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# Pastoralists' Social Networks in Access to and Use of Antibiotics: Implication on Drug Resistance in Ngorongoro Conservation Area of Tanzania

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**Abstract**
Social networks are important for enhancing sharing resources. However, access to and use of antibiotics without prescriptions through sharing can engender risk of antibiotic resistance problem. This paper examines actors involved in social networks and how they enable access to and use of antibiotics in livestock among Maasai Pastoralists in Ngorongoro Conservation Area, Tanzania. Descriptive cross-sectional research design was adopted involving purposive and random sampling techniques. Household survey involved 221respondents for quantitative data. Key informant interviews and focus group discussions were conducted for getting qualitative data. Quantitative data were coded using Statistical Package for Social Sciences version 24 for descriptive analysis involving frequency and percentages. Content analysis was employed for qualitative data categorised into various themes. Results from the study revealed that social networks enabled sharing of knowledge, information and antibiotics without prescriptions from veterinary experts. Actors involved included neighbours, friends, relatives, interest groups and traditional dealers connected with social ties based on trust as well as reciprocity. However, limited knowledge on antibiotics handling and administration, engendered misuse of drugs resulted to risk of antibiotics resistance. Therefore, awareness creation and capacity building on proper access to and use of antibiotics is important.

**Keywords:** *antibiotics, pastoralists, social networks*

## Introduction

This paper presents on how social networks of Maasai pastoralists enable access to and use of antibiotic drugs in livestock including implication on drug resistance in Ngorongoro Conservation Area of Tanzania. Social networks are of critical importance to enable interactions since people get connected by sharing views, resources and support one another (Baird & Gray, 2014). The authors further argue that in Maasai communities in northern Tanzania, traditional social networks of exchange and reciprocity are critical components of household security, disaster relief as well as social wellbeing (*ibid*.). Such social networks comprise family, clan, age-set members and friends (*ibid*.). As such, they are the basis for a household's support system and the first people to which the household will turn to when it confronts problems together with need for assistance (Baird and Gray, 2014). However, in some situations, for example, sharing antibiotics can engender the risk

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of drug resistance, leading to more problems (Barber*et al.*, 2017) because drugs require animal or human health professionals for prescriptions.

Borgatti and Halgin (2011) explain social networks as a set of nodes (called actors) along with a set of ties of specified type (such as friendship) that link people. Nodes are individuals or collective individuals (e.g., corporate boards, families, organizations, nations). Social Networks are tied by one or more specific types of interdependency (Halgin, 2012). They include friendship, kinship, common interest, financial exchange, dislike, sexual relationships, or relationships of beliefs, knowledge or prestige. The social network theory by Granovetter (1973) stipulates that the degree of overlap of actors (nodes) in a social network varies with strength of their ties to another one. Granovetter (1983) argue that in social networks, weak ties are less likely to be socially involved with one another than strong ties. Gilbert and Karahalios (2009) assert that strong ties exist where people are highly trusted and whose social circles tightly overlap with others. As such, strong ties involve more interactions than weak ties in enabling resource sharing and providing mutual assistance (Bridge, 2002; Devereux and Getu, 2013).

Fesenmaier and Contractor (2001) explain that social networks are not what humans know, but whom they know in community. They serve as actors that occupy structurally equivalent positions, often with similar characteristics due to connection of nodes in a similar set of actors, and more likely, they receive similar pieces of information or social influence (Liu *et al*., 2017). This was used as a lens on case of Maasai pastoralists who have similar characteristics, related livestock problems and receive similar pieces of information through sharing practice in their communities. In this article, social networks focus on sharing of knowledge, information and antibiotics on access to and use of drugs in livestock in the context of rural settings.

The paper addresses the following objectives: first, to map out actors involved in social networks together with their associated ties of Maasai pastoralists in Ngorongoro Conservation area of Tanzania. Second, to examine how social networks ease access to and use of antibiotics in livestock; and third, to analyse implications of social networks on antibiotics resistance in the study area.

**The scope and limitation of the study**

This study was confined to Maasai pastoralists in Ngorongoro Conservation Area of Tanzania where there are interactions of human beings, livestock and wildlife. As such, generalization can be done on the environment with similar characteristics. The paper is organised in five sections including first, introduction involving conceptualization of social networks objectives, scope and limitations. The second section presents literature review on antibiotics resistance situation and social networks. The third section presents the study context and methodology, while the fourth section presents empirical findings and discussions on actors involved in Maasai social networks, their associated ties, and implications on antibiotics resistance. The fifth section provides conclusion.

**Literature Review**

Access to antibiotic is defined as 'having medicines continuously available and affordable at the public, private health facilities or medicine outlets within the proximity to the population (UNDG, 2003:46). It includes physical availability, economic affordability, geographical accessibility and social–cultural acceptability crossly linked with safe, efficacy, quality as well as cost–effectiveness (Jacobs *et al.,* 2011; Kabandika, 2012). A study by McKee and Mills (1999) in the United States of America (USA) indicated that a substantial proportion of individuals obtained antibiotics from friends and family members' leftover pills or obtained antibiotics directly from pharmacists without prescription. In this paper 'access to' and 'use' of antibiotics mean the conducts in which Maasai pastoralists obtain antibiotics and utilize for various purposes to their livestock.

