Temporal And Spatial Distribution Of Common Bacterial Livestock Disease Outbreaks In North Gondar, Ethiopia

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Abstract: Aretrospective longitudinal study was conducted from November 2013 to April 2014 to assess the spatial and temporal distribution of major bacterial livestock disease outbreaks and to identify risk factors in selected districts of North Gondar. The data were extracted from monthly and annual reports of the period of 2009 to 2013 from the Veterinary Services. The data were analyzed in relation to temporal and spatial factors. Of the total 254 outbreaks 132 were due to anthrax, 61 of blackleg, 33 of bovine pasteurellosis and 28 ofovine pasteurellosis. Highest and lowest number of outbreak were registered in the years 2010 (22.44%) and 2013 (15.74%), and during spring (29.52%) and, summer (19.29%) seasons, respectively. Outbreaks of anthrax followed by blackleg were the most frequent outbreak recorded diseases. The highest number ofoutbreak of anthrax, 40 of 132 (30.30%), was recorded in winter, with peak in February. The highest outbreak of blackleg, 33 (54.09%) of 61, was recorded in spring with peak in October and of bovine pasteurellosis, 14 (42.42%) of 33, outbreaks was recorded in winter, with peak in February. The highest outbreak of ovine pasteurellosis, 10 (35.71%) of 28, was recorded in winter, with peak in January. The highest and lowest numbers of outbreak were recorded in midland (54.00%) and highland (14.17%) agro ecology, respectively. Outbreak occurrence of the diseases follow relatively similar pattern of spatial distribution in respect to agro ecology. Whereas, the temporal distribution point of view, anthrax and blackleg follows opposite patterns of occurrence, but bovine and ovine pasteurellosis follow similar patterns of occurrence in both temporal and spatial distribution. Generally, lowest numbers of outbreak were recorded during the season of summer and within the agro ecology of highland. The study indicated that occurrence of outbreak had been affected by temporal and spatial factor. Therefore, animal owners and animal health service providers should give more emphasis to implementation of control and prevention measures in spring and winter seasons and for midland agro ecological regions to prevent occurrence of disease outbreaks in their animals in the study area.

Keywords: Outbreaks, risk factors, spatial and temporal distribution, North Gondar, Ethiopia

INTRODUCTION

Ethiopia has a large livestock population and many rural communities depend on animals for food, income and draught power. However, the contribution from these huge livestock resources to national income is disproportionally small due to several factors. Diseases of various etiological origins are among numerous factors responsible for poor production and productivity. Bacterial diseases are one of the diseases that are believed to have negative impacts on livestock production.[15] Animal diseases generate a wide range of socio-economic impacts that may be both direct and indirect, may vary from much localized to global problems. When animal disease occurs, there are several different types of commonly recognized impacts: loss of livestock productivity (market disruption, the effects of death, illness leading to condemnation, poor weight gain, poor milk yield, poor feed conversion, poor reproductive capacity and poor work capacity for plowing or transport, and treatment costs); loss of revenue from activities making use of animal resources (energy, transport), human welfare (diseases or even deaths, food safety and quality); prevention costs(production costs, public expenditure) or sub-optimal use of production potential (animal species, genetics, husbandry practices). As a whole, animal diseases jeopardize the livestock assets or of products of poor countries, limit market-access opportunities for animals and animal products and restrict possibilities for intensifying livestock farming.[7][10] Animal diseases also represent a serious public health and sustainable growth problem, as well as severely constraining the social and economic development of affected countries. Trans boundary diseases, diseases transmissible to humans, and soil-borne diseases currently pose a particularly grave threat to poor populations, national economics and the economies of neighboring or importing countries.[5] Livestock in Ethiopia suffer from a wide range of diseases. Drought, high temperature or excessive rain and high humidity impose stress on animals that renders them more susceptible to disease. Poor husbandry practices and inadequate veterinary services are the major factors favoring the expansion of livestock diseases.[1] Bacterial diseases are infectious in nature i.e., they can be transmitted from one host to another. Out- breaks of infectious diseases are often compared with forest fires. Once a fire has spread through an area, it does not return until new trees have grown up. Outbreaks develop when a large population of susceptible animals is present. If immunized animals are present in the herd (i.e., herd immunity) then outbreaks cannot occur until a sufficient number of young, nonresistant animals have been bred or non-immune animals from outside are introduced in the herd.[1] The general patterns of disease occurrence reflect the randomness or nonrandomness of their distribution in the dimensions of time and space. The spatial patterns of disease is typically a consequence of environmental factors including aspects of climate (temperature, humidity, rainfall) as well as aspects of animal management (management of animals in a certain area of a country may result in high rates of a disease

