

## Animal Husbandry Practices in Rural Bangladesh: Potential Risk Factors for Antimicrobial Drug Resistance and Emerging Diseases

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**Abstract.** Antimicrobial drug administration to household livestock may put humans and animals at risk for acquisition of antimicrobial drug-resistant pathogens. To describe animal husbandry practices, including animal healthcare-seeking and antimicrobial drug use in rural Bangladesh, we conducted semi-structured in-depth interviews with key informants, including female household members ( $n = 79$ ), village doctors ( $n = 10$ ), and pharmaceutical representatives, veterinarians, and government officials ( $n = 27$ ), and performed observations at animal health clinics ( $n = 3$ ). Prevalent animal husbandry practices that may put persons at risk for acquisition of pathogens included shared housing and water for animals and humans, antimicrobial drug use for humans and animals, and crowding. Household members reported seeking human and animal healthcare from unlicensed village doctors rather than formal-sector healthcare providers and cited cost and convenience as reasons. Five times more per household was spent on animal than on human healthcare. Strengthening animal and human disease surveillance systems should be continued. Interventions are recommended to provide vulnerable populations with a means of protecting their livelihood and health.

### INTRODUCTION

It is estimated that 73% of emerging human diseases are of zoonotic origin.<sup>1</sup> Since 2003, worldwide attention to avian influenza has heightened concerns regarding the link between animal husbandry practices and emerging infectious diseases.<sup>2,3</sup> Studies from developing countries demonstrated that contact with free-range domestic poultry increase the risk of diarrhea in children,<sup>4–8</sup> and poultry farm workers and their family members are at greater risk for carriage of antimicrobial drug-resistant pathogens than the general population.<sup>7–10</sup> The presence of antimicrobial drug-resistant bacteria in these populations is associated with animal husbandry practices, including antimicrobial drug use and proximity of humans and animals.

Inappropriate antimicrobial drug use for humans is pervasive in developing countries and is a significant contributor to the growing public health threat of antimicrobial drug-resistant bacteria.<sup>11–18</sup> However, assessment of agricultural antimicrobial drug use in low- and middle-income countries has largely been neglected.<sup>19–25</sup> Few studies have examined the extent of animal antimicrobial drug use in low and middle-income countries where vulnerability to drug-resistant infectious diseases is greatest.<sup>18</sup> In high-income countries, DNA-based analyses and other techniques have been used to identify animal antimicrobial drug use as a major risk factor for recurrent and drug-resistant human infections.<sup>26–33</sup>

Using qualitative methods, we examined animal husbandry practices and medication use in animals and humans in rural Bangladeshi households and discusses the implications for emerging diseases, including infections from antimicrobial drug-resistant bacteria, in low and middle-income countries.

### METHODS

The study was conducted in the comparison arm of the Project to Advance the Health of Neonates and their Mothers

(PROJAHNMO), a three-year trial to evaluate the impact of a package of obstetric and neonatal care that includes community health education, provision of safe delivery, essential newborn care, and management of neonatal infections in northeastern Bangladesh. The methods and data collection procedures for PROJAHNMO have been described elsewhere.<sup>34</sup> The study area is characterized by a weak health system and a high infant and child mortality rate. We used qualitative methods to understand local animal husbandry practices and knowledge of antimicrobial drugs and other medication use for animals and humans. We carried out semi-structured in-depth interviews with key stakeholders, including women who had a child < 18 months of age, and healthcare providers, and conducted field observations at animal clinics and medicine stalls.

Semi-structured in-depth interviews conducted by trained anthropologists (NA, AA, and DA) with women from 42 households in the comparison arm of PROJAHNMO identified factors associated with transfer of microbes between animals and humans. The interview guides were developed on the basis of a literature review and in consultation with the anthropologists to ensure themes of interest are covered. Twenty-six interviews focused on animal health practices in households and 16 focused on health-seeking and medicine use for humans. To be eligible for participation, women had to reside in the comparison arm of PROJAHNMO for the six months before the interview, be  $\geq 18$  years of age, have a baby < 18 months of age, and live in a household that owned  $\geq 6$  chickens.