Antibiotics are substances commonly used in human and veterinary medicines to treat a variety of infectious diseases caused by bacteria microbes (Guardabassi &Kruse, 2008). Overuse or misuse of antibiotics has been linked to emergence and spread of micro–organisms, which are resistant to them thereby rendering treatment ineffective and posing a serious risk to public health (Laxminarayan and Brown, 2000). Antibiotics resistance is ability of bacteria to resist effects of an antibiotic to which they were once sensitive (WHO, 2013; Davis, 2012; Millar, 2010; Sahoo, 2008; Levy &Marshall, 2004; Laxminarayan & Brown, 2000). In socio-economic context, resistance makes people use stronger and more expensive antibiotics than the case could be resulting into poverty (IRENA &WHO, 2014; USFDA, 2011). Moreover, unreasonable use of antibiotics can engender emergence, persistence and spread of resistant bacteria and hence, they pave the way for antibiotics resistance risk (USFDA, 2011). Scientific expert bodies assert that there is a connection between irrational use of antibiotics in animals and resistance (Chandy, 2008). In this context, risk of antibiotics resistance is regarded as occurrence of livestock diseases, illnesses and other reasons that lead to frequent use of antibiotic drugs for treatment based on Maasai pastoralists' notion.

Aslam and colleagues (2018) assert that antimicrobial resistance including antibiotic resistance poses a serious global threat of growing concern to human, animal and environmental health. The problem is highly revealed due to excessive use of drugs (Aslam*et al*., 2018; GARP–Tanzania Working Group, 2015). It can lead to misuse of drugs, which involves prescription of an incorrect dose, frequent use, or duration redundant, or when such drugs have the potential for adverse interactions with other drugs (Chandy, 2008). In Sub-Saharan Africa, antibiotics are widely accessed and misused, especially in rural areas due to limited or lack of access to veterinary services (Catley *et al.,* 2004). As such, antibiotics users rely on various sources that are within their reach. However, this is done with minimal knowledge and information on types of drugs, dosage and types of diseases to be treated (Katakweba *et al.,* 2012).

In Tanzania, like in other Sub-Saharan African countries, high prevalence of excessive and inappropriate antibiotics access as well as misuse affecting both human and

livestock health are experienced (GARP–Tanzania Working Group, 2015; Sosa *et al.*, 2010). Inappropriate access to and misuse of antibiotics in livestock can be contributed by unexplored social networks at the grassroots community level such as of Maasai pastoralists on the context of access to and use of antibiotics. This is because treatment and handling of livestock health problems rests in hands of untrained drug suppliers as well as personnel, pastoralists and owners of veterinary implements or shops (Katakweba *et al.*, 2012). In Ngorongoro Conservation Area, it was revealed that Maasai pastoralists buy antibiotics from private suppliers to treat their livestock without prescription from veterinarians (SUA/UCPH, 2014; Mshana *et al.*, 2013; Kambarage *et al.*, 2003). It enables them to share knowledge, information and drugs through their social networks (Wawire, 2003) based on trust as well as reciprocity (Koissaba, 2013; Goldman and Riosmena, 2013; Zhang & Yu, 2012; Fu, 2004; Putnam, 2000). Sharing of common resources based on mutual assistance networks is also practiced among Maasai pastoralists (Tarayia, 2004; Potkanski, 1994). A study by Fesenmaier and Contractor (2001) noted that social networks are not what humans know, but whom people know at community level. In this case, social networks are viewed on the context of actors who have access to and use antibiotics in livestock for various purposes through sharing of local knowledge, information, antibiotics and experiences. Social ties binding the actors were also examined to bring about attention to the situation in Ngorongoro Conservation Area of Tanzania.

**The Study Context and Methodology**

The study was done in four villages –Nainokanoka, Endulen, Irkepus and Esere in Ngorongoro Conservation Area of Tanzania. Identification and selection of the study area was guided by presence of Maasai pastoralists inhabiting the area with unique characteristics of traditional social networks of sharing resources, knowledge and information on access to and use of antibiotics in livestock. As such, the study assumed that social networks of Maasai pastoralists through sharing of antibiotics, knowledge and information might lead to inappropriate access to and misuse of antibiotics (see also, Alhomoud*et al.*, 2017) in livestock and hence, there were implications on drug resistance.

Descriptive cross-sectional research design was employed as the logic structure of inquiry. Employed data collection methods included focus group discussions (FGDs), household survey involving a sample size of 221 pastoralists drawn using structured questionnaires and key informant interviews involving village leaders and community animal health workers.

The mixed research approach was chosen to allow collection of both quantitative and qualitative data sequentially. The study began by conducting four FGDs in order to obtain an overview picture of social networks and access to and use of antibiotics in livestock in the Ngorongoro Conservation Area. Participatory wealth ranking was also done during FGDs to determine respondents' wealth status based on Maasai pastoralists' own views and criteria such as number of livestock herds owned. Three categories of wealth status identified include the poor (127) owning less than 20 cattle

herds. The middle (72) wealth category owned 20 to 100 cattle herds and the rich (22) amass more than 100 herds of livestock. The exercise was deemed important because inequalities in wealth affect access to every aspect of people's livelihoods (Grandin, 1983). After FGDs, a broad household survey was conducted in order to generalize results to pastoralists' population on mapping of networks including identification of key actors involved and their associated ties as well as the manner they enable accessibility and use of antibiotics. Thereafter, 21 key informant interviews were conducted to collect detailed opinions from pastoralists and local government leaders. Such data were complemented with documentary reviews relevant to the topic at hand.

