American Journal of Human Ecology
Vol. 3, No. 3, 2014, 27-34
DOI: 10.11634/216796221403557

Farmers' Beliefs and Risks of Bovine Tuberculosis in Cattle

Lillian A. Phenice[1*], Robert J. Griffore[1], John B. Kaneene[1] and Mikiyasu Hakoyama[2]

[1]Michigan State University, MI, USA
[2]Central Michigan University, MI, USA

This research examined farmers' beliefs and possible association with *Mycobacterium bovis* in cattle. A survey of farmers in Midwest, U.S. with TB Positive herds, a Matching Control sample from TB positive areas, and farmers from areas that were TB Free was conducted. Data from 31 respondents yielded insights about the beliefs of farmers concerning how Bovine TB was transmitted and how the disease can be prevented. Comparison of the three groups suggests some important differences. Evidence suggests that farmers' beliefs are important factors to consider with regard to control of the transmission of Bovine TB. While beliefs alone do not translate into behaviors, the findings suggest possibilities for preventive solutions that are specific to characteristics of a particular human ecosystem.
Keywords: Bovine tuberculosis, ecosystems, epidemiology, farmers, minimizing risk

Introduction

Human tuberculosis caused by the bovine bacillus M. bovis is scarce in developed countries, due to control and regulation of meat products and the dairy industries; however, this is not the situation for the Third World. In less developed countries, Bovine TB, *Mycobacterium bovis*, has been identified in a wide variety of domesticated and non-domesticated animals (World Organization for Animal Health, 2009; Zinsstag et al., 2006). According to Bolognesi (2007) Bovine TB has been observed in Egypt, Nigeria, and Zaire based on research between 1950 to 1970 and more recent research on the African continent has revealed the TB infection in Chad, Mozambique, South Africa, Tanzania, Uganda, Kenya, and Rwanda.

According to the Centers for Disease Control and Prevention (2013), there are ongoing research collaborations with China, India, Mexico, Peru, Philippines, Russia, Thailand, and Vietnam to name just a few countries. In most developed countries transmission of TB from animals to humans is scarce; however, this is not the situation for those in the Third World. During development infants and children who are malnourished and HIV infected have compromised immune systems that are stressed by living in close contact in vulnerable communities (Bronfenbrenner, 1989; Naess, 1989). These children are at particular risk and susceptible to infections from animal sources (Centers for Disease Control and Prevention, 2013; Kleeberg, 1984). Over half a million children become infected with TB each year.

The fear of Bovine tuberculosis infecting our meat products and dairy industries is real and necessitates quick actions and immediate eradication policies. This was the case of *M.Bovis* found in several herds of cattle in the Midwest and this is where the authors became involved. Cattle farmers in the United States have been adversely affected by transmission of Bovine TB to their herds. Bovine TB in deer has presented serious consequences for cattle farmers and their families in Michigan (Griffore & Phenice, 2001; 2004; 2008), as well as in other states. Many factors affect transmission of the disease. Contaminated food is a possible cause of spreading bovine TB. Baiting and feeding can cause deer aggregation and transmission (O'Brien, et al., 2002; Schmitt, et al., 1997). The World Organization for Animal Health (2008) notes that inhalation of infected droplets is the usual mode of infection. Transmission can occur through nose-to-nose contact, as well as through inhaling aerosol droplets from an infected animal, and animal density can affect transmission of *M. bovis* (State of Michigan, 2003). The disease can be transmitted through the use of a common watering place, or to humans through drinking unpasteurized milk (United States Department of Agriculture, 2008).

Humans have been involved in the transmission of Bovine TB. According to Bolognesi (2007), settlers from Europe are thought to have been involved in the spread of the disease. For example, it is hypothesized that humans brought Bovine TB to Africa in the early 1800s. In recent years, the dynamics of human involvement in transmission of Bovine TB have become clearer with evidence of human-to-human transmission of *M. bovis*. In one study it was shown that a patient infected with *M. bovis* infected five others, who developed the active disease (Bouvet, et al., 1993). A study of Bovine TB in Ethiopia (Kiros, 1998) has shown both *M. bovis* and *M. tuberculosis* in dairy farm workers and tuberculosis patients. A higher prevalence of Bovine TB in cattle owned by tuberculosis patients than in cattle not owned by tuberculosis patients suggests the possible role of Bovine TB in humans (Regassa, 1999).

