodysenteriae **Spectinomycin** (oral) – E. coli **Neomycin** (oral, water) – E. coli **Apramycin** (feed) – E. coli **Carbadox** (feed) – Salmonella cholerasuis, Serpulina hyodysenteriae **Tiamulin** (feed) – Serpulina hyodysenteriae **Virginiamycin** (feed) – Serpulina hyodysenteriae
	Other	Leptospirosis	**Erythromycin** (inj.) **Oxytetracycline** (inj., water, feed)
		Brucellosis	
		Tuberculosis	
		Staphylococcus hyicus	**Lincomycin** (inj., water) for arthritis
		Mycoplasma hyosynoviae	**Lincomycin** (inj., water, feed) **Tylosin** (inj.)
		Erysipelothrix rhusiopathiae	**Lincomycin** (inj., water) for arthritis **Penicillin** (inj.) **Tylosin** (inj.)
		Eubacterium suis	
		Streptococcus spp.	**Lincomycin** (inj., water) for arthritis **Chlortetracycline** (feed) – Group E Strep.

Penicillin injectable products are labeled for "organisms susceptible for penicillin".

Combinations are listed only if they extend the therapeutic spectrum beyond either compound alone.