Both qualitative and quantitative data analyses were employed. Qualitative data analysis focused on making deductions and draw inference on how social networks through sharing and interactions enable access to and use antibiotics in livestock. As such, information collected during the FGDs and key informant interviews were subjected to content analysis. Quantitative data collected were coded, processed and analysed using the SPSS version 24 computer software. Descriptive statistics were used in mapping and describing social network actors including their associated ties. Mapping of social networks was done based on the highest percentage scored from the multiple responses of actors, depending on whom they were interacting more with than others. That aspect was important in combining information on multiple types of ties as noted by Wasserman and Faust (1994) that it saves to provide insights for social networks analysis. The aim was to score strength of all of an actor's relationships in a rank order from the strongest to the weakest, based on the highest percentage rates in multiple responses. This is due to the fact that, relationships are critical for obtaining information, solving problems and learning how to do work (Wasserman and Faust, 1994). However, whether information is relevant or irrelevant, problems are solved and learning to do work takes place through social networks that is not properly mirrored. Therefore, this article reflects on how social networks through sharing enable access to and use of antibiotics in administering to livestock.

## Findings and Discussions

Empirical findings are based on mapping out actors of Maasai pastoralists' social networks, their associated ties and how they enabled access and use of antibiotics in livestock. This analysis is imperative because it provides a better understanding on how Maasai pastoralists' interactions facilitate sharing of knowledge, information and resources including antibiotics that can ease access to and use of antibiotics.

### Actors in Maasai Pastoralists' Social Networks in Ngorongoro Conservation Area

Social networks of Maasai pastoralists in Ngorongoro Conservation Area were identified and assessed to determine multiplicity of actors who constitute an important source of antibiotics, knowledge and information for livestock. It was revealed during FGDs by Maasai pastoralists in Ngorongoro Conservation Area that, actors who were the most important and had more interactions in Maasai pastoralist social networks include friends, neighbours, relatives and interest groups of herdsmen. They were end-

users of antibiotics located in rural areas and found in close proximity to each other. Apart from being end users of drugs, they supply drugs to others through selling and sharing in terms of reciprocity. The said actors were frequently consulted in case of livestock health problems. However, they do not have professional knowledge on prescriptions of drugs. Such practice can result into misuse of drugs in livestock and hence, lead to risk of antibiotics resistance problem as an implication.

Results in Table 1 from the household survey data showed that all (100%) neighbours and friends (77.8%) were the most important actors in sharing the antibiotics with others.

**Table 1: Actors in Social Networks and Their Roles in Access to and Use of Antibiotics**

| Actors | Roles | Number | Per cent |
|---|---|---|---|
| Friends | Share antibiotics with others | 172 | 77.8 |
| | Make information available for access and use of antibiotics | 49 | 22.2 |
| Relatives | Share antibiotics with others | 142 | 39.1 |
| | Make information available for access and use of antibiotics | 1 | 0.3 |
| Neighbours | Share antibiotics with others | 221 | 100.0 |
| | Make information available for access and use of antibiotics | 143 | 39.2 |
| Interest groups of herdsmen | Share antibiotics with others | 167 | 46.0 |
| | Make information available for access and use of antibiotics | 184 | 50.5 |
| Community animal health workers | Make information available for access and use of antibiotics | 185 | 51.0 |
| Traditional dealers | Make information available for access and use of antibiotics | 22 | 10.0 |

*Note: Percentages and totals are based on multiple responses providing more than one answer*

Results in Table 1 further show that community animal health workers (51.0%) and interest groups of herdsmen (50.0%) also played an important role of making information available to others in the networks. It is important to note that actors in social networks of Maasai pastoralists are bound with social ties based on trust as well as reciprocity that enable access to antibiotics and use in livestock through sharing. They make it easier even for the poor to access and use antibiotics more frequently in livestock. Sharing of antibiotics among actors was easy due to their geographical proximity they enjoy. Similar findings were revealed by Wawire (2003) in Kenya that social networks in form of relatives and friends assisted residents of Turkana District in sharing information and knowledge on access and use of veterinary drugs.

Actors and their roles in social networks of Maasai pastoralists in Ngorongoro Conservation Area sometimes overlap. For instance, a relative actor can be a friend or a neighbour and assume similar roles. Furthermore, interviews with Maasai pastoralist respondents informed that neighbours were sharing more antibiotics than information

in a social network. Sharing drugs, knowledge, information and experience was also common among Maasai pastoralists of Ngorongoro, Tanzania through actors in social networks. Actors are bound with social ties that enable more interactions enabling access and use of antibiotics in livestock. This finding is similar to previous studies conducted elsewhere in most parts of rural areas in Africa involving Rummel (1996) and Homans (1961) who pointed out that social interactions are practices of people mutually oriented towards sharing and exchange of knowledge, experience, and speculations.

