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The Role of Trust and Moral Obligation in Beef Cattle Feed-lot Veterinarians' Contingent Adoption of Antibiotic Metaphylaxis Recommendations

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Abstract. In light of concern over possible public health consequences arising from the use of antibiotics in the animal industries, we examine the willingness of beef-cattle feed-lot veterinarians to forgo the recommendation of antibiotic mass treatment to their beef-feed-lot clients as a contingency based on the demonstration of a definite harm to human health. We explore this contingency as an example of the negotiation by health professionals of conflicting obligations to public health, animal well-being, and the economic pressures of feed-lot medicine. We base our study on survey data (n=103) collected from a national sample of U.S. feed-lot veterinary practitioners. Factors that predict willingness are primarily psycho-social, including social influence, moral duty, and trust or distrust, characterized as competency. We define the dimensions of trust across an array of salient others determined by the structural and regulatory context of the American cattle feeding industry.

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Introduction

Veterinarians play multiple roles in their practice. They are charged with providing care to their patients, yet many must also meet the obligations and other pressures that arise from practising medicine as a business. Furthermore, in the case of new or controversial treatment technologies, they may also negotiate among potentially conflicting obligations under conditions of social and scientific uncertainty. *How do veterinarians achieve a balance between an obligation to promote patient well-being and potentially conflicting instrumental values under conditions of social uncertainty?* We explore the role of trust and moral duty in this dynamic within the context of a common and contentious practice, the recommendation by cattle veterinarians to their beef-feed-lot operator clients to administer antibiotic metaphylaxis during an era of mounting concern over the public health consequences of antibiotic resistance.

Animal Production Medicine and the Antibiotic Controversy

Metaphylaxis, also commonly known as mass treatment, is a procedure often recommended by veterinarians employed in the food-animal industries. With metaphylaxis, all animals determined to be at an unacceptable high risk of developing a bacterial disease are administered a therapeutic dosage of an antibiotic. Metaphylaxis differs from the administration procedure used in human health settings and among companion animals in that a population of animals, often referred to as a herd, pen or lot, is treated in advance of disease rather than an individual patient after disease has been diagnosed (Radostits, 1994). Metaphylaxis is not to be confused with the more controversial administration of antibiotics to populations of animals at subtherapeutic levels to prevent disease in cattle at risk of exhibiting clinical signs of disease or to promote weight gain (Radostits, 1994).

In the U.S., veterinarians are allowed to prescribe, sell, and administer antibiotics. These antibiotic practices place the practitioners of production medicine at the nexus of controversy. Criticism of agricultural antibiotic use has been extant at least since the late 1960s with the publication in the U.K. of the Swann Report (1969), the Center for Science in the Public Interest's (CSPI) more recent advocacy for a U.S. ban of subtherapeutic use (FDA-CVM, 1999), and recent editorials against agricultural antibiotic use in popular newspapers such as the *New York Times* (Kristof, 2009; Kennedy, 2010; *New York Times*, 2010). Currently, the U.S. Food and Drug Administration Center for Veterinary Medicine (FDA-CVM) has issued a guidance document that states antibiotics should only be administered to assure animal health and should be overseen by veterinarians (FDA-CVM, 2010), a position that does not necessarily impact metaphylaxis, but suggests a move toward greater regulation of agricultural antibiotic use (Harris, 2010).

Debate addresses two recipients of moral obligation for veterinary practitioners: public health, and the well-being of animals (Rollin, 2001). From the public health standpoint, critics of the use of agricultural antibiotics are concerned selective pressure from antibiotics used in animal production will result in populations of antibiotic resistant bacteria that endanger public health (Avorn et al., 2001; Gorbach, 2001). Proponents of agricultural antibiotic use argue the pathways by which an antibiotic resistant strain of bacteria could make its way into human populations are evident; however, little to no evidence currently exists that quantifies the extent to which this has occurred (Hays and Black, 1989). The claim of insufficient evidence was the

pre-eminent argument put forward to justify continued use in animal agriculture by the American Veterinary Medical Association (AVMA) and a number of pharmaceutical and animal agriculture industry groups before the U.S. Food and Drug Administration during the comment phase of their update of the New Animal Drug Application policy. Supporters of continued use argued the source of the resistant pathogens plaguing human health are bacterial reservoirs made resistant through imprudent use of antibiotics on the part of physicians and human patients (Dean and Scott, 2005).

Another salvo in this debate involved an August 2007 study from the University of Illinois, which found resistance genes present among bacteria in lagoons and groundwater adjacent to intensive swine operations (Koike et al., 2007). This study was cited in an 18 September editorial in the *New York Times* calling for the end of population-level antibiotic treatment in confinement agriculture (*New York Times*, 2007).