Farmers may be involved in the transmission of Bovine TB through farm management practices, beliefs, and attitudes. For example a farmer's attitude towards risk and uncertainty may affect the risk for culling due to a health disorder (Beaudeau et al., 1996). While some farms, both dairy and beef, have had infected Bovine TB positive cattle (O'Brien, et al., 2002; Schmitt, et al., 1997), other farms within the same area have been free of the transmission of TB bacteria to cattle. This suggests the potential of a complex role for farm managers in the epidemiology of Bovine TB. Research suggests that the spread of Bovine TB is more likely when there is sharing of pasture and other territory between domesticated and wild animals (O'Reilly & Daborn, 1995).

A matched case control study in Ireland suggested that TB outbreaks were more likely to occur in intensively managed dairy herds than in other herds. In this study, there was no support for transmission due to poor boundaries, cattle housing, infected water supplies, or transmission due to vehicle movement to farms (Griffin et al., 1993). A study in Zambia found that Bovine TB was highly associated with husbandry practices of cattle herd. **(**Munyeme et al., 2008). Research in the UK found the probability of transient Bovine TB breakdown was affected by purchase of cattle, and that the probability of persistent breakdown was affected by type of herd and silage storage (Reilly & Courtenay, 2007). Another study found that factors specifically related to cattle management were very important, causing the authors to suggest improvements to procedures for testing and managing TB in cattle, reduced stocking density, and more human input in management of cattle (White & Benhin, 2004). There were conflicting findings in the literature, which meant that this research needed to focus on the social aspects of cattle farmers, their beliefs, their behaviors, and practices within specific ecosystems.

The present research is based on the possibility that farmers' beliefs relate to transmission of Bovine TB to their cattle. The interest is to investigate the nature of these beliefs and differences in beliefs in three groups of farmers: (1) farmers with TB Positive herds, (2) a Matching Control sample from the TB positive area, and (3) a sample from areas that were TB Free.

Method

Procedure

The data of primary interest in this study were collected by use of a survey instrument mailed to members of farm families. The initial draft of the survey instrument was developed based on review of literature concerning factors related to transmission of Bovine TB to cattle. (O'Brien, et al., 2002; Schmitt, et al., 1997). In order to shape and refine the survey instrument, four focus groups were conducted. The Michigan State University IRB approved collection of data in focus groups for this purpose. The first focus group involved four Michigan County Extension Directors who had experience with Bovine TB in Northern Michigan. The second focus group included two veterinarians in northern Michigan. The third focus group involved three additional veterinarians in northern Michigan. These veterinarians had experience in the field with bovine TB. The fourth focus group was held at Michigan State University with six scientists, each of whom had particular knowledge and expertise with the epidemiology of bovine TB. At each focus group, input was solicited concerning drafts of the farm family member survey instrument. Focus group participants suggested adding and deleting items, made language revisions and suggestions concerning format of the survey instrument. Based on suggestions and recommendations, the survey instrument was revised and approved by the MSU IRB.

A letter containing the purpose of the study, contact information, and voluntary nature of the study was mailed to a sample of farmers who are in the cattle business, to complete, sign, and date in a separate consent form if they agreed to participate and return it along with the survey.

Survey Instrument

Open-ended questions asked the respondents views on causes of and countermeasures against transmission of Bovine TB. Fill-in questions asked to write in the numbers such as the age of the respondent and years in operation. Twenty-three multiple choice questions asked the respondent to select one of the five answer choices that ranged from strongly disagree to strongly agree to the statement, which were to examine the participants' belief related to knowledge that was believed to help them prevent from risk of having their cattle to become Bovine TB positive.

The sample included 228 farmers, 40 of whom were farmers with bovine TB positive cattle. Twenty percent of the matched control sample consisted of farmers living in the bovine TB epidemic area with cattle with no bovine TB positives, and the rest were randomly selected cattle farmers in the bovine TB Free areas. A reminder was mailed a few weeks later.