A list of households that met these eligibility criteria was generated from a census carried out by PROJAHNMO.<sup>34</sup> An equal number of households were randomly selected from low ( $\leq 1$  U.S. dollars/day), medium (1.01–3.99 U.S. dollars/day), and high ( $> 4$  U.S. dollars/day) socioeconomic groups to identify differences in animal husbandry practices by socioeconomic status. With this sample size, we expected to reach saturation of themes in each of the three groups. Average household size was eight persons. Women with young children were selected because they were believed to be a good source for information on human and animal medicine use and health care and were most likely to be home during the day when interviews were conducted.

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TABLE 1

Emerging themes regarding animal husbandry practices in rural Bangladesh

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Human and animal health care are sought from untrained village doctors, rather than formal health care providers; the same provider often provides care to both humans and animals
More money is spent on animal health care than human health care. Animals and humans are crowded in closed spaces.
There is shared housing and water sources for animals and human
There is a high level of antimicrobial drug use for humans and animals and medicines are often shared

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Interviewers were trained to observe animal husbandry practices and record information from the interview and from packages of medicine or prescriptions available in households for either human or animal use, including the medicines' name, producer, source, cost, size, color, odor, indications, use, and outcome for each medicinal treatment. In most instances, other household members were present during interviews and supplemented observations and information provided by the women. Interviews were tape-recorded and interviewers documented the mood, tone, and environment. Interviewers expanded these notes within three days of the interview.

Interviews were conducted with an additional 37 women who met the above inclusion criteria to learn about the village doctor network by using a structured form. Participants were asked to name the three most popular village doctors in the area and whether they treated children, adults and/or animals, and whether they sold medications. We asked each woman to name an animal doctor if she had not already done so.

Semi-structured in-depth interviews with 10 village doctors/drug sellers who were most often identified by the 37 women were conducted to learn about their prescribing practices, training, information sources, and medicine suppliers. Information obtained included recent human and animal medicines sold, most popular medicines, most common human and animal illnesses, and knowledge of antimicrobial distribution policies. Because of the sensitivity of this topic, interviews were not tape-recorded and only abbreviated notes were taken in the field and expanded within three days of the interview.

Themes of interest were identified from interview transcripts and are listed in Table 1. Animal husbandry themes included symptoms and underlying causes of diseases, medicines purchased and their cost, healthcare providers, household animal husbandry practices, and cost of animals owned by the household. The series of events leading to animal medicine administration were plotted for each interview and these were compared with each other. Matrices were constructed to display trends in animal healthcare seeking. Human healthcare-seeking themes included human disease symptoms, healthcare providers, and use and cost of medicines.

Open-ended, in-depth interviews were conducted with 27 key informants, including veterinarians, physicians, village doctors, drug sellers, pharmacists, pharmaceutical representatives, representatives of micro-credit programs that supported poultry rearing, poultry farm owners, fish farm owners, and farm workers, who were identified by using a snowball sampling technique, to gain a broader understanding of each sector's role in animal healthcare provision.

**Field observations.** Field observations were conducted at the headquarters of pharmaceutical companies, distribution facilities, pharmacies, drug-seller booths, indigenous healthcare/

homeopath chambers, clinics, hospitals, animal clinics, small- and large-scale poultry farms, household farms, village markets, microcredit offices, and government animal health clinics. A checklist was developed on the basis of a literature review and in consultation with the anthropologists to collect information on animal husbandry practices, animal healthcare-seeking behavior, and animal medicine use in various settings. Veterinarians in three animal health clinics were observed during their practice for seven days. Data collectors used a checklist to record information on the type of animal treated, nature of the visit, health history of the animal, previous treatment or care-seeking for the current complaint, regular animal healthcare provider, animal husbandry practices, and type of animal raised for each client visit.

This study was approved by the Johns Hopkins University Bloomberg School of Public Health Institutional Review Board and the Ethical Review Committee of the International Center for Diarrheal Disease Research, Bangladesh.

## RESULTS

**Types of animals owned.** In addition to household ownership of chickens, more than half of households also owned cattle, goats, or ducks. Two high socioeconomic households owned mynah birds and one also owned an elephant. Poultry was the main livestock raised because of their low purchase price and relative efficiency as sources of food and income.