The well-being of animals constitutes another focal point of this controversy. In their testimony before the FDA, the AVMA and agricultural trade and industry groups contended antibiotic treatments are necessary for promoting the well-being of the animals in their charge (FDA-CVM, 1999). Critics of the role of antibiotic use in animal agriculture also admit antibiotics may sometimes be necessary. Rollin (2001) holds that it would be unethical to deny an animal suffering from a bacterial infection the appropriate antibiotic treatment. However, he argues the crowded conditions under which animals are raised in large-scale confinement operations create conditions of stress and intensive contact that promote infectious diseases while militating against animal well-being. According to Rollin, these conditions, especially the large number of animals in confinement, demand an economy-of-scale approach to treatment, thereby necessitating the use of metaphylaxis procedures. In turn, the acceptability and adoption of metaphylaxis makes large-scale confinement agriculture possible.

Obligations, Social Pressure and Trust under Conditions of Uncertainty

In the U.S., licensed veterinarians take an oath:

> 'Being admitted to the profession of veterinary medicine, I solemnly swear to use my scientific knowledge and skills for the benefit of society through the protection of animal health, the relief of animal suffering, the conservation of animal resources, the promotion of public health, and the advancement of medical knowledge' (AVMA, 2003).

The structure of this oath stipulates the principal aim of veterinarians is to promote the 'benefit of society', by engaging in a series of beneficial actions. These obligations are refined in the Principles of Veterinary Medical Ethics of the AVMA (2003).

Feed-lot veterinarians also face a further set of demands in achieving a balance between the competing obligations that arise from their involvement in an antibiotic economy. Antibiotics, which they may not only prescribe but also sell or distribute, are a commodity and veterinarians may profit financially from antibiotic transactions. Furthermore, their cattle patients are also commodities often owned, or at least managed, by their feed-lot manager clients.

Controversies regarding the relationship between antibiotics, animal well-being and human health speak to these obligations, placing veterinarians in a double bind.

When forming their beliefs about the appropriateness of an antibiotic treatment, they must account for the immediate relief of animal suffering among their patients, and they must also promote public health. Furthermore, they must somehow balance these obligations against the personal and fiduciary obligations they hold towards their feed-lot operator clients, and against the social pressures derived from the financial demands of their veterinary business and demands to treat or not treat from a host of other actors.

A set of further complications arises from the social and technological uncertainties attendant with antibiotic use in the cattle feeding industry. Given their multiple obligations, if feed-lot veterinarians are to come to a well-considered decision on how to proceed with a treatment, they must account for all of the possible consequences of recommending that treatment. As there are currently many disagreements among experts regarding the consequences of antibiotic metaphylaxis on human health, feed-lot veterinarians must evaluate the reliability or trustworthiness of information from multiple and potentially conflicting sources. The practice of feed-lot medicine also involves the contingencies that arise from depending on multiple actors. Veterinarians advise feed-lot operators on medical protocols, but metaphylactic treatment often relies on the feed-lot operator and other employees to interpret treatment regimens, and to calculate dosages and administer treatments.

Moral Obligation, Social Expectation and Trust

We developed a rational-choice model to clarify the role of social expectations, trust and moral obligation in attitude formation toward metaphylaxis. Given conflicting pressures from a range of social actors, we ask what factors influenced the antibiotic decision-making of the beef-cattle feed-lot veterinarians in our study?

Contingent Adoption

To develop our model, we began with the adoption and diffusion of innovations research programme, which provided a well-tested rational choice model that has often been applied to agricultural technology decisions under conditions of uncertainty. The initial formation of attitude toward the adoption of an innovation has been defined as the persuasion stage, where 'innovation evaluation information' is used by an innovator in their valuation of the consequences of a particular technology (Rogers, 1995).

The final stage of the persuasion stage has been described as symbolic adoption, which refers to the innovation's initial acceptance (Klonglan and Coward, 1970; Sapp and Korsching, 2004). We further refined these concepts to examine how actors evaluate multiple outcome contingencies. Our source of inspiration was the literature on contingent valuation where resource economists ask respondents to evaluate their willingness to pay within imaginary markets to determine values for goods that lay outside markets. Kahneman et al. (1993) demonstrated contingent valuation of public goods to be of little value for placing a monetary value on goods, but to be strongly indicative of attitudes towards these goods. We refer to this contingent valuation as contingent adoption when we specify that a respondent considers a particular uncertain contingency as an outcome of a technological decision.

Moral Obligations

Rogers (2003) identified the relative advantage that arises from the adoption of a new technology as the principal value that motivates attitude formation during the persuasion stage. However, we expect veterinarians to take other values including moral principles into account in their attitude formation such as their oath bound duty to promote public health.