Results

A total of 41 surveys were returned, 10 of which were unusable. Of the 31 surveys analyzed, 8 were from farmers whose cattle were identified as Bovine TB positive, 8 were from farmers in the matching control group and 15 from farmers in the TB free zone. Of the 31 surveys analyzed, 27 were answered by farm owners, two by farm managers, and two by family members. The age of the respondents ranged from 21 to 84 (mean = 55.26, SD = 15.19). The number of years the participants were in cattle business ranged from 7 to 72 (M = 29.48, SD = 16.88), and the number of cattle in the farm ranged from 0 to 530 (M = 102.74, SD = 129.53). The number of years cattle have been on their property ranged from 3 to 126 (M = 50.83, SD = 33.35).

Qualitative Responses

Two open-ended questions in the survey asked for participants' views related to Bovine TB. One question asked the participants their views on how Bovine TB is transmitted to cattle. Of the 31 participants, 23 respondents expressed their views while 8 left the space blank. Four of the 23 respondents stated "I don't know," there were others who expressed more than one idea in their responses. As a result of the analysis, 43 comments were identified. Of the 43 comments, 10-8 answers included the deer or other animals as the primary vectors for transmission of Bovine TB. Others pointed out ideas, which may be related to the means by which TB is spread, but surprisingly 5 comments included not knowing/ no idea. See Table 1.

Table 1. Participants' Views on How Bovine TB is Transmitted, N=31

	Responses	Number of Responses
1	Deer	10
2	Other animals such as raccoon and opossums	8
3	Hay/Feed/Water	5
4	Wildlife/Environment	5
5	Cattle	4
6	Saliva/Blood/Manure	3
7	Nasally/Breathing	2
8	Do not know/No idea	5
	Total	43

Participants were also asked to provide qualitative responses on their views regarding ways of preventing Bovine TB infection in cattle. While 8 respondents left the space blank, 23 respondents expressed their views. Four of the 23 responses indicated that they had no idea. However, 19 respondents stated their views, responses of some of whom contained multiple ideas. Some of the prevalent responses include statements such as controlling the number of deer in the area, eliminating positive animals and wildlife, and intervention by governmental agencies including United States Department of Agriculture (USDA), Michigan Department of Agriculture (MDA), and the Department of Natural Resources (DNR). Participants' responses are provided in Table 2.

Table 2. Participants Views on How to Prevent Bovine TB, N=31

	Responses	Number of responses
1	Controlling deer herd (e.g., Kill deer, increase hunting #s, should thin the deer herd down, reduce deer numbers in "hot spots", no bait, no crops left for deer)	7
2	Elimination of TB infected wildlife/deer/cattle	4
3	Vaccine/Continuing yearly testing	3
4	Lower the presence of raccoons and other animals	2
5	Isolating all cattle and feed from wildlife/deer	2
6	Intervention by USDA, MDA, DNR	2
7	Educate public (esp. bait hunters)	1
8	No idea	4
9	Other	4
	Total	29

Qualitative responses of participants in the TB-positive group were compared with those of the other groups. With regard to the question that asked participants their views of how bovine TB was transmitted, response of all three groups (TB-Positive, Matching Control, and TB-Free) included contact with deer, cattle, and other animals. Food sources such as hay, water, and feed were not mentioned by the respondents in the TB-Positive group, while they were mentioned by their counterparts in both the Matching Control and TB Free groups. A summary of responses by the groups is provided in the Table 3.

Table 3. Participants' Views on How Bovine TB is Transmitted by Group N=31

	Responses	*Number of Responses*			
		TB Positive	Matching Control	TB Free	Total
1	Deer	4	4	3	11
2	Other animals such as raccoon and opossums	2	4	2	8
3	Hay/Feed/Water	--	1	4	5
4	Wildlife/Environment	3	2	--	5
5	Cattle	1	1	2	4
6	Saliva/Blood/Manure	--	--	3	3
7	Nasally/Breathing	--	--	2	2
8	Do not know/No idea	2	--	3	5
	Total	12	12	19	43

Qualitative responses regarding participants' views on preventive measures were also examined. Respondents in the Matching Control group were most active in sharing their views on how to prevent bovine TB. All but one of the eight respondents in the Matching Control group stated their views, and some of them contained multiple ideas. Of the eight respondents in the TB-Positive group, only 50% (4/8) expressed their views, as two left the space blank and two stated that they had no idea. Of the 15 respondents in the TB-Free group, five (33.33%) did not respond. Of the rest of the 10 respondents, two did not know any ideas. Although the sample size was the same for TB-Positive and Matching Control groups, the number of ideas as well as types of ideas expressed by the Matching Control group were greater than those by the TB-Positive group and those by the TB-Free group, the sample size of which was twice as large as the Matching Control group. Views expressed by the participants are summarized in the Table 4.

