Sponsors

University of Minnesota
College of Veterinary Medicine

College of Agricultural, Food and Environmental Sciences

Extension Service

Swine Center

Editors
W. Christopher Scruton
Stephen Claas

Layout
David Brown

Logo Design
Ruth Cronje, and Jan Swanson;
based on the original design by Dr. Robert Dunlop

Cover Design
Shawn Welch

Balancing the benefits and risks of antibiotic use in swine

Bob Morrison and John Deen

University of Minnesota Swine Group

The relationship between animal agriculture, bacterial disease, and antibacterial agents has been the subject of research, analysis, and now controversy. As responsible caregivers for animals, we control infectious disease to create a sustainable enterprise that is not only financially viable, but prevents the deleterious effects of disease on the welfare of the animals. We have used antibiotics to treat and prevent disease in individual animals and to control disease and even eradicate pathogens in populations.

The benefits of antibiotics are undeniable, both in humans and in animals. However, we know that with use comes reduced effectiveness of the same and related products. Thus there are restrictions on the use of antibiotics. These restrictions range from outright banning of use in food animals to the requirement of guidance by veterinarians with specific indications and dosages.

Many critics argue that the current restrictions of use in food animals (and in humans) are inadequate and that our pattern of use is leading to unacceptable risks to public health. Irresponsible and profligate use is a charge that must be addressed earlier rather than later in animal agriculture. This may be occurring in some herds, and it behooves all of us to identify and correct such situations. In addition, we need to define and illustrate the discipline in which antibiotics are used and the methods in which the needs of the animals, owners, consumers, and the general public are balanced. We must describe the decision framework and seek objectives in a manner that is useful in creating new policy and refining antibiotic use on swine farms.

To address these concerns we have begun developing a model that takes the following objectives into account:

- Minimize the potential effects of swine diseases on the welfare of pigs. The effects to measure include mortality and morbidity, which can be expressed as clinical signs such as coughing and diarrhea but also reductions in feed intake and growth performance. The number of days that a pig is sick is often a conditional measure of pig welfare.
- Measure the financial effects of swine disease and the costs of interventions, including antibiotic use.
- Measure the quantity of antibiotics used.

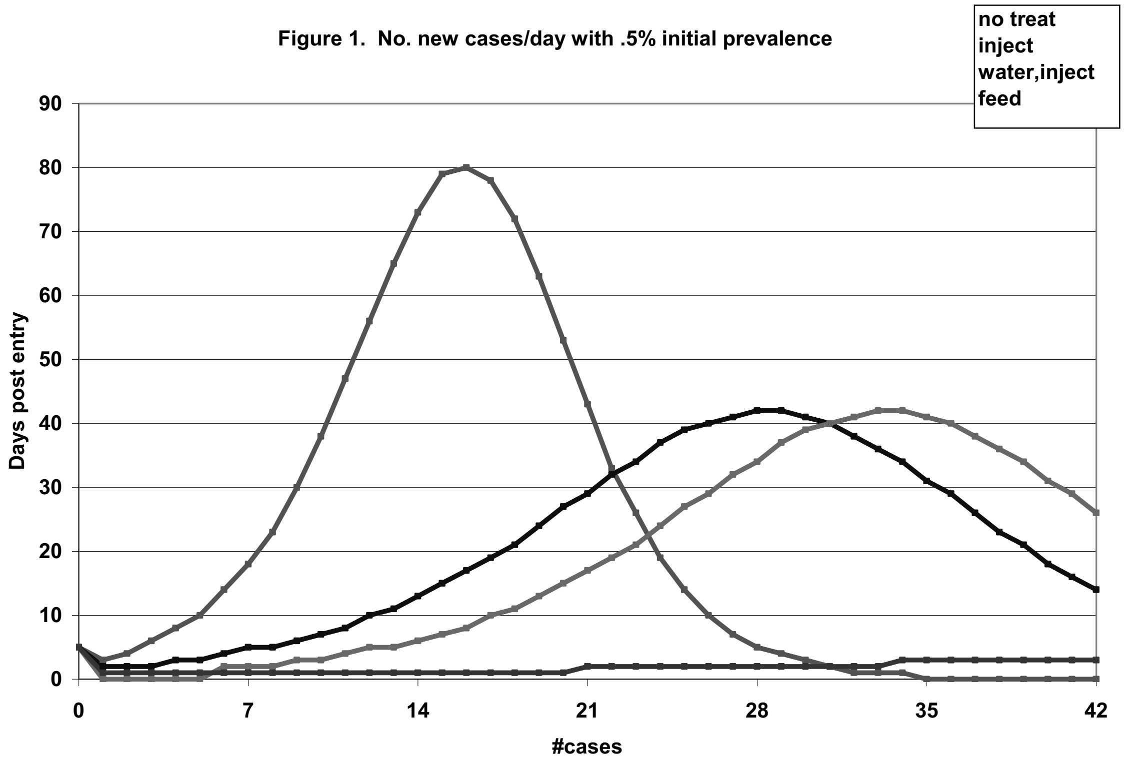
Though the request has often been to minimize antibiotic use, it is unclear as to the exact measurement. Much analysis has been in terms of the mass used, even though the potency of antibiotics differs greatly.