Such values are expressed in the relationship between moral obligation and behavioral intentions. In regard to client-based professions such as the insurance industry (Kurland, 1995), law (Robin et al., 1996) and nursing (Werner and Mendelsson, 2001), strong moral obligations are associated with positive behavioural intentions, indicating the value placed by these professionals on their obligations to clients. Outside the professional sphere, the relationship between moral beliefs and behavioral intentions has been demonstrated in a number of studies (Sparks et al., 1995; Sparks and Shepherd, 2002; Conner et al., 2003; Kaiser and Scheuthle, 2003; McMillan and Conner, 2003).

The values expressed by humans in their interactions with animals have been addressed by a number of researchers. Much of this work has arisen from the scholarship on animal welfare and animal rights, including that of Rollin who has expounded on the conflicted obligation of veterinarians to treat patients with antibiotics while limiting the scope of treatment to protect human health consequences from antibiotic overuse (Rollin, 2001, 2007). Empirical work has identified a variety of ways in which humans value animals. Animal rights activists have expressed a commitment to an equivalent value status between humans and animals in opposition to many farmers who grant greater status to humans (Hills, 1993), and Serpell (2004) has identified two dimensions to the human valuation of animals: affective or emotional responses, and instrumental responses.

As a profession, medicine is normatively distinguished from livelihoods where self-interest may be the acceptable behavioural norm (Arrow, 1963). Among veterinary professionals, limited attention has been given to the role obligations to others, especially to animals, may play in the formation of behavioral intentions within settings where self-interest or other non-patient or client interests may compete against professional obligations.

Social Expectation

The influence of salient others has been prominently featured within the diffusion of innovations research programme as an explanation for the formation of attitudes towards technological innovations. Salient others and opinion leaders are resources that allow potential adopters to reduce the uncertain consequences of adoption (Rogers, 1995). Diffusion of innovations scholarship has identified a number of means by which salient others influence innovation attitudes, including social pressure from peers and other important figures, as well as the information provided by experts and opinion leaders (Burnkrant and Cousineau, 1975; Bearden et al., 1986). There is limited research on the role social expectation plays in determining veterinary behaviour, although one study has identified the importance strong international professional ties play in countering social pressures to act counter to appropriate veterinary behaviour among veterinarians in African nations (Leonard, 1993).

Trust and the Reduction of Uncertainty

We do not expect feed-lot veterinarians to be only concerned with their own obligations as they formulate beliefs about antibiotic metaphylaxis. We expect feed-lot veterinarians to also account for the behaviour of others when they process intentions. Trust and distrust are paired concepts that many social scientists use to describe possible attitudes towards others in a position of responsibility towards ourselves (Earle and Cvetkovich, 1995). Our reliance on scientific and bureaucratic forms of expertise is necessitated by the increasing complexity of our modern social and technical universes (Weber, 1963; Freudenburg, 1993).

Research on trust has identified multiple dimensions to attitudes about reliance. One dimension is the expectation of competency, where others are expected to possess some modicum of skill in their appointed tasks and to base the information they provide on well-founded beliefs (Barber, 1983; Johnson, 1999; Allum, 2007). Within the diffusion of innovations literature, this corresponds to the claim that adoption behaviour is influenced by salient others, especially opinion leaders (Burt, 1987; Rogers, 1995; Kraut et al., 1998). Work by Brown and Michael (2003) has examined the role relative proximity to knowledge production plays in trust, and perception of an information source's competency is a determinant of symbolic adoption (Sapp and Korsching, 2004).

A second dimension of trust has been identified as the care dimension (Johnson, 1999) or as fiduciary responsibility (Barber, 1983), speaking to ethicist Annette Baier's definition of trust as a form of responsibility legitimated on the goodwill of the trusted individual (Baier, 1986). Empirical accounts of the role of trust in the willingness of others to behave responsibly within complex economic networks are rare, especially in regards to the formation of behavioural intention. One exception is Hart and Saunders (1997), who examined interorganizational business networks, and discovered trust in actors' willingness to behave responsibly with regards to sharing of confidential business information predicted the adoption of technologies reliant on sharing this information.

Trust's objects are multidimensional. Many empirical accounts of trust treat the trusting relationship as a social dyad. This is a likely outcome of the role trust plays in the literature on risk management and communication, where the presiding focus is on the relationship between the public and risk experts or risk managers. However, the complex of regulatory, public, business and other actors involved in many public controversies suggests the relationship between the 'truster' and multiple groupings of actors may impact belief formation.

Bryan Wynne's (1989) ethnographic account of the effects of an animal movement ban on sheep farmers in North Cumbria following the Chernobyl deposition of radioactive cesium on their farm lands found the varying degrees of trust placed in multiple actors was a factor in explaining the acceptability of the movement ban. The differences in trust allocated to distinct and competing sources of information has been demonstrated by Priest et al. (2003) to predict biotechnology acceptance, and Brown and Michael (2001) have explored the impact of new technologies on deep-held cultural beliefs and the consequential fragmentation of credibility. Following the insights of Wynne, Brown and Michael, and Hornig et al., we expect the variable trust placed by feed-lot veterinarians in a range of pertinent social actors to inform their contingent adoption of metaphylaxis recommendations.