Table 4. Participants Views on How to Prevent Bovine TB by Group N=31

		Number of Responses			
	Responses	TB Positive	Matching Control	TB Free	Total
1	Controlling deer herd (e.g., Kill deer, increase hunting #s, should thin the deer herd down, reduce deer numbers in "hot spots", no bait, no crops left for deer)	1	3	3	7
2	Elimination of TB infected wildlife/deer/cattle	--	2	2	4
3	Vaccine/Continuing yearly testing	--	2	1	3
4	Lower the presence of raccoons and other animals	--	2	--	2
5	Isolating all cattle and feed from wildlife/deer	1	--	1	2
6	Intervention by USDA, MDA, DNR	--	2	--	2
7	Educate public (esp. bait hunters)	--	1	--	1
8	No idea	2	--	2	4
9	Other	2	2	2	6
	Total	6	14	11	31

The findings in this study provide some insights about differences beliefs in the Bovine TB Positive group and the Matching Control group. To sharpen the contrasts between groups, items were selected on which 7 or 8 of the 8 Matching Control group participants agreed or strongly agreed. These responses were in contrast to levels of agreement or strong agreement among farmers with Bovine TB Positive cattle, which are shown in parentheses.

1. Keeping deer from grazing on the farm (4)
2. Keeping wild animals other than deer off your farm (4)
3. Acquiring and using control permits (5)
4. Preventing fence-line contact with wild animals (2)
5. Watering cattle only in a confined area (4)

These five items form a *Bovine TB Risk Index*. The index may be useful in informing farmers of attitudinal differences between farmers whose cattle acquire Bovine TB and farmers whose cattle do not acquire Bovine TB. Prevention in the form of attitude change may be useful.

Discussion

This research examined the presence of Bovine TB in the farm ecosystem and aspects of the possible role of the farmers in minimizing the risk of transmission of the disease. There were diverse views on how Bovine TB is transmitted. Deer were identified most often, and other animals were named almost as frequently. It is noteworthy that only 2 farmers identified nasal/breathing; only three identified saliva, blood, or manure as possibly involved in transmission, and only 4 identified cattle. These responses suggest that farmers have limited understanding of how Bovine TB is transmitted.

There were also diverse views on preventing transmission of Bovine TB. Controlling the deer herd was mentioned most often. Controlling TB infected wildlife was identified next, with 4 responses. However, the significant general finding was that few individuals had ideas about how to prevent Bovine TB.

While two respondents in the TB Positive group and three in the TB Free group said they did not know how Bovine TB was transmitted, no respondents in the Control group indicated they did not know. The contrasts between the TB Positive and Matching Control groups on the question of how Bovine TB is transmitted suggest that farmers in the Control group have more information than farmers in the TB positive group. It is interesting that two members of the TB Positive group said they had no idea how the disease could be prevented. While farmers in the Control group clearly agreed with using control permits, keeping wild animals and deer off the farm, watering cattle in confined areas, and preventing fence-line contact with wild animals, farmers in the TB Positive group agreed to a considerably lesser degree with these practices.

The findings provide insights about differences in farmers' beliefs. It is probable that members of the Matching Control group hold beliefs that lead to preventive actions that are consistent with minimizing the risks of their cattle acquiring Bovine TB.

Although limitations of sample size should be considered, there is evidence to suggest that becoming aware and being informed about the importance of certain beliefs in the management of cattle and the potential consequences of one's actions in understanding the epidemiology of Bovine TB may be important in reducing the spread of infection in cattle and hence to humans. Individuals' ways of thinking are rooted in their beliefs about how to manage the farm to sustain their economic well being, and these beliefs about how to manage the farm are subject to their control. A growing awareness to control their sustainability as farmers can lead to change in beliefs, thinking, and management practices.

The proper management of Bovine TB should be placed in a larger context. There is reason to suspect that tuberculosis in humans has sometimes not been appropriately recognized as TB caused by *M. bovis*. Bolognesi (2007) quotes Claire Geoghegen of the Mammal Research Institute at the Department of Zoology and Entomology in the University of Pretoria, with the statement that *M. bovis* is very similar to *M. tuberculosis*. Specifically, strains of TB share 99% of the DNA sequences, thus making it difficult to understand the origin of manifestations of tuberculosis in humans.