**Animal husbandry practices.** We observed free-roaming livestock on roads near humans and using the same water sources used by humans for drinking and bathing. Most poultry were left to range freely around the household by day and placed in baskets under the bed at night. Cows and goats were generally kept outside the household in a shed made of natural material to protect them from cold and from theft. In a few households, goats were also reported to sleep under the bed at night and in one case cows were kept in the kitchen at night. Poultry waste was often used as fish feed or fertilizer, and cow waste was sometimes used as biofuel in a kitchen structure usually situated outside the main house.

**Management of sick animals.** *Illnesses of animals.* All respondents reported illness in their animals in the last 6 months. Most had sought care:

"It was in the month of Oghrayon [November]; they [chicken] had runny stool – just like water. They had become extremely weak and lost a lot of weight as well. Their fur used to stand up on its end... [we] didn't isolate them – took them to [village doctor] – We brought [village doctor] over to home... The doctor asked to give 3 medicines every 15 days and finish all 9 tablets in that schedule. It took 200 taka [3.5USD] for nine tablets."

Respondents reported that back pain, blisters, diarrhea, and fever affected cows and stomach swelling and diarrhea affected goats. Poultry were commonly afflicted with white diarrhea, fever, and tiredness, which together often preceded death. Veterinarians reported that Newcastle disease, a vaccine-preventable viral disease, with the symptoms described in the previous sentence is the most common cause of poultry death in rural Bangladesh.

Respondents generally described livestock symptoms the same way that human symptoms were described in studies of the same population:

"Their stomachs swell up, have watery stuff coming out of their mouths, can't walk, have blisters on their feet or

hooves,... goats have their eyes swell up,... have *dasto* [diarrhea] ...” “The cow/s had problems in their eyes. They couldn’t see. They had *ful* [lens opacity similar to cataracts in humans] in their eyes. Also, they had problems in their legs, where they developed blisters on their feet and hooves and couldn’t walk, except for with a lot of pain.”

Veterinarians reported that foot and mouth disease is a common cause of cattle morbidity in rural Bangladesh and is likely what the respondents were describing. Reported perceptions of underlying causes of disease included being overworked, and “evil eye” (if someone was jealous of the owners or the animal then the animal would become sick). Illness in cows or goats was considered very grave because it could negatively impact household livelihood. In cases attributed to “evil eye”, traditional healers were visited and amulets were used to ward off malevolent spirits.

**Animal treatments.** Most respondents had used antimicrobial drugs and could name them by using local terms or the brand name. The most commonly used antimicrobial drugs were oxytetracycline and metronidazole. Other substances administered to animals included vitamins, paracetamol, homeopathic medicines, and food additives, which ranged from premixed feed purchased at a feed store to unknown substances. A few households reported injections being administered to chickens by household members or village doctors but were unable to report the name of the medicines. Other informants said only government veterinarians gave injections. Human medicines were sometimes given to animals, particularly when the animals symptoms were similar to those observed in the human illness.

**Home remedies.** Home remedies for sick animals included combinations of traditional and Western methods. Two respondents reported using only traditional methods. Mixed methods often consisted of isolating sick animals and changing their diet:

“...Bathed them with bitter water [water mixed with local leaves], apply the water with chicken feathers – call [village doctor] and keep the sick ones separated from the rest.”

**Animal healthcare seeking.** Respondents reported seeking animal healthcare from many healthcare providers, including drug sellers, homeopaths, human medical doctors, village doctors, and village elders, and rarely veterinarians. Drug sellers and pharmacists were the most popular animal healthcare provider and were consulted by all respondents for all types of animals. There was considerable overlap in human and animal care-providers. In most cases, the health-care practitioner who treated the household’s children also treated the animals:

“[Brother-in-law’s son] went and got the [animal] medicine from [NAME deleted] pharmacy ...he [pharmacist] is a people’s doctor primarily...the boy administered the injection himself.”

Villagers rarely sought help outside their village doctors, unless their large and more expensive animals were sick, because of the cost involved. Some respondents recalled that trained veterinarians were only sought for immunizations.

“...don’t remember when, but people from the village ... fetch the government provider. .... provider gives injections to all the village livestock and poultry in front of the mosque. . .These arrangements are made on a yearly basis – they do not take any money for their services. If they deem it necessary, then they provide medicines as well. . .”

Most respondents had little interaction with trained veterinarians and often expressed dissatisfaction with them, as noted below. However, they still wanted government assistance with serious diseases.