Furthermore, trust and reciprocity norms played an important role in connecting Maasai community members with drug suppliers in the villages, based on the exchange process. The importance of trust in connecting community members to each other has been long appreciated with other scholars dealing with online social networks research (Zhang &Yu, 2012; Fu, 2004). The study by Koissaba (2013) on effects of globalization in the Maasai family in Kenya too revealed the importance of trust ties in binding the community together. Furthermore, during FGDs with the Maasai pastoralists indicated that borrowing drugs were also seen to be based on trustworthiness as well as reciprocity norms on both parties of users and suppliers not necessarily by cash.

**Ties of Actors in Social Networks of Maasai Pastoralists and Access to Antibiotics**

Mapping was done based on household survey data to indicate interactions and social ties connecting actors in social networks. It involved actors and magnitude (percentages) of interactions with antibiotic end-users in social networks. Household survey data showed that actors with more interactions have ***strong ties***. They include friends (100.0%) bound with *friendship ties*, relatives (99.5%) with *kinship ties*, neighbours (99.1%) with *neighbourhood ties*, drug supplier shops within villages (85.1%) with *ties due to exchange processes based on trust;* and interest groups of herdsmen (76.5%) *with age set ties*.

Strong ties enabled Maasai pastoralists' access not only to antibiotics, but also to other resources to fulfil social needs. As such, social network ties strengthen actors' relationships and thus, leading to access and use of antibiotics in livestock through sharing involving trust and reciprocity. Gilbert and Karahalios (2009) assert that strong ties exist where people are highly trusted and whose social circles tightly overlap with others. Such social ties sometimes overlap with other ties. For example, kinship, friendship; neighbourhood and age set ties were found to overlap in Maasai pastoralists of Ngorongoro Conservation Area that make them strong to enable more sharing of antibiotics and use in livestock. This resonates with a study by Potkanski (1994) in Ngorongoro and Salei that disclosed that Maasai communities share common resources and have kin-based mutual assistance networks for livestock health management. The practice of sharing resources is good, however, when it comes to sharing of antibiotics, knowledge and information related to their use without proper prescription from health professionals it can result into more livestock health problems. Bridge (2002) as well as Devereux and Getu (2013) noted that in Africa

neighbourhood ties in social networks provide mutual assistance to people in the same residential nearby areas for sharing resources, knowledge, information and experience. This is also reflected in access and use of antibiotics in livestock among Maasai Pastoralists of Ngorongoro Conservation Area in which strong ties were revealed among actors. This can result into implications on drug resistance.

Actors with moderate interactions had *moderate ties* and they include drug vendors (64.3%) because their services are seasonal, mostly during market days. Also, such actors are normally found at grazing areas. As such, the existing ties are based on the exchange process. Actors with minimal interactions such as veterinary health experts (46.2%) have *weak ties* and they are not easily reached by users of antibiotics. Furthermore, community animal health workers (33.5%) have minimal interaction with *weak ties* not because of their limited availability but due to lack of facilities. They have basic knowledge on animal health that could help in getting appropriate drugs and information but Maasai pastoralists seek for alternative sources where they obtain needed facilities including drugs as revealed by one of the users that,

> "Community animal health workers sometimes do not have drugs and so, if you consult them when there is immediate need you waste time. It is better to go to the person with drugs to solve problems quickly" (Respondent, Esere village).

In line with that, Granovetter (1983) argued that in social networks, weak ties are less likely to be socially involved with one another than strong ties. In due regard, with strong ties in a close network where everyone knows each other, information is shared and subsequently, potential sources of information are quickly relayed down. Thus, the weak network quickly becomes futile in terms of access to new information. Therefore, weak ties in social networks are superior to strong ties for providing new information. However, this depends on kind of information needed by the community. In case of Maasai pastoralists, immediate information to solve their livestock problems is very important and cannot wait for weak ties. The ties sometimes become strong, depending on level of social interactions in Maasai pastoralists. Again, they overlap with one or more ties, for example, neighbourhood, friendship and kinship ties and thus, making a relationship stronger. The Maasai's social networks resonate with social networks as alluded to in theory by Granovetter (1973) that holds that degree of overlap of actors (nodes) in a social network varies with strength of their ties to another one. All such connections and interactions among the Maasai pastoralists enable them to access antibiotics and use in livestock through sharing without prescriptions. This can be associated with misuse of drugs that requires more attention for improvement of livestock health.

**Sources of Knowledge and Information on Antibiotics Availability and Usage**

Based on household survey data, the sources of information did not differ with regard to wealth categories in the study area as presented in Table 2.