Metaphylaxis and Contingent Attitude Formation

To characterize the negotiation between the instrumental interests of feed-lot production medicine and the value of public and animal health, we constructed a model that specifies the change in the willingness of veterinarians to alter their recommendation practices contingent on a definite harm to public health. Our dependent variable measures the intention to recommend to feed-lot clients a reduction in the number of high-risk cattle that receive metaphylaxis for disease prevention, contingent on a proven and definite risk to human health.

Theoretical Construct

In our model, veterinarians' considerations of public well-being as they evaluate metaphylaxis recommendations was the outcome. This attitude was designed to capture symbolic adoption (Klonglan and Coward, 1970; Sapp and Korsching, 2004). Veterinarians were further instructed to take 'good science' as an evidentiary standard for their valuation of this contingency. This term was chosen because of its ubiquity as a marker of scientific legitimacy among the feed-lot veterinarians and feed-lot operators we interviewed. The outcome was contingent adoption of metaphylaxis recommendations; more specifically, the willingness of a feed-lot veterinarian to reduce their recommendations of antibiotic metaphylaxis contingent on proven and definite risk to public health.

Six categories of constructs were expected to be principal determinants of contingent adoption. The first category of predictive construct examined the pressure on feed-lot veterinarians that arises from their presence within a competitive industry. Rogers (1995) argued beliefs about competitive advantage are central to the formation of attitudes towards the adoption of innovations. To account for the pressure of competitive advantage on feed-lot veterinarians' belief formation, we developed belief constructs to account for the specific advantages of metaphylaxis, the general necessity for metaphylaxis, and the economic pressures to use metaphylaxis.

The social character of the feed-lot industry suggested a range of conceptual categories for predicting contingent adoption. The first of these was social expectation (Burnkrant and Cousineau, 1975; Bearden et al., 1986; Ajzen et al., 2004). The belief that salient others expect a feed-lot veterinarian to recommend metaphylaxis was expected to be an associate of contingent adoption.

A second normative category was that of moral obligation. We expected the explicit demands placed on veterinarians by their oath to the veterinary profession and feelings of moral obligation to the animals in their care to effect contingent adoption. The construct of moral obligation was developed to examine its impact on the contingent adoption of metaphylaxis by feed-lot veterinarians. Moral obligation, contextualized as the duty of veterinarians to their patients (feed-lot cattle) to recommend metaphylaxis to their clients (feed-lot operators), was expected to determine the contingent adoption of metaphylaxis recommendations.

The third and fourth social-normative categories were based on the literature on trust. Following Wynne (1989), Brown and Michael (2001) and Priest et al. (2003), we expected the varying degrees of trust placed in a range of other actors within the feed-lot economy to impact contingent adoption. Across a range of actors, two categories of trust were expected to account for contingent adoption: trust in informa-

tion sources (Sapp and Korsching, 2004) and trust that others will behave as stated (Hart and Saunders, 1997).

We also included a range of demographic, structural, and control constructs into our model. Years of experience and age have been demonstrated to predict the adoption of an innovation (Rogers, 1995). Feed-lot size and the size of the veterinary practice may enable an adopter to absorb some of the potentially negative fall-out from adopting a new technology (Rogers, 1995).

Methods

Sample

Our analysis was based on a cross-sectional exploratory analysis of a survey delivered to practitioners of cattle feed-lot veterinary medicine. A random sampling of veterinarians, chosen to achieve a sampling error of 3%, resulted in a list of 325 feed-lot veterinarians from 37 different U.S. states. Respondents were identified from the membership lists of the American Association of Bovine Practitioners (AABP) and the Academy of Veterinary Consultants (AVC). Addresses were corroborated through Internet searches and state veterinary licensing boards. We followed the Dillman technique (2000). An initial contact letter was followed by a copy of the questionnaire, a follow-up postcard, and then another questionnaire, resulting in a sample size of 103 with a *post hoc* statistical power of .95 in a regression model of up to eight independent variables, when variance explained equals or exceeds .20.

After excluding veterinarians who indicated they no longer practice feed-lot medicine, we arrived at a response rate of 42%. This response rate is high for surveys of veterinary professionals. For example, a response rate of 31% was returned on a recent email survey of U.S. veterinary faculty after a fourth and final contact (Heleski et al., 2006). We also suspect many of our non-respondents no longer practice feed-lot medicine, but neglected to return their questionnaires.