Especially in developing countries, there is a risk that human-to-human transmission of Bovine TB may be a serious problem, especially where HIV is also present in the population. There is cited evidence that TB is an opportunistic infection in persons infected with HIV (Raviglione, Snider & Kochi, 1995). By better understanding the epidemiology of Bovine TB in human ecosystems, related human health problems can be reduced. As an opportunistic infection, Bovine TB creates more serious health conditions for those who are afflicted with other diseases. Where HIV is a serious health problem, an opportunistic infection of Bovine TB could manifest into a devastating genocide of its populace (Moda et al., 1996). There is an abundance of evidence of a significant increase in HIV-attributable TB cases in geographically diverse regions. If the human population is unlikely to learn about the global risk of opportunistic infections until there is a crisis, then our best strategy is to become aware to prevent the possibility of a crisis which is already here for half a million global children who become ill with tuberculosis each year. Another 70,000 children die of TB each year, and there are over 10 million orphans, due to parental TB deaths in 2010 (Centers for Disease Control and Prevention, 2013).

Insights gained from this small study can provide health officials, policy makers, and nations/states to consider the importance of human ecology in understanding, managing, and preventing the epidemics of disease such as human tuberculosis whether it is human tubercle bacillus, *M tuberculosis* or caused by *Bovine tubercle bacillus*. The importance of the individuals' beliefs must be taken into account to understand the decision makers' actions. Husbandry management of cattle is a cultural practice embedded in diverse webs of human ecological interactions. For policy makers and health officials by understanding what cultural beliefs are associated with cattle owner's actions, more effective preventive solutions could be practiced.

Acknowledgment

The authors wish to acknowledge the U.S. Department of Agriculture for support of this research.

References

Bastolla, U., Fortuna, M. A., Pascual-García, A., Ferrera, A., Luque, B., Bascompte, J. (2009). The architecture of mutualistic networks minimizes competition and increases biodiversity. *Nature, 458,*1018–1020.

Beaudeau, F., van der Ploeg, J.D., Boileau, B., Seegers, H., Noordhuizen, J.P.T.M. (1996). Relationships between culling criteria in dairy herds and farmers' management styles. *Preventive Veterinary Medicine, 25* (3-4), 327-342.

Bolognesi, N. (2007). TB or not TB: The threat of bovine tuberculosis. Retrieved July 15, 2012 from http://glcrsp.ucdavis.edu/news/media/tb_or_not_tb.pdf

Bouvet, E., Casalino, E., Mendoza-Sassi, G., Larivan, S., Vallee, E., Pernet, M., Gottot, S., Vachon. F. (1993). A nosocomial outbreak of multidrug-resistant *Mycobacterium bovis* among HIV –infected patients. A case-control study. *AIDS, 7*, 1453-1460.

Bronfenbrenner, U. (1989). Ecological systems theory. In R. Vasta (Ed.). *Annals of child development*. Volume 6, pp. 197-249. Greenwich, CT: JAI Press.

Centers for Disease Control and Prevention (2013). Global tuberculosis. Retrieved July 5, 2013 from http://www.edc.gov/tb/topic/globaltb/default.htm

Griffin, J.M., Hahesy, T., Lynch, K. Salman, M.D. (1993). The association of cattle husbandry practices, environmental factors and farmer characteristics with the occurrence of chronic bovine tuberculosis in dairy herds in the Republic of Ireland. *Preventive Veterinary Medicine, 17* (3-4), 145-160.

Griffore, R.J. Phenice, L.A. (2001). Bovine tuberculosis: The perspective of farm families. Michigan Agricultural Experiment Station, Michigan State University: East Lansing, Michigan.

Griffore, R.J. Phenice, L.A. (2004). The social impact of bovine tuberculosis in northern Michigan. East Lansing, Michigan, Michigan State University.

Griffore, R.J. Phenice, L.A. (2008). Farm families and Bovine TB: Stress and adaptation. *Critical Social Work, 9* (1).

Kiros, T. (1998). Epidemiology and zoonotic importance of bovine tuberculosis in selected sites of Eastern Shewa Ethiopia. [MSc. Thesis]. Faculty of Veterinary Medicine, Addis Ababa, University and Freie Universitat, Berlin, Germany.