**Table 2: Sources of Information on Antibiotics Availability in Ngorongoro Conservation Area**

| Sources of information on antibiotic availability | Wealth status | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Poor (n=127)** | | **Middle (n=72)** | | **Rich (n=22)** | | **Total(n=221)** | |
| | N | % | N | % | N | % | N | % |
| Relatives | 126 | 99.2 | 71 | 98.6 | 22 | 100.0 | 219 | 99.1 |
| Neighbours | 127 | 100.0 | 72 | 100.0 | 22 | 100.0 | 221 | 100.0 |
| Friends | 126 | 99.2 | 72 | 100.0 | 22 | 100.0 | 220 | 99.5 |
| Traditional dealers | 14 | 11.0 | 19 | 26.4 | 8 | 36.4 | 41 | 18.6 |
| Interest groups | 105 | 82.7 | 62 | 86.1 | 19 | 86.4 | 186 | 84.2 |
| Veterinary experts | 61 | 48.0 | 32 | 44.4 | 9 | 40.9 | 109 | 48.0 |
| Community animal health workers | 60 | 47.2 | 37 | 51.4 | 11 | 50.0 | 108 | 48.9 |
| Drug suppliers (shops) | 103 | 81.1 | 66 | 91.7 | 19 | 86.4 | 200 | 90.5 |
| Drug vendors | 63 | 49.6 | 49 | 68.1 | 13 | 59.1 | 125 | 56.6 |

*Note: Percentages and totals are based on multiple responses providing more than one answer*

It was disclosed further that sharing of resources including antibiotic drugs enable all individual pastoralists to access and frequently use antibiotics, regardless of their wealth status. The act of sharing is culturally embedded, based on trust and reciprocity. As such, it enables pastoralists obligated to support one another in terms of problems facing livestock.

Also, household survey data revealed that sources of knowledge and information on availability of antibiotics were actors in social networks. They included relatives (99.1%), neighbours (100%), friends (99.5%), traditional dealers (18.6%) and interest groups (84.2%) [Table2]. Drug suppliers with shops (90.5%) and livestock drug vendors (58.4%) also form another category (Table 2). Community animal health workers (56.6%) and veterinary experts (48.0%) form the last category based on respondents' opinion (Table 2).

Reasons for attaching more importance to source of information related to (actors) found within villages and therefore, users of drugs did not need to travel far to obtain information on proper use of antibiotics for their livestock. In addition, such actors as sources of drugs in the social networks were held in social ties, which bound them to help each other in times of difficulties as discussed in the previous section. This is where trust and reciprocity would tend to work for the benefit of community members. Despite importance attached to actors in the Maasai social networks as sources of information and antibiotics, one needs to note that in most cases, they lack veterinary expert knowledge. This can lead to misuse of antibiotics, resulting to risk of antibiotics resistance as an implication.

Other sources of knowledge and information on antibiotics involved drug suppliers with shops. They were individuals involved in businesses, residing in the villages and therefore, they were closely connected to people. In most cases, such actors went where users were found, however, they were not knowledgeable enough to provide veterinary expertise knowledge on the on use of antibiotics as confirmed by one of the key informants that,

> "Most suppliers in drug shops are not knowledgeable enough to give more accurate information on use of drugs and expiry dates. Therefore, you have to know the drugs and their use. Otherwise, you have to find someone to give you information on use and read the expiry date before you purchase the drug" (Village leader Endulen)

Based on the given narration, it can be clear that some users of the drugs for their livestock do not know how to read instructions and thus, such practice can lead to inappropriate use of drugs. Veterinary experts and community animal health workers were expected to be among the most important sources of information on the proper use of antibiotics for livestock because of their rich knowledge and skills. However, this was mentioned by slightly less than a half (48.0%) of respondents (see Table 2) than other sources as revealed by household survey data from Maasai respondents. This was because said experts were not closely connected to users of antibiotics in the study area. The veterinary experts reside in urban areas and such situation made it difficult for antibiotic users to benefit from their rich knowledge. Therefore, users had to establish their own ways of accessing information on use of antibiotics, as one of the leaders from Nainokanoka village remarked that,

> "Normally, veterinary experts are unavailable in rural areas, except when they are engaged in special operations to vaccinate livestock. Also, due to geographical location of the village, you have to incur high cost for transports to places livestock experts are located. On top of that, we have only one community-based animal health worker for advice but you cannot obtain drugs to purchase. Therefore, one finds it worth time to go to sellers to obtain both information and antibiotics" (Village leader, Nainokanoka)

In an ideal situation, access and use of antibiotics for livestock require a veterinary prescription. This is essential because giving high or low doses of antibiotics reveals misuse of drugs that can lead to drug resistance. However, they are few in number to cater for needs of Maasai pastoralists as presented in the quote. It is important that veterinarians should exercise their medical judgment and careful oversight of antibiotic use in livestock production.

**Types of Antibiotics Commonly Used and Shared and the Reasons**

It was important to identify types of antibiotics commonly shared and used through social networks of Maasai pastoralists and the associated reasons. It was revealed that different types of antibiotics were commonly used and shared amongst users. Results for the said aspects were provided in various wealth categories in the past six months of the study period. Based on household survey data from Maasai respondents, findings in Table 3 reveal that Oxytetracycline (OTC) antibiotic was the most

commonly used and shared by all (100.0%) respondents in all wealth categories, followed by Penstrep by more than 86 percent. This is because OTC is one of the most commonly used antibiotics in the study area.