“They [vets] never come around to this village – if [local village doctor’s] medicines work, they work, or else we just throw the animals into [the river]...If there were animal doctors and hospitals, then the livestock and poultry would not die out as they do. The doctors at the animal hospital are not cooperative – they do not give anything, even if you ask for them.”

“Cows and goats die, ducks and chicken die – why should we have to go over to [the large towns] for the treatment? There should be enough facilities close-by, preferably within the village.”

Veterinarians voiced their concern about rural animal health especially endemic poultry diseases such as Newcastle disease but believed that access to remote areas was a barrier.

**Animal medicine expenditures.** Money spent on healthcare seeking was proportional to the number of livestock owned. Cost of individual tablets ranged from 12 to 60 taka (< 1 U.S. dollar) each. We could not ascertain from interviews if costs were related to medication type.

Most respondents reported borrowing money from neighbors and family to treat sick animals. In some cases, the family paid the village doctor with healthy animals. Some respondents believed that they had wasted money on medicines because the treated animals often died.

More than half of households spent on average an estimated 12 U.S. dollars for animal medicine and spent < 3 U.S. dollars on human medicine for all household members combined during the same time period of six months.

**Micro-credit agents.** We found that little information on poultry husbandry was provided to poultry microcredit enrollees. However, we identified microcredit programs that provide animal antimicrobial drugs to enrollees and recommend their use.

**Unlicensed village doctors: multiple roles.** Village doctors, pharmacists, and drug-sellers have multiple roles, and villagers often used these terms interchangeably when discussing healthcare practitioners. Respondents with animals usually listed doctors who treated both animals and humans as those they perceived to be the most popular. Drug sellers usually sold human and animal medicines. Women reported that some village doctors treated animals from their homes, drug stands, markets, and human health facilities.

Several drug sellers described initially selling drugs for humans before transitioning to human and animal medicine sales then eventually switching to exclusive sale of animal medicines because the latter was more profitable and not associated with risk of harming people. No village doctor, pharmacist, or drug seller was able to tell us about official drug sales policies.

**Importance of animals to livelihood in rural Sylhet.** Respondents pointed to poor job stability, inadequate transportation and communication, and unavailability of healthcare as major obstacles to providing acceptable living standards for their families. Seasonal monsoons flood more than half of Bangladesh each year and destroy crops, livestock, and devastate infrastructure. The latter was reported as an obstacle to seeking adequate healthcare for humans and animals when needed. This was also cited as an obstacle by veterinarians.

Nearly all respondents derived most of their food and income from animals. Many described going into debt to care for their animals and protect the livelihood derived from them.

"...cows and goats die, ducks and chicken die... we are poor people...we can hardly buy food for ourselves, let alone the livestock... we do buy medicines for livestock when they fall sick."

**Use of animals.** Households used animals as their main source of meat, milk, and eggs, as well as for commodities for trade. Larger animals were also needed for plowing and transportation. Some owners rented their animals in exchange for money or agricultural products. Animals were used for food even if diseased. As one respondent described:

"if their disease doesn't seem too bad, then we (respondent's family) even slaughter and eat them."

**Costs of animals.** Total household spending on animals appeared to be disproportionate to income. Households spent on average 40 U.S. dollars in the year before the survey. In some households, household animals were given to household members as payment for work or as a gift.

**Case study: formal animal health care as a last resort.** Villagers from remote areas seeking care usually visit veterinarians in the nearest town as a last resort after trying local doctors:

"A farmer took cows and 2 oxen that had been suffering from loss of appetite, diarrhea, and weight loss for a few months to the veterinarian in the district headquarter. The farmer had first sought care from the local village doctor and treated the animal with the medicines that the village doctor had prescribed and sold to him. The treatment was not successful. The farmer brought with him the prescription that the village doctor had written. The prescription listed 5 medications: 2 antibiotics, 1 steroid, 1 anti-helminthic and 1 vitamin."

The veterinarian reported seeing  $\geq 10$  similar cases per week in which farmers came to him as a last resort after treatment failure. He explained that local animal health providers tended to prescribe multiple medicines to treat bacterial and parasitic infections, and vitamin deficiencies. Trained veterinarians complained about the difficulty in treating animals that are brought to them at a late stage with many complications. Some attributed this to drug-resistant pathogens.