Kleeberg, H. (1984). Human tuberculosis of bovine origin in relation to public health. *Rev. sci. tech. Off. Int. Epiz., 3(1),* 11-32.

Moda, G., Daborn, C.J., Grange, J.M., Cosivi. O. (1996). The zoonotic importance of *Mycobacterium bovis. Tubercle and Lung Disease, 77*, 103-108.

Munyeme, M. Muma, J.B., Skjerve, E., Nambota, A.M., Phiri, I.G.K., Samui, K.L., Dorny, P., and M. Tryland, M. (2008). Risk factors associated with bovine tuberculosis in traditional cattle of the livestock/wildlife interface areas in the Kafue basin of Zambia. *Preventive Veterinary Medicine, 85* (3-4), 317-328.

Naess, A. (1989). *Ecology, community and lifestyle*. New York, NY: Cambridge University Press.

O'Brien, D. J., Schmitt, S.M., Fierke, J.S., Hogle, S.A., Winterstein, S.R., Cooley, T.M., Moritz, W.E., Diegel, K.L., Fitzgerald, S.D., Berry, D.E., Kaneene, J.B.. (2002). Epidemiology of *Mycobacterium bovis* in free-ranging white-tailed deer, Michigan, USA, 1995-2000. *Preventive Veterinary Medicine 54*, 47-63.

Odum, H.T. (1994). *Ecological and general systems: An Introduction to systems ecology*. Niwot, Colorado: The University Press of Colorado.

O'Reilly, L.M. Daborn, C.J. (1995). The epidemiology of Mycobacterium bovis infections in animals and man: A review. *Tubercle and Lung Disease, 76* (Suppl 1), 1-46.

Raviglione, M.C., Snider, D.E., Kochi, A. (1995). Global epidemiology of tuberculosis. *Journal of the American Medical Association, 273*, 220-226.

Regassa, A. (1999). Preliminary study on bovine tuberculosis in Wolaita-sodo, soth Ethiopia. [DVM Thesis.] Faculty of Veterinary Medicine, Addis Ababa University, Debre-Zeit, Ethiopia.

Reilly, L.A., Courtenay, O. (2007). Husbandry practices, badger sett density and habitat composition as risk factors for transient and persistent bovine tuberculosis on UK cattle farms. *Preventive Veterinary Medicine, 80* (2-3), 129-142.

Schmitt, S.M., Fitzgerald, S.D., Cooley, T.M., Bruning-Fann, C.S., Sullivan, L., Berry, D., Carlson, T. Minnis, R.B., Payeur, J.B., Sikarskie, J. (1997). Bovine tuberculosis in free-ranging white-tailed deer from Michigan. *Journal of Wildlife Diseases, 33*, 749-758.

Shitaye, J.E., Tsegaye, W. Pavlik, I. (2007). Bovine tuberculosis infection in animal and human populations in Ethiopia: a review. *Veterinarni Medicina, 52*, 317–332.

State of Michigan (2003). Transmission and Development. Retrieved July 15, 2012 from http://www.michigan.gov/emergingdiseases/0,1607,7-186-25804-75601--,00.html

United States Department of Agriculture (2008). Questions and Answers: Bovine Tuberculosis Signs and Symptoms. Retrieved July 15, 2012 from http://www.aphis.usda.gov/publications/animal_health/content/printable_version/faq_bovine_tb_.pdf

White, P.C. & Benhin, J.K. (2004). Factors influencing the incidence and scale of bovine tuberculosis in cattle in southwest England. *Preventive Veterinary Medicine, 63* (1-2), 1-7.

World Organisation for Animal Health (2009). Bovine Tuberculosis. Retrieved July 15, 2012 from http://www.oie.int/fileadmin/Home/eng/Health_standards/tahm/2.04.07_BOVINE_TB.pdf

Zinsstag, J., Kazwala, R.R., Cadmus, I. Ayanwale. L. (2006). *Mycobacterium bovis* in Africa. In C.O. Thoen, J.H. Steele, M.F. Gilsdorf (Eds.). *Mycobacterium bovis Infection in Animals and Humans*. 2nd ed. (pp. 199-210). Ames, Iowa: Blackwell Publishing Professional.