**Table 3: Types of Common Antibiotics Used and Shared by Wealth Status**

| Most commonly used antibiotics | Wealth status | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Poor (n=127) | | Middle (n=72) | | Rich (n=22) | | Total (n=221) | |
| | N | % | N | % | N | % | N | % |
| Oxytetracycline | 127 | 100.0 | 72 | 100.0 | 22 | 100.0 | 221 | 100.0 |
| Penstrep | 110 | 86.6 | 65 | 90.3 | 20 | 90.9 | 195 | 88.2 |
| Tylosin | 104 | 81.9 | 68 | 94.4 | 21 | 95.5 | 193 | 87.3 |
| Sulpha | 76 | 59.8 | 50 | 69.4 | 18 | 81.8 | 144 | 65.2 |
| Tetracycline capsules | 62 | 48.8 | 30 | 41.7 | 11 | 50.0 | 103 | 46.6 |

NB: Percentages and totals are based on multiple responses providing more than one answer

Moreover, availability of Tetracycline is also one of factors for its accessibility by users. In the same vein, OTC is considered to be multipurpose for treatment of many diseases and thus, making its use be frequent. Besides, Tylosin was used and shared among pastoralists by more than 80 percent followed by sulpha used by more than 50 percent (Table 3). Likewise, findings in Table 3 indicate that Tetracycline capsules were used and shared by less than 50 percent (Table 3). This is because drugs were affordable and also, they are meant mainly for treatment of human beings rather than livestock and as such, they can access them easily through purchase.

The explanations given by some participants during FGDs on how tetracycline capsules are being used show that the capsules are given to livestock orally after dissolving them in water or mixing with OTC injections. The mixture is then injected intramuscularly in livestock or sometimes mixed in feeds. Knowledge of mixing these antibiotics is acquired through social networks. This puts the public health at risk of antibiotics resistance, resulting into increased incurable diseases to livestock and eventually, to people. A similar practice was revealed by Roderick and colleagues (2000) in Maasai Pastoralists in Kenya that trypanocides and antibiotics are mixed together before injection for treatment of livestock diseases in a number of cases. Also, Redding and co-authors (2014) noted that knowledge of how drugs are used can provide some measures of drug misuse, magnitude of the risk of disease and the need to introduce other disease control methods.

Sharing antibiotics among or between users in different wealth categories, for instance, the rich and the poor, contributes to frequent access and use of antibiotics in livestock. As such, it can have implication of drugs resistance. A study by McKee and Mills (1999) in the USA reported before that individuals obtained antibiotics from friends and family members' leftover pills or obtained antibiotics directly from pharmacists

without prescription. In such situations, it is quite obvious that the way users obtain antibiotics contributes to misuse of drugs in livestock. It was similarly reported that there was sharing of common resources in Maasai of Kenya (Tarayia, 2004). Moreover, a similar trend was noted by Koissaba (2013) in Kenya that each Maasai family member is responsible for the welfare of each other and for those who live within close proximity, they share resources and responsibilities. Helping one another implies functioning of social networks in seeking assistance to access and use antibiotics for use to livestock.

Wide use of antibiotics is not confined to pastoralists in Ngorongoro Conservation Area only. A study done by Katakweba (2014) in Mikumi National Park in Tanzania, shows that most commonly used antibiotics were Oxytetracyline, Sulphadimidine/trimethoprim/(STX), penicillin-streptomycin and gentamycin. The author further noted that only slightly more than 54 percent of respondents obtained their antibiotics through prescription by veterinarians and the potential risk factors were identified to be sources of development of antimicrobials resistance (*ibid*.). Sources of antimicrobial resistance included livestock management systems, antibiotics handling and types of antibiotics used (*ibid*.).

**Reasons for Choice of Antibiotics by Maasai Pastoralists in Ngorongoro Conservation Area**

Reasons for choice of each antibiotic were provided by participants during FGDs based on their perceptions and understandings. Provided reasons for choice of antibiotics included cost saving, easy availability, lack of trust to veterinarians, effectiveness, and lack of veterinary experts as well as being multipurpose for other diseases. Also, it was revealed through household survey data that most of the drugs were chosen by users because of being easy to obtain them. In due regard, OTC was chosen by 72.4 percent, Tetracycline by 88.9 percent, Penstrep by 60.4 percent, and Tylosin by 60.8 percent of users. This is due to availability of various sources including an established open market that allows many suppliers of livestock drugs from various places. Another reason provided was cost saving by 97.0 percent for Tetracycline, 25.8 percent for OTC and only 6.6 percent for Penstrep, 3.6 percent for Tylosin, and 12.2 percent for Sulpha by users. Users of Tetracycline capsules explained that capsules save cost for treatment of young sheep (*mbelelo),* which normally get sick regularly. In view of this observation, it can be explained that most of the antibiotic drugs are costly and, for that matter, their affordability is low. When drugs are unaffordable in terms of high cost, they lead to limited purchase, resulting into under dosage. Moreover, effectiveness of drugs was one of the reasons given by most of users for Tylosin (75.8%), Penstrep (70.4%), OTC (50.7%), Sulpha (23.9%), and Tetracycline (19.2%). Based on users' opinion, it was revealed that the mentioned antibiotics were considered being effective.