**Case study: small scale farming and transfer of technology.** In general, independent small-scale farmers adopted Western poultry rearing methods, including use of vitamins, antimicrobial drugs, and steroids, which they had learned about from family members or neighbors who worked on large poultry farms in Bangladesh or Arab countries:

"We visited a small scale poultry farmer in town. He explained that he added special vitamins (the vitamin package label listed vitamins and antimicrobials as ingredients) to the water when the chickens were little and then added another type of special vitamins to the feed for bigger chickens. He was a poultry farmer in Saudi Arabia more than 20 years ago and learned a lot about poultry farming there."

**Pharmaceutical promotions and distribution.** During field visits with farmers, village doctors, pharmacists, government veterinarians, and animal feed shops, we found pharmaceutical promotional materials, such as pens, calendars, posters, and notepads. In houses of farmers, we found calendars from 1999, indicating that animal medicines have been promoted in rural Bangladesh since at least that year. Interviews with

pharmaceutical representatives confirmed that animal medicine sales have increased steadily since 1995. When asked about animal medicines, formal sector veterinarians showed us pamphlets from pharmaceutical companies that explained antimicrobial administration to animals.

We visited pharmaceutical offices and distribution centers to obtain information about types and amounts of products sold, and distribution practices during the study period. Pharmaceutical representatives explained that with their resources they are able to reach remote areas to provide an important service to rural communities that "you can't provide", referring to our affiliation with a non-profit organization. We observed that boxes of medicines were often packed into rickshaws, vans, or motorized rickshaws at offices in town for transport to rural areas.

## DISCUSSION

We present evidence that animal medicines, including antimicrobial drugs, are being used extensively in rural households in Bangladesh. Animal husbandry practices that include shared living spaces and drinking and bathing water between humans and animals, together with injudicious use of antimicrobial drugs, provides a pathway for transfer of antimicrobial drug-resistant pathogens and zoonotic pathogens from animals to humans and *vice versa*.

Livestock provide an opportunity for low-income farmers to accumulate capital, which helps improve food security.<sup>35-37</sup> The loss of livestock for small-scale farmers can have severe consequences, including loss of income and social standing within the community. European organizations have recognized this problem and have funded several projects to improve animal health clinics in sub-Saharan Africa. These interventions have also become an important means for improving husbandry practices, including antimicrobial drug use.<sup>37-40</sup> Our study population would benefit greatly from provision of similar interventions.

An important finding of this study is the substantial penetration and promotion of animal drug use by pharmaceutical companies and their agents even in this remote study area. The effect of the pharmaceutical industry's heavy promotional activities on prescriber practices in this population requires further investigation. This primacy of sales representatives and pharmaceutical company publications in providing animal health information has also been found in Indonesia.<sup>41</sup> Anecdotal information suggests that pharmaceutical companies target human and animal drug dispensers in much the same way as other industries target sellers by providing financial incentives.<sup>42</sup>

We worked in rural Sylhet District of Bangladesh, thus the results may not be generalizable to other parts of Bangladesh. Triangulation of data collection methods enhances the validity of findings; observational findings supplemented interview data and provided an opportunity to understand the situation from the health care providers' point of view. Women were the main respondents in our study because they were the primary poultry care takers and had information on animal medicine use and health-care seeking. When possible, other animal care takers were also interviewed to verify information obtained from the primary respondents. Semi-structured interviews with village doctors were difficult to conduct because

of reluctance to discuss aspect of their business that involved selling medicines.

The results indicate that several animal husbandry practices recognized as important risk factors for transmission of antimicrobial drug-resistant zoonoses in the literature are common in rural Bangladesh. The link between livestock antimicrobial use and emergence of resistant pathogens has been well established,<sup>1-11</sup> and it is important to adopt measures to prevent antimicrobial drug misuse in developing countries where inadequate health systems cannot cope with additional burdens. Strengthening animal healthcare systems is important in decreasing misuse of animal antimicrobial drugs that may otherwise add to the already substantial health burden rural populations face.

A thorough understanding of risk factors for emergence and spread of antimicrobial drug-resistance pathogens and other emerging diseases in developing countries is needed to design appropriate interventions. Research must address animal agricultural and human drug use, social and economic influences on prescribing practices and medication behaviors, traditional beliefs and local cultures, and environmental factors that promote transmission of infectious diseases and drug-resistant pathogens.

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