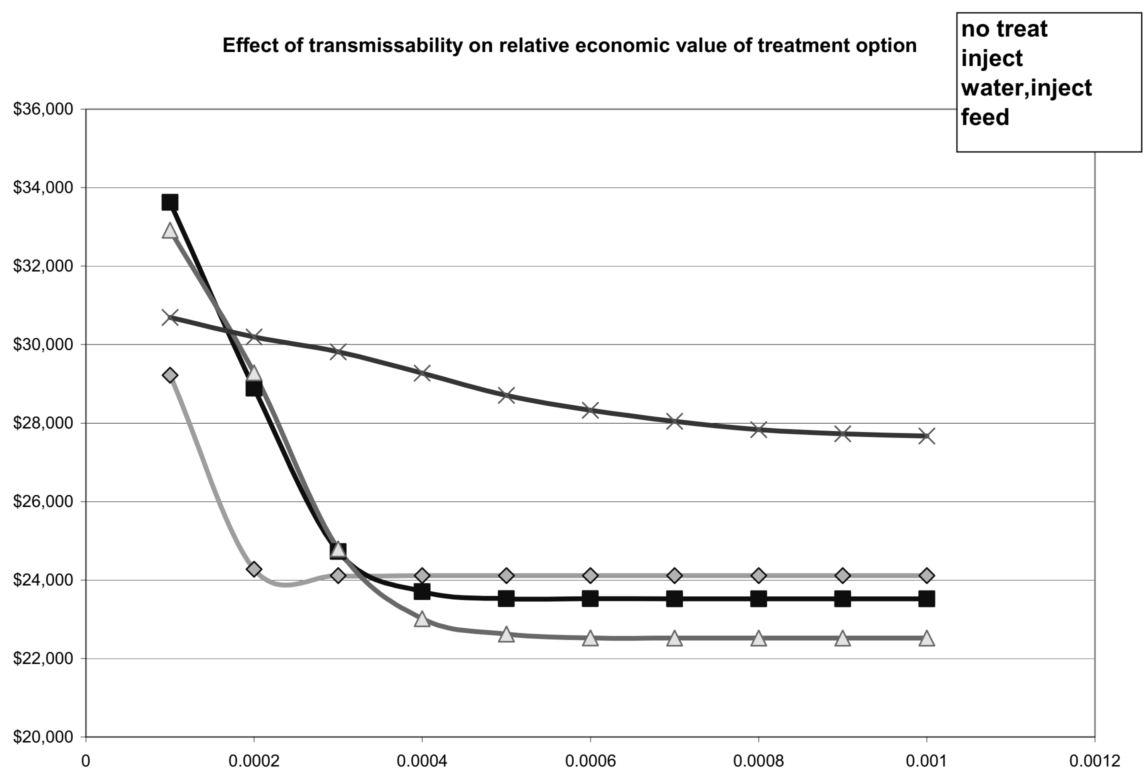
Our approach for addressing the competing objectives is not to develop a final answer, but to model the benefits and costs to the differing constituencies. The balance between consumer safety, pig well being, and economic benefit cannot be answered by a model. It must be addressed by a discourse that enaables each party to understand the needs of the others. Producers particularly are at risk in discussions as the burden of proof appears to be with them. The justifications for use must be described in some detail to allow discussion.