Instrument

We developed this survey in two stages. We began with a series of open-ended interviews. Thirty-two interviews were conducted with individuals involved in feed-lot medicine, including feed-lot owners/operators, veterinarians, regulators and policy makers at federal agencies including the U.S. FDA, the Centers for Disease Control and Prevention, and the U.S. Department of Agriculture (USDA), as well as pharmaceutical company employees and executives. Among these questions, participants were asked to elaborate their beliefs about the role of antibiotics in feed-lot medicine and the attendant risks of antimicrobial use for public health. They were also asked to 'describe your role and obligations to others in the management of antimicrobial resistance', to identify their obligations to animals, organizations, financial partners, and public welfare, and to identify the impact of government bodies, political agendas, non-governmental institutions and pharmaceutical companies on their antibiotic use (a full list of questions is available from the first author on request).

These interviews were used to identify beliefs about the costs and benefits of specific antibiotic practices as well as the actors involved in the enactment of these practices. Veterinarians identified a range of actors involved in their daily feed-lot

practice, including sources of influence or expertise, and non-veterinarians who dispense antibiotics and advice on antibiotic use to feed-lot operators.

We used the content of these interviews and previously determined correlates of the diffusion of innovations to develop our mail-out survey. This survey was pretested with 10 veterinary medical faculty members who specialize in beef production medicine. In the survey, we focused on a number of antibiotic practices and beliefs. These included metaphylaxis, which we defined within the survey as 'the use of an injectable antimicrobial, or sometimes an orally administered antimicrobial, at therapeutic levels, following a strategically timed dosage regimen expected to reduce morbidity and/or mortality in a group of animals determined to be at high risk for disease(s) caused by bacteria'.

Measurement of Variables

As current research into the antibiotic decision-making of beef-cattle veterinarians is lacking, new variables were developed to measure factors expected to contribute to an explanation of contingent adoption. Variables were developed in part, as modified versions of pre-existing variables used in a range of rational-choice models including adoption/diffusion, social trust, moral obligation and the theories of reasoned action and planned behaviour. Variables were also developed based on inferences from field research and the prior experience of two of the authors as feed-lot veterinary consultants.

For the dependent variable, feed-lot veterinarians were asked 'If "good science" was to show a definite risk to public health from using antibiotics at feedlots, over the next year would you voluntarily plan to recommend that your clients change the number of cattle treated when recommending metaphylaxis to prevent disease in groups of high risk cattle?'. Veterinarians were queried on a six-point scale ranging from 'greatly increase', followed by 'increase', 'no change', 'decrease', 'greatly decrease', to 'eliminate use'.

Independent variables included moral obligation, beliefs about the necessity of metaphylaxis, number of cattle treated, industry experience measured in years of feed-lot practice, expectations of social peers and opinion leaders, confidence in information from social peers and opinion leaders, confidence in others to behave with prudence, and structural and demographic measurements found to be significant correlates of technology adoption.

To determine moral obligation, we asked veterinarians to evaluate 'how strongly do you agree or disagree with the following statement about values? I have a moral duty to recommend metaphylaxis to prevent disease in high-risk cattle' (five-point scale: 'strongly agree' to 'strongly disagree').

To determine beliefs about the necessity of metaphylaxis, we asked if it was 'necessary to use metaphylaxis to prevent disease in high-risk cattle' (five-point scale: 'strongly agree' to 'strongly disagree'). Using the same scale, we asked if economic pressures make it difficult for them to not recommend metaphylaxis for high-risk cattle to prevent disease.

Other elements of the necessity component included questions to measure beliefs about outcomes of metaphylaxis. The outcomes were the improvement of cattle health, profitability for the feed-lot, and cattle well being (five-point scale: 'very likely' to 'very unlikely'). We then asked respondents to assess the importance of these outcomes (five-point scale: 'very important' to 'very unimportant'). We created

a multiplier variable by multiplying the corresponding importance and likelihood variables (Ajzen et al., 2004).

To measure social expectations, we asked 'Which of the following individuals or groups would expect or not expect you to recommend metaphylaxis to prevent disease in high-risk cattle?' (five-point scale: 'strongly expect' to 'strongly not expect'). Actors identified through interviews with key informants included other veterinarians, clients' nutritionists, clients, retained owners, beef packers, beef retailers, consumers, pharmaceutical companies, professional organizations, the FDA and state licensing boards.

Trust in information sources was measured by two questions. We asked veterinarians 'How confident or unconfident are you that the following individuals or groups base their recommendations (or decisions) about antibiotic use on "good science"?' (five-point scale: 'very confident' to 'very unconfident'). Actors included feed-lot clients, other feed-lot operators, nutritionists, themselves, veterinary organizations, drug distributors, technical service veterinarians, other feed-lot veterinarians, pharmaceutical salespersons, cattle-feeder associations, the FDA, the USDA, and the CDC. With the same scale, veterinarians were asked to evaluate treatment regimens, judicious use guidelines and regulations from a variety of sources, including other feed-lot veterinarians, nutritionists, feed-lot operators, pharmaceutical salespersons, technical-service veterinarians, over-the-counter drug outlets, the FDA, veterinary organizations, cattle-feeder associations, and consumer and advocacy groups.