The findings further showed that the choice of OTC was because it was perceived to be multipurpose, treating many diseases. Considering OTC being multipurpose without proper knowledge whether or not diseases are caused by bacterial infections,

can lead to use of drugs for treatment of non-bacterial infections. A study by Viberg and colleagues (2010) in eight districts in Tanzania also revealed that some drug suppliers referred to antibiotics as a strong drug that treated many diseases. It results into prolonged illnesses in livestock and thus, leading to not only economic loss, but also public health hazards due to risk of antibiotics resistance.

The study further revealed that lack of veterinary experts was one of the reasons for choice of drugs such as Tylosine (25.5%), Tetracycline (24.2%), OTC (23.1%), Penstrep (23.0%), and Sulpha (10.9%). It was noted from findings that lack of experts was not mentioned by majority to be the major reason for choice of access and use antibiotics in livestock without any prescription. However, there are some places where veterinary experts are available but not ready to respond immediately on call. Furthermore, the high costs involve hindered access to veterinary experts as one of the community health workers key informant explained:

> "Veterinary experts normally take long time to respond to an emergency call about livestock. Yet, you match costs involved for transporting them and for the advice they give you. This makes pastoralists take their own initiatives to access and use antibiotics" (Community Health Worker, Nainokanoka village).

Generally, reasons for choice of particular antibiotics also depended on an individual's perception and attitude on drug. For instance, ease of availability of antibiotics and their effectiveness were among reasons for choice of using Penstrep and Tylosine. However, these reasons for the choice are insufficient to access and use antibiotics without prescriptions. This is because it is important to have experts with appropriate knowledge of livestock diseases and their treatments.

**Implications of Social Networks on Antibiotics Resistance**

One of the salient features of social networks among pastoralists in Ngorongoro Conservation Area was sharing of antibiotics amongst themselves as discussed before. Without doubt, pastoral communities are socially differentiated, particularly in terms of household wealth. However, households engaged in sharing of antibiotics under fear norms that unless they contribute to good health of their neighbours' herds, their own herds will not be safe from livestock diseases. Access and use of antibiotics through sharing can lead to misuse of antibiotics, resulting to an increased risk of antibiotics resistance as an implication.

Findings revealed that all respondents admitted to have obtained and used antibiotics in livestock in the past six months for the major purpose of treatment of diseases. Sharing of this important information is perhaps an inevitable outcome due to the fact that professional knowledge from veterinary experts is very limited. This study revealed from household survey data that more than 70 percent of users were not seeking veterinary advice before obtaining antibiotics to use them for livestock. They only seek advice when there are widespread diseases that are out of their control as explained by one village leader that,

> "When an extensive outbreak of livestock diseases occurs, pastoralists organize themselves and liaise with the government veterinary officers to vaccinate their livestock. On the contrary, not all livestock are taken for vaccination" (Village leader, Irkeepus).

Also, it was noted from the FGDs that many pastoralists do not take livestock for vaccination very often because first, not only that vaccines were reported to be expensive, but also, they believed that vaccinated livestock will not be cured with other drugs when they become sick again. In addition, many pastoralists were unwilling to expose numbers of livestock they own. This is because they believe that counting livestock can bring a bad omen to them and thus, increase their deaths. Second, they are normally unsure of purposes or intentions the size of livestock is for. Thus, they find their ways of treating livestock diseases, leading to an implication of drugs resistance. This finding is contrary to that of Homewood and colleagues (2006) in Kenya who noted that pastoralists from all economic backgrounds viewed livestock vaccination positively. Homewood and colleagues (2006) further argued that the decision to vaccinate was strongly associated with a measure of wealth that included livestock numbers and economic security.

Users opt for social networks for sharing knowledge, information, experience and antibiotics to use in livestock that can result into imprudent use of antibiotics. Table 4 provides in detail reasons for not seeking advice from veterinary experts based on household survey data.

**Table 4: Reasons for Not Seeking Veterinary Expert Advice**

| Reasons for not seeking veterinary experts' advice | Wealth status | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Poor (n=127) | | Middle (n=72) | | Rich (n=22) | | Total(n=221) | |
| | N | % | N | % | N | % | N | % |
| Confident in self-knowledge and experience on the types of diseases and treatment | 67 | 56.3 | 44 | 63.8 | 15 | 78.9 | 126 | 60.9 |
| Lack of veterinary professionals | 16 | 13.4 | 9 | 13.0 | 4 | 21.1 | 29 | 14.0 |
| Consult neighbour, relative or friend who are knowledgeable on antibiotics use | 49 | 41.2 | 20 | 29.0 | 3 | 15.8 | 72 | 34.8 |
| Consult community animal health workers | 8 | 6.7 | 2 | 2.9 | 0 | 0.0 | 10 | 4.8 |
| Obtain instructions from the suppliers | 31 | 26.1 | 24 | 34.8 | 6 | 31.6 | 61 | 29.5 |
| **Total** | **119** | **57.5** | **69** | **33.3** | **19** | **9.2** | **207** | **100.0** |