The biggest difficulty we have with antibiotic use in pig production is that it is very rare for the decision, and thus costs and benefits, to be limited to a single animal. We work with populations of animals and all applications of antibiotics must be described in terms of those populations. In other words, treating a pig in the nursery has an effect upon that pig but also affects the likelihood of pathogen transmission and thus the overall extent of the disease. Both benefits must be calculated and recognized as strategic benefits of medication.

Some critics of animal agriculture have argued that antibiotic use should be limited to treatment. Taken to its fullest extent, this means that mass medication is contraindicated, as not all animals within a population are sick at the same time. Prevention and control are an almost inevitable outcome of antibiotic use, yet it has often been poorly described and documented in pig populations. We would argue that it has been so poorly documented, that much of the use that is actually directed at prevention and control has been attributed to growth promotion.

As our starting point, we used the Reed-Frost model, which is a well described simulation model of infectious disease. Treatment was relatively easy to incorporate. We estimated the effect of the treatment for the animal and the owner by considering the number of pigs sick, the likelihood that they were detected and treated, and the effectiveness of the treatment. As this was done, we could estimate the amount of antibiotic used. We recorded this as daily doses of an antibiotic.





Public Issues

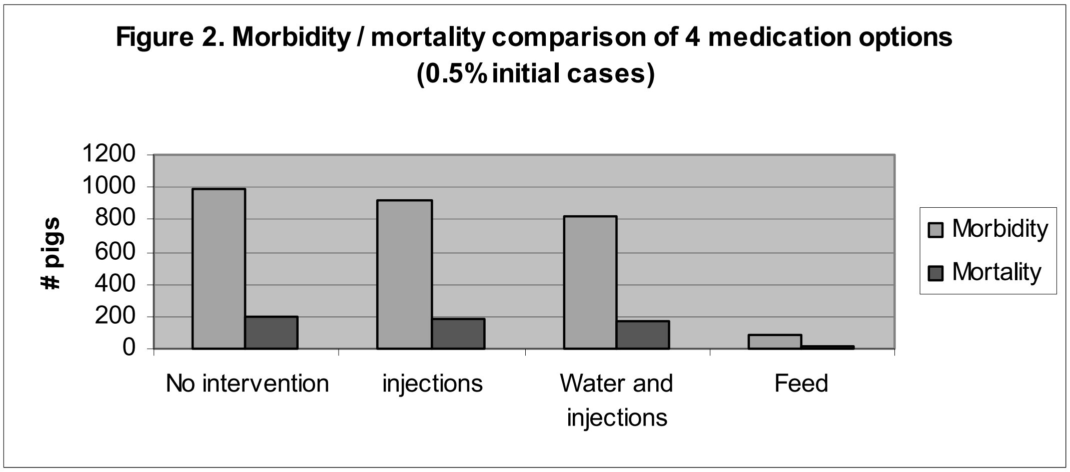
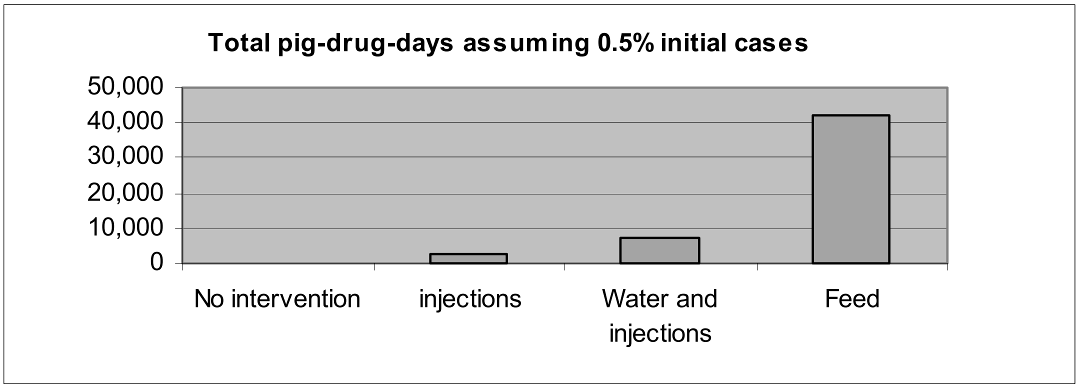
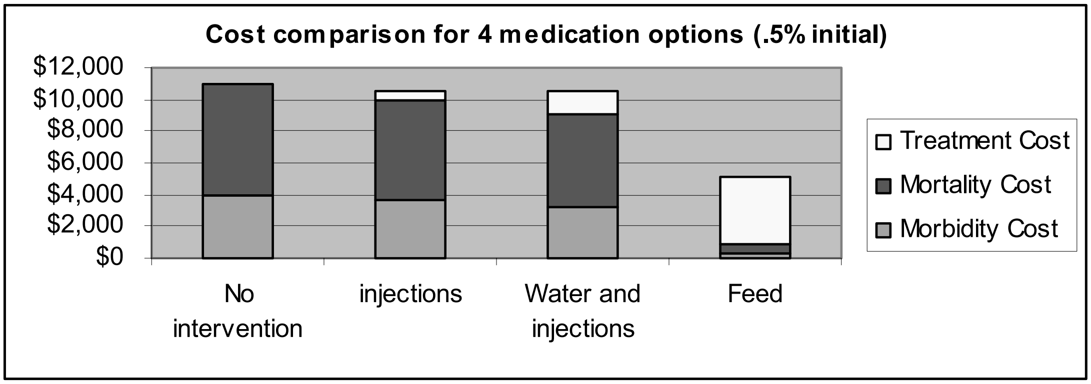