To measure the trust veterinarians place in others' behaviours, we asked, 'How confident or unconfident are you that the following individuals or groups are willing to follow voluntary judicious-use guidelines for antibiotics?'. The scale was identical to the previous confidence questions. Salient actors were technical-service veterinarians, themselves, other feed-lot veterinarians, feed-lot operator clients, other feed-lot operators, nutritionists, drug distributors, pharmaceutical salespersons, non-cattle veterinarians, other cattle veterinarians, stocker-cattle operators, and cow-calf operators.

Analysis and Measurement Assessment

All statistical tests were performed in SPSS (Version 18). Principal component analysis with varimax rotation was used to investigate the dimensionality of the outcome belief scale and the degree to which the variance in the individual scale item was adequately represented by these dimensions. The minimum eigenvalue criterion was 1.0 and factor loadings of .400 or above were considered acceptable. A Chronbach's standardized α score was used to assess the reliability of the factor. All predictors have been reported as standardized estimates.

Results

Confidence Rankings

Of the confidence questions, the two that evaluate confidence in information sources were significant in the regression model. Each question was scored 1 for 'very confident' to 5 for 'very unconfident'. A score of 3 is 'neither confident/unconfident'. Means are reported in parentheses. For confidence in treatment regimens, judicious-use guidelines and regulations, veterinarians were most confident in other veteri-

narians (1.82), veterinary organizations (2.32), the FDA (2.41), cattle-feeder organizations (2.56), nutritionists (2.63), technical service veterinarians (2.72), and feed-lot operators (3.00). They were not confident in drug salespersons (3.09), over-the-counter drug outlets (3.60), and consumer and advocacy groups (3.74).

For confidence that actors base their recommendations on good science, veterinarians were most confident in themselves (1.44), their feed-lot clients (1.59), veterinary organizations (1.82), nutritionists (1.93), technical-service veterinarians (2.10), cattle-feeder associations (2.18), other feed-lot operators (2.25), other feed-lot veterinarians (2.25), the FDA (2.29), the USDA (2.29), the CDC (2.44), pharmaceutical salespersons (2.55), and drug distributors (2.61).

Factor Analysis

A factor analysis was run on the behavioural beliefs questions. This analysis resulted in one factor with an eigenvalue greater than 1, which consisted of the importance and effectiveness of metaphylaxis for feed-lot profitability, animal well-being and cattle health (α=0.670).

A factor analysis using varimax rotation was conducted for the arrays of questions on social expectations/social norms, trust in information sources to base their knowledge on good science, trust in information sources, and trust in the behaviour of others to follow regimens and regulations. The following factors had eigenvalues greater than 1.

The analysis of social expectations and social norms identified three factors (α=0.783). Factor 1 consisted of groups downstream from the feed-lot, such as meat packers, consumers and retailers, in addition to institutions that regulate or guide feed-lot-veterinarians, such as the FDA, state licensing boards and professional organizations. Factor 2 consisted of individuals directly involved in the feed-lot, specifically clients, cattle owners who function as a kind of indirect client, and nutritionists who are involved in day-to-day feed-lot management. Factor 3 consisted of other veterinarians, pharmaceutical companies, and veterinary professional organizations with a weak factor loading for the third component.

The analysis of veterinarian confidence that salient others base their recommendations on good science resulted in four factors (α=0.814). Factor 1 consisted of government agencies. Factor 2 consisted of different kinds of veterinarians, with the exception of a weak factor loading for cattle-feeder associations. Factor 3 consisted of feed-lot operators, with a very weak factor loading for nutritionists and respondents themselves. These are individuals who advise operators on the health of feeder cattle. Factor 4 consisted of nutritionists, drug distributors, pharmaceutical salespersons, and cattle-feeder associations.

The factor analysis for confidence in the judicious-use guidelines or regulations of salient others resulted in three factors (α=0.740). Factor 1 included nutritionists, feed-lot operators, over-the-counter drug outlets and consumer and advocacy groups. This factor consisted of non-experts. Nutritionists and feed-lot operators may be involved in the administration of antibiotics, but veterinarians do not characterize them as antibiotic experts. Factor 2 included other feed-lot veterinarians, pharmaceutical salespersons and technical-service veterinarians. These are individuals involved with drug distribution. Factor 3 consisted of the FDA, cattle-feeder associations and veterinary organizations. These are groups with extensive access to antibiotic expertise.

The factor analysis for behavioural trust resulted in four factors (α=0.804). Factor 1 consisted of nutritionists, drug distributors, pharmaceutical salespersons, and non-cattle veterinarians. These are non-experts involved in drug distribution. Factor 2 consisted of technical-service veterinarians, respondents themselves, and other feed-lot veterinarians, all of whom are experts in feed-lot production medicine. Factor 3 consisted of the two groups of cattle producers that precede feed-lot operators in the supply chain. Factor 4 consisted of feed-lot operators in general, with a weak factor loading on feed-lot nutritionists.