The study further revealed that reasons provided by pastoralists for not seeking veterinary advice include having confidence in self-knowledge, experience, types of

diseases and treatment. They were reported by 56.3 percent of the respondents in the poor wealth category (Table 4). Consult neighbours or relatives or friends who are knowledgeable about antibiotics use was reported by 34.8 percent in the middle wealth category and 31.6 percent were reported by the respondents in the rich wealth category (Table 4). This implies that social connections through social ties enable users to access and use antibiotics without appropriate knowledge. This can lead to imprudent use of antibiotics and thus, resulting to risk of antibiotics resistance. At some point, lack of veterinary professionals was explained by few (14.0%) respondents who indicated that experts were available but pastoralists were unwilling to consult them due to mistrust or due to costs involved in engaging experts. One FGD participant had this to say,

> "It is very expensive to engage a veterinary expert because you need to find transport, which generally, public transport is unavailable in our village; there are neither motorcycles nor bicycles available. Veterinary experts depend on transport from Ngorongoro Conservation Area, which, again, they are unreliable" (FGD participants Esere, village, 2014).

The implications of social networks on antibiotics resistance were revealed to emanate from various factors, ranging from policy to grassroots level. One of the issues in the National Livestock Policy is based on the premise that, "Livestock diseases are among the constraints limiting the development of the livestock industry. There is a high prevalence of livestock diseases in the country…" (URT, 2006:4). Besides, the policy recognizes that constraints facing use of veterinary medicines include their availability, high costs, poor quality, and stakeholders' low awareness on the aspect, poor distribution network and infrastructure.

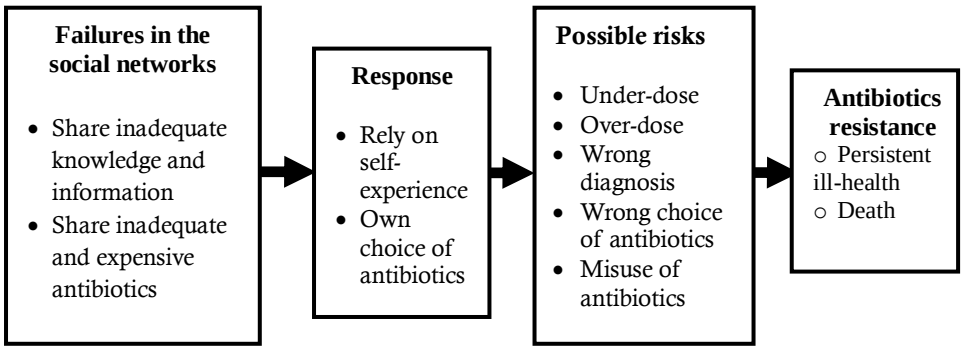


**Figure 1: Implication of Social Networks on Antibiotics Resistance**

Moreover, one of the objectives of the National Livestock Policy (2006) is to ensure adequate supply, accessibility and affordability of safe, quality as well as efficacious veterinary medicines. This objective has not been fully achieved due to various challenges facing livestock development sector such as diseases as revealed by URT (2006, 2001). Apart from the policy showing awareness on existing factors facing use of veterinary medicines, there have been some factors contributing to livestock diseases

and deaths that require attention, which are worth noticing, such as social networks at the community level. Figure 1 shows implications of social networks on risk of antibiotics resistance.

The problem of antibiotics resistance develops slowly to the extent that it becomes difficult to trace its severity. Sometimes, when this problem is noted, it must have taken a long time to realise its symptoms. In situations where users of antibiotics are unaware of the initial symptoms of the problem, they take no steps to solve it and instead, they continue using the drugs. Awareness level on antibiotics resistance provides an understanding on how well users are informed about the problem in their area. For example, if users are well informed and become aware of the antibiotics resistance problem, they become attentive and cautious of the cause of the problem and the risks associated with it. Hence, they abide by appropriate accessibility and use of antibiotics in livestock.

The study further revealed that majority of pastoralist respondents in Ngorongoro District had low awareness level about the problem of antibiotics resistance. This went on contributing to continued access and use of antibiotics without prescription by livestock health experts. This was revealed by one of the key informants that,

> "In this area, many people are unaware of antibiotics resistance problem but they are aware on use of expired drugs. That is why, many people rely on information from others and sellers of drugs before purchase" (Village leader, Irkeepus).

This finding further supports Muhairwa's (2014) assertion that livestock keepers in Tanzania have never heard of antibiotics resistance.

**Conclusion**

Based on study findings, social networks of Maasai pastoralists in Ngorongoro Conservation Area enabled them to ease access and use of antibiotics in livestock. This was practiced through sharing of knowledge, information and antibiotic drugs among actors in social networks without prescription from veterinary professionals. Such sharing in Maasai pastoralists' social networks was associated with various social ties based on trust and reciprocity for mutual assistance thereby putting additional obligations to end users of antibiotic drugs. This resulted into misuse of drugs in livestock that eventually engendered to additional problems of antibiotics resistance. Therefore, it is recommended that there should be awareness creation and capacity building to Maasai pastoralists on proper access and use of antibiotics in livestock. Livestock policy makers should consider existing social networks at the rural community grassroots level to address the livestock health care. Generally, in light of this paper, the importance of social networks is that they connect people with social ties based on trust and reciprocity thereby engaging mutual assistance. Moreover, they serve as a reminder to policy makers not to underestimate the existing social connections in Maasai pastoralist communities when addressing livestock development.

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