Figure 2. Morbidity / mortality comparison of 4 medication options (0.5% initial cases)



Total pig-drug-days assuming 0.5% initial cases



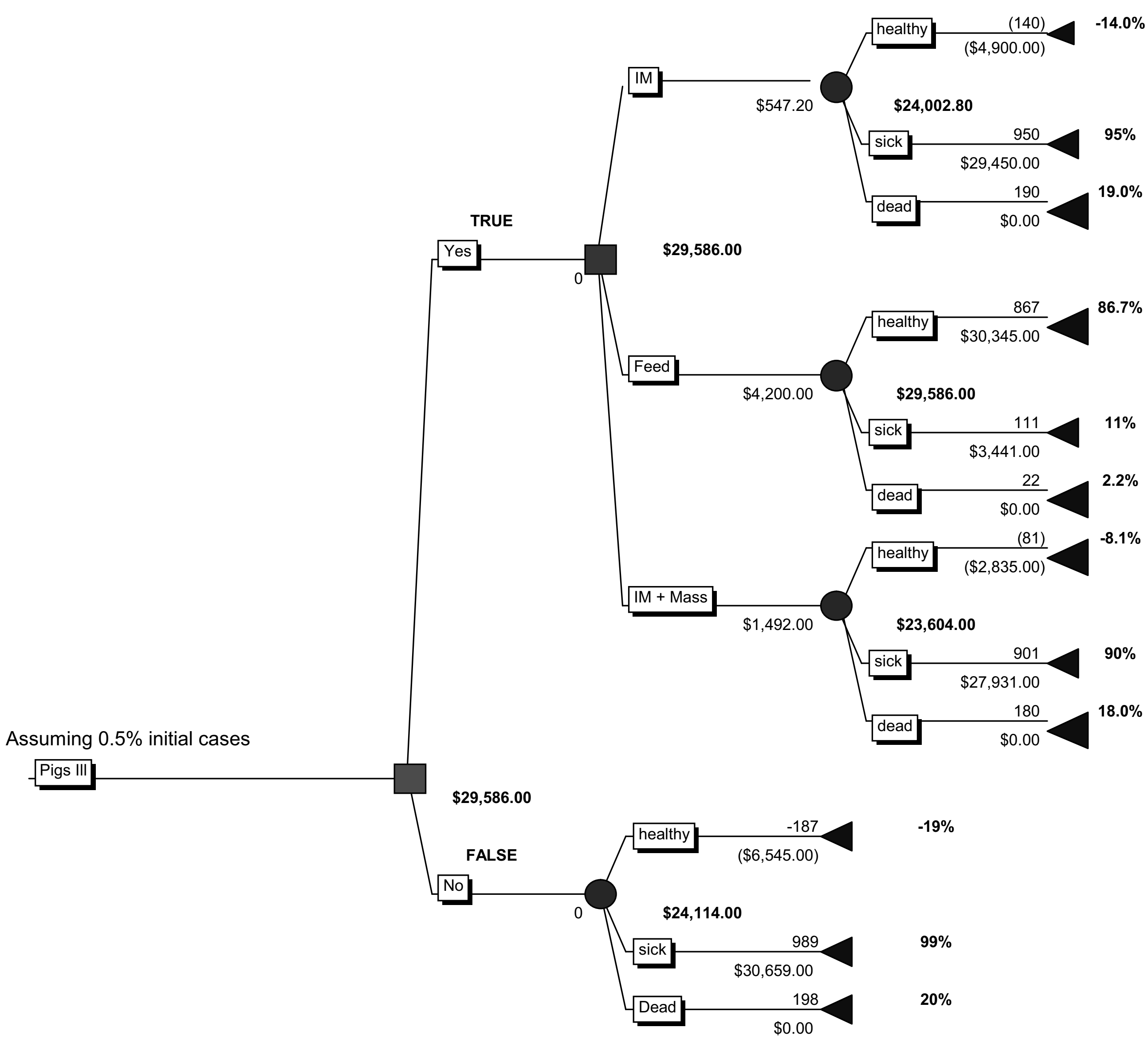
Cost comparison for 4 medication options (.5% initial)

In our model, we show four epidemic curves of *Haemophilus parasuis* clinical cases depending on the therapy given (Figure 1). The therapies that we are examining fall into the classes of injectable therapy, mass therapy, and combinations of these. By no means does this graph intend to give estimates of the effects of different treatment categories. Instead, it tries to take the information that is available on the farm and estimate the effect of an antibiotic intervention on controlling the disease and preventing further cases. The probability of pathogen transmission is a key driver influencing the epidemic curve, and in turn, the response to medication. When transmission is relatively infrequent, the economic choice may be individual therapy by injection whereas with high transmission, ongoing mass therapy may return most economic value (Figure 1b).

The model has a number of different variables in it to determine the potential effects. They include:

- The number of initial cases present at the time of the medication decision. This affects the likelihood of having an outbreak.
- The likelihood of the disease causing death. This is called the case fatality rate and reflects the severity of the disease.
- The likelihood of the pathogen spreading to unaffected pigs. Highly infectious pathogens should be controlled early to decrease the likelihood of an outbreak.
- The case detection rate is important as early detection is needed for injectable therapy to be effective.

Figure 3. Decision tree for evaluating economics of medication options



- The effectiveness of the antibiotic in reducing the severity of disease and reducing the likelihood of the pathogen spreading. The latter effect can be seen in both affected animals by reducing shedding and also unaffected animals by reducing the likelihood of infection.

Economics is not the only measure of success of a medication program (Figure 2). We should also consider health and well-being of the pigs (measured as morbidity and mortality in the model) and quantity of antibiotic used (pig-drug-days) (Figure 3).

Substantial work has to be done yet in determining the predictors of disease outbreaks in our herds. In our review, little information has been published on the dynamics of disease. It points to a need for further research and record-keeping in this area.

We must justify antibiotic use in more detail. The benefits are often trivialized by critics as are the issues presented to producers. As we use antibiotics, we balance the health benefits to the pigs with the risks to public health. Models such as this one will first be descriptive in an attempt to help us compare the benefits and risks of antibiotic use and routes delivered. As we gain more understanding of disease dynamics and interactions with antibiotic use, we can refine our models and describe farm level challenges and refine our antibiotic use.