Regression Model

Prior to interpreting our regression model, we examined our dependent and independent variables to insure each met acceptable standard assumptions for normality, and we assessed our models for conformity with linearity, homoscedasticity of errors and independence of residuals assumptions. Table 1 reports the results of our stepwise linear regression model. We were able to predict the dependent variable measuring the willingness of feed-lot veterinarians to decrease their recommendation of metaphylaxis if good science were to demonstrate a definite harm with an adjusted r^2 of .480.

Several items were associated negatively with the likelihood that feed-lot veterinarians would decrease their metaphylactic treatments. These items included: the strength of the economic pressure to recommend metaphylaxis; the strength of the

Table 1. Regression model with dependent variable 'If good science were to show a definite risk to public health from using antibiotics, over the next year would you voluntarily plan to recommend that your clients change the number of cattle treated?'.

	B	Std. Error B	Standardized Beta
Economic pressure to recommend high-risk metaphylaxis	–.167	.079	–.221*
Social expectation of other veterinarians, pharmaceutical companies and veterinary professional organizations to recommend metaphylaxis	–.324	.079	–.455***
Moral obligation to recommend high-risk metaphylaxis	–.255	.075	–.364***
Trust in information			
Confidence government agencies base their recommendations on good science	–.243	.074	–.335**
Confidence in regimens and recommendations of nutritionists, feed-lot operators, over-the-counter drug outlets, and consumer and advocacy groups	–.255	.072	–.369***

Notes: * $p<0.05$, ** $p<0.01$, and *** $p\leq0.001$. Adjusted r^2=0.480, n=62. Dependent variable is coded: 2=greatly increase, 1=increase, 0=no change, –1=decrease, –2=greatly decrease, –3=eliminate use; moral duty is coded: 1=strongly agree, 2=agree, 3=neither agree/disagree, 4=disagree, 5=strongly disagree; expectation is coded: 2=strongly expect, 1=expect, 0=neither expect/not expect, –1=not expect, –2=strongly not expect; confidence is coded: 2=very confident, 1=confident, 0=neither confident/unconfident, –1=unconfident, –2=very unconfident; economic pressure is coded: 1=strongly agree, 2=agree, 3=neither agree/disagree, 4=disagree, 5=strongly disagree.

moral obligation to recommend metaphylaxis regardless of negative consequences to human health; the strength of the expectations of other veterinarians, pharmaceutical companies and professional organizations to recommend metaphylaxis; the confidence that government agencies base their claims about antibiotics on 'good science'; and the confidence in treatment regimens provided by non-experts in feed-lot production medicine such as nutritionists, feed-lot-operators, OTC drug outlets and consumer advocacy groups. All items measuring fiduciary trust, structural and demographic characteristics were insignificant in the model.

Discussion and Conclusion

The analysis examined how some veterinarians contend with potentially conflicting values as they evaluate antibiotic treatment options. We explored these deliberations through the concept of contingent adoption, an attitude defined as the intention to adopt or cease a particular technological behaviour under specified consequences, here stipulated as definite harm to human health. Although structural and demographic measurements did not predict metaphylactic recommendations, psycho-social characteristics, defined within the agro-industrial context of feed-lot medicine, successfully predicted the willingness of feed-lot veterinarians to forgo the recommendation to their clients of antibiotic metaphylaxis to at-risk cattle if this behaviour were to have definite negative consequences for public health.

Our findings that feed-lot veterinarian perceptions of economic pressure to recommend metaphylaxis would militate against their willingness to reduce such treatments, regardless of other considerations confirm the well-founded claim of the diffusion of innovations literature that relative advantage is an innovation characteristic that encourages the formation of positive attitudes towards a particular technological practice (Rogers, 1995). As expected from the results of earlier research, pressure from others who are positively inclined towards antibiotic use such as other veterinarians, professional organizations, and pharmaceutical companies also promoted the use of metaphylaxis (Burnkrant and Cousineau, 1975; Bearden et al., 1986; Ajzen et al., 2004). However, a more complex story unfolded as we explored other factors in our model of contingent adoption. Moral obligation was of particular importance. This finding entails a balancing act between moral duty and economic pressure. To the extent that veterinarians consider metaphylaxis to be a moral obligation, this obligation will not come into conflict with the pressure to prescribe metaphylactic treatments. However, as a veterinarian's moral obligation to administer metaphylaxis diminishes, they become more likely to consider the reduction of metaphylaxis, counter to economic pressure.