that may not be seen in other areas). Geographic information system and easy access to spatial data (e.g. image) have facilitated the ability to conduct spatial epidemiological analysis in recent years.[17] In endemic diseases, there is clustering both in time and in space. This means the disease affects more individuals in specific region during a specific time than would be expected. Knowledge of spatial and temporal pattern of animal disease distribution is important to understand the natural history of infectious diseases in specific time and place. This in turn helps in budgeting, planning and efficient utilization of resources. Itis also useful for early detection and immediate response to control and prevent animal diseases. There is no established report about the temporal and spatial distribution of infectious animal diseases in the study area.This output can be used in better understanding and forecasting of the diseases distribution and planning of interventions to control and prevent outbreaks in the area.

Therefore the objective of this study is:-

- To determine the spatial and temporal distribution of common bacterial outbreaks of animal diseases and identify risk factors for their occurrence in North Gondar using descriptive statistics.

MATERIALS AND METHODS

Study Area

This study was conducted in North Gondar. North Gondar is one of the eleven Zones in Amhara Regional State, which is located in the Western part of the country. It consists of 21 districts. The total area of the zone is 5,934,090 square Kilometers and the population density is 64 persons per square Kilo meter. The livestock population was estimated as: Cattle, 2,771,701; Sheep, 815716; Goats, 1,251,867; Horse, 27,248; Mules, 9,695; Donkeys, 376,841; Camels, 3,002; Poultry, 3,628,832.[4] North Gondar comprises highland,midland and lowland agro-ecologies. Sedentary (mixed crop-livestock production) and mobile livestock production systems are practiced in the Zone.[9] The data was collected from the11 districts of North Gondar shown in colored in Figure 1, bellow.

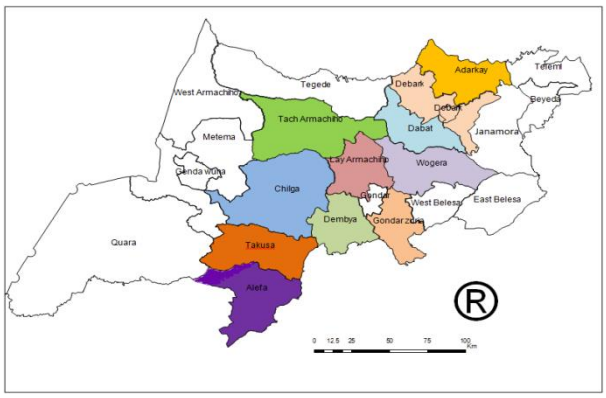

Fig 1. *Map of the study area.*[11]

Study Design and Data Collection

The study was a retrospective longitudinal study in which outbreak data from 11 districts of North Gondar over the past 5 years of documented data was reviewed. Information regarding the outbreaks each year was extracted from the reports submitted by field veterinarians from and around the districts and was used for this study. The variables, which were considered in relation to the outbreaks, were agro ecology; farming system; season and year of occurrence were collected to assess their significant for the frequency of the diseases. The data was recorded according to the number of outbreak, number of case and number of death.

Data Management And Analysis

The data was recorded according to the number of outbreak, number of case and number of death against agro ecology, farming system, season and year, and the collected data were entered in to excel spread sheet. Descriptive statistics was used to describe the data. Time pattern was evaluated to see any cyclicity or long term trend in the occurrence of the disease.

RESULTS

Over All Disease Outbreaks

The outbreaks of common bacterial livestock diseases in North Gondar are presented in Table 2, shown below. Outbreaks were high in some districts and low in other districts even in other few districts there were no record of outbreak. Records of outbreaks of anthrax, blackleg,bovinepasteurellosis and ovine Pasteurellosis were examined. A total of 254 outbreaks were documented over the 5 years in 11 of the 21 districts of North Gondar Zone from January 2009 to December 2013 with individual number of outbreaks of anthrax 132 (52.00%), blackleg 61 (24.00%), bovine pasteurellosis 33 (13.00%) and ovine pasteurellosis 28 (11.00%).

Table 1: *Short Summery of Common Bacterial Disease Outbreak in Eleven district of North Gondar, Ethiopia (2009-2013)*

	Name of disease and Number of outbreak			
Year	**Anthrax**	**Blackleg**	**Bovine pasteurellosis**	**Ovine pasteurellosis**
2009	30	12	5	5
2010	26	14	10	7
2011	23	15	7	7
2012	30	6	9	8
2013	23	14	2	1
Season				
Winter	40	10	14	10
Autumn	33	5	9	9
Summer	26	13	5	5
Spring	33	33	5	4
Agro ecology				
Highland	19	6	8	3
Midland	65	28	22	22
Lowland	48	27	3	3

Disease Outbreak within the Year

Though all thefour disease outbreaks were distributed throughout the 5 years, there was higher occurrence of anthrax as compare to the others. The outbreaks of the above livestock diseases in North Gondar are shown in the Figure 2.The number of outbreaks of anthrax was similar in 2009 and 2012 (22.72%), and 2011 and 2013 (17.42%). It had a lowering pattern from 2009 through 2011 but again sharply increasing until its peak in 2012 and again lowering in 2013. Blackleg on the other hand, had an increasing pattern from 2009 through 2011 and sharply lowering to the minimum level in 2012 and again getting suddenly higher in 2013; which is exactly the opposite pattern of anthrax outbreak. Both outbreak of bovine and ovine pasteurellosis had a fairly smooth increasing pattern from 2009 through 2012 and drastically decreased in 2013 (Figure 2).

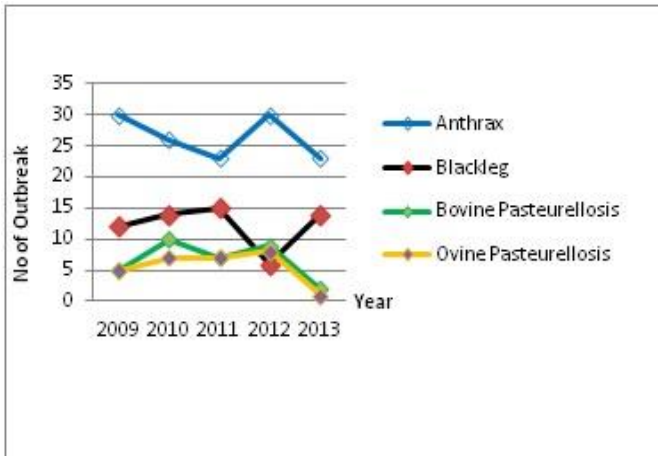

Fig 2. *Disease outbreak within years.*

Disease Outbreak Within The Season Of The Year

The outbreaks of anthrax were highest in the winter season (30.30%) and lowest in the summer season (19.7%) whereas the outbreaks of blackleg were highest in spring (54.09%) and lowest in the autumn (8.19%0.Both bovine and ovine pasteurellosis had highest value of outbreaks in the winter (42.42% and 35.71%) as compared to other seasons and smoothly decreasing from summer to spring. Both anthrax and blackleg were sharply decreasing from the highest level in the winter to the lowest level in the autumn for blackleg and in the summer for anthrax, and getting a sharp rise until reaching, a peak in spring for blackleg and still a higher level in spring for anthrax (Figure 3).

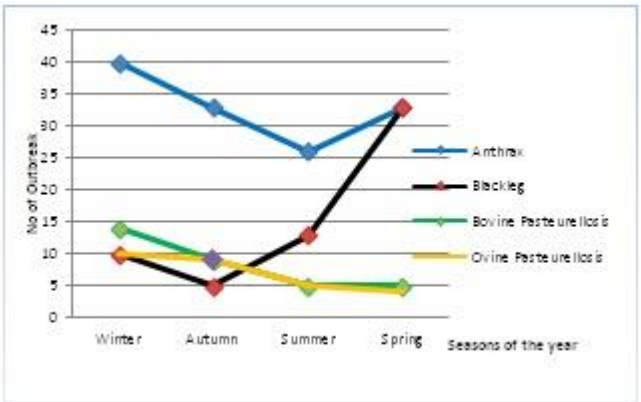

Fig 3. *Disease out break within seasons of the years (2009-2013)*

Disease Outbreak Within The Districts

Generally, the outbreak of the four diseases had irregular patterns within the districts; however, a roughly similar pattern is exhibited for anthrax and blackleg in most of the districts. Anthrax outbreaks were highest in Debark and lowest in Alefa. Similarly, blackleg was high in Dabat, but absent in Adiarky. Bovine and ovine pasteurellosis exhibits a fairly similar pattern of occurrence within the districts except Lay Armachiho and TachArmachiho where in both districts there was no record of ovine pasteurellosis. Takusa had the highest number of ovine and bovine pasteurellosis outbreaks (Figure 4).

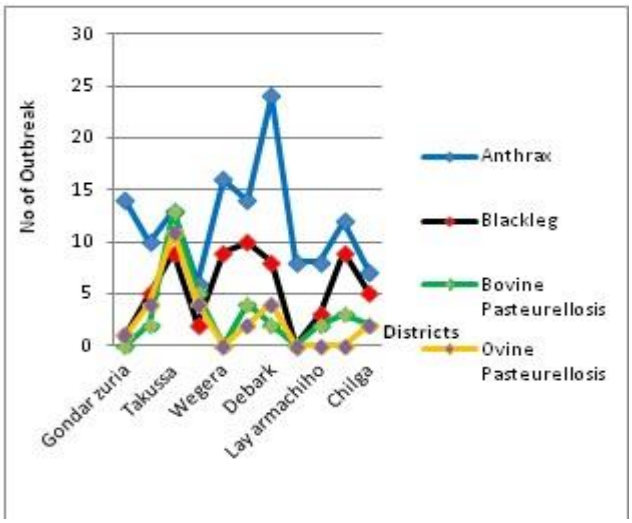

Fig 4. *Disease out break within the districts of North Gondar*

Disease Outbreak within different Agro ecologyEven though the outbreak of anthrax is highest as compared to other diseases, theoccurrence ofoutbreak forall diseases showed similar patterns within the different agro ecology. The highest outbreak record was in midland (49.24% and 46%) and lowest in the highland (14.4% and 9.83%) for anthrax and blackleg and still highest in the midland (66.66% and 78.57%) and lower in lowland (9.1%) and in both highland and lowland (10.71%) for bovine and ovine pasteurellosis, respectively (Figure 5).

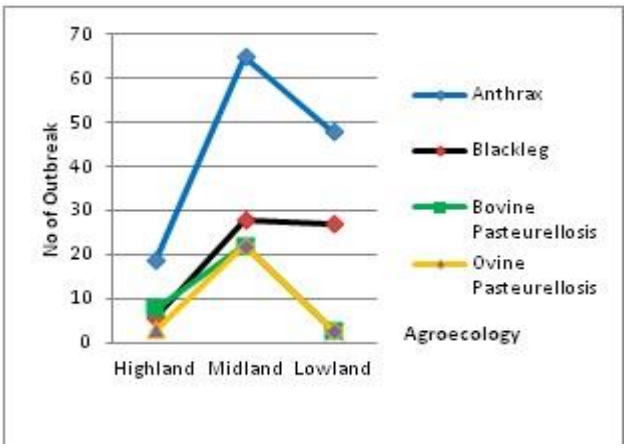

Fig 5. *Disease out break within the different aroecology*

DISCUSSIONS

This paper describes the spatial and temporal distributions of common bacterial livestock disease outbreaks of Anthrax, Blackleg, Bovine pasteurellosis and Ovine pasteurellosisin North Gondar. In the past decade there has been an increasing interest in understanding factors underlying the distribution of infectious pathogens, emerging, and re-emerging infectious diseases. Some recent research efforts have been in attempt to determine large scale ecological factors associated with diversity richness and distribution of infectious diseases;[19] and to explore the impact of global environmental change on distribution and spread of infectious diseases. These studies have offered valuable insights into understanding socio-environmental processes and factors underlying the distribution of infectious diseases. This study focused on spatial and temporal association of common bacterial infectious diseases and attempt was made to explore whether these diseases follow similar patterns observed in other studies.Anthraxandblackleg outbreaks were the most frequently reported diseases in the study period. This showed, partly, the two diseases are more important than the others. The importance of anthrax and blackleg was also reported by other authors.[2][12][13] The fact that there was improper disposal of carcass (disposal of dead animals in the open field) by farmers in the study area had likely maintained the endemicity of the diseases in the area. Sefirt[16] described that scavenger birds and carnivores are able to spread the causative agent spores over a wide area. Other explanations could be due to low vaccination coverage in all villages of the district and the causative agents may be introduced to the wider areas during over flooding from the highlands.[8] In the present study highest and lowest number of outbreak were registered in the years 2010 (22.44%) and 2013 (15.74%), and during spring (29.52%) and summer (19.29%) seasons, respectively. Anthrax is present worldwide, outbreaks typically occur in tropical and subtropical regions. The bacterium germinates during the dry season and can also be present during the wet season.[3] In the present study the outbreak of anthrax were also high in dry season (from December-February) with the value of 30.30% which is similar to pervious investigationby Dragon and Rennie[6] who had proposed anthrax outbreaks during dry periods interspersed with rain. Most disease outbreaks werealmost evenly distributed over the years with a small decrease in occurrence in 2011. This is possibly a result of intensive vaccination protocols, which is evidenced to play an important role in reduction of outbreaks. However the increase again after 2011cannot be attributed to any specific