Like Arrow's physicians (1963), feed-lot veterinarians are rational actors constrained by duty. Their behaviour and attitudes can be understood as the product of production forces such as the economic benefits that accrue from antibiotic use, and their understanding of the moral obligations and social pressures implicit in their participation within a feed-lot production economy. Current rational-choice models of moral obligation focus on a general obligation. A person is asked if they are morally bound to perform a particular behaviour. Whereas moral obligation in a generally defined sense is understood to be a predictor of attitudes and behaviours (Sparks et al., 1995; Sparks and Shepherd, 2002; Conner et al., 2003; Kaiser and Scheuthle, 2003; McMillan and Conner, 2003), little empirical work has examined the balancing of moral obligation to one party against the conflicting social expectations of others.

The veterinarian oath stipulates a veterinarian's moral obligation is principally to the 'benefit of society' and their duty to the well-being of animals is to be carried through so as to promote this overall benefit (AVMA, 2003). Subsidiary benefits that support this moral object include animal health and the relief of animal suffering, or essentially the promotion of animal well-being, and public health. It is not entirely clear from this oath if any of the subsidiary goods are to supersede another, although the benefit to society would suggest overarching importance is placed on human health. Such a hierarchical approach to attitude formation did not take place among the feed-lot veterinarians we surveyed. Moral duty to cattle well-being was an important predictor of contingent adoption; and the obligation to human well-being stipulated as a contingency in our measure of contingent adoption did not entirely supersede the duty to recommend metaphylaxis. When faced with a conflict, feed-lot veterinarians calculated a balance between obligations to humans and cattle.

When veterinarians form attitudes towards antibiotic metaphylaxis, they not only consider their own obligation to treat their patients, but also consider the expectations of other parties within the feed-lot production economy, and the trustworthiness of these parties. We conceptualized the attitude towards these obligations as trust, specifically as trust in information and fiduciary trust. Although the item measuring fiduciary trust was not significant, we found two measures of trust in information to be of importance in veterinarians' contingent adoption of metaphylaxis.

If feed-lot veterinarians believed government agencies base their beliefs on good science, then they were more likely to reduce recommendations of antibiotic metaphylaxis, contingent on a legitimate claim that such a treatment will harm human health. Furthermore, feed-lot veterinarians were more likely to recommend a reduction, contingent on definite harm to human health, as their trust in non-experts increased. The presence of these two groups in the regression model supports previous research that indicates the differential role that trust in distinct actors plays in belief formation (Wynne, 1989; Priest et al., 2003).

Brown and Michael (2001) identified the transmission of knowledge through the popular media and the portrayal of certainty by scientific experts as sources for the limited confidence placed in government experts by members of the public. A different dynamic exists between feed-lot veterinarians and the other social actors they encounter as they engage in antibiotic decision-making. The relative ranking of actors in the confidence in recommendations, guidelines and regulations question provides some clues to this dynamic. The two groups in which they place the greatest degree of confidence are other veterinarians and their professional organizations, followed by the FDA. Nutritionists and technical-service veterinarians are also evaluated with some degree of confidence. All of these groups are professionally credentialed experts who deal regularly with antibiotic use in a feed-lot context, either as practitioners or as advisors and regulators. Thus, all these groups possess a shared framework for interpreting the certainties inherent in antibiotic use (Dean and Scott, 2005), even if they may disagree on the degree of certainty necessary to take precautionary measures on regulation. Furthermore, they are groups that communicate through a set of shared professional journals, with the exception of nutritionists who nevertheless do overlap in their readership of specialist material on feed-lot medicine, rather than the popular media. It is the presence of such shared conceptual frames and value systems that form a basis for social trust (Earle and Cvetkovich, 1995). Such a basis is lacking between many feed-lot veterinarians and

the groups that fared least well in their ranking of trusted advisors on antibiotic decision-making. Consumer and advocacy groups are not in immediate contact with feed-lot veterinarians, and their interactions are most often mediated, either through the news media or their circulars. These circumstances mirror the conditions described by Brown and Michael (2001) that exist between the media-viewing public and professional and governmental experts.

We would be remiss if we do not address certain weaknesses to our study. The focus of our model of contingent adoption on individual behaviour does not address a host of socio-economic and political factors that would likely impact the antibiotic behaviour of feed-lot veterinarians. For example, veterinarians are expected to follow FDA-CVM antibiotic regulations. The impact of socio-political dynamics and economic agents on the regulatory environment that permits this behaviour, and of the socio-economic impact of agribusiness or the pharmaceutical industry on regulation and behaviour within the cattle feeding industry are not addressed by this study. A complete account would address the moral reasoning of feed-lot veterinarians within these larger economic, political and social contexts.

Nevertheless, we designed the concept of contingent adoption as a heuristic tool to reveal the moral reasoning of feed-lot veterinarians in relationship to their larger social environment. These professionals negotiate an acceptable choice within a socio-economic context defined by a range of other moral actors. By understanding trust not only as a matter of apparent competency, but as an attitude towards the moral propensities of salient others, we can understand the calculation of acceptable behaviour by feed-lot veterinarians not only as a product of their own moral duties, but also their understanding of other actors' competencies and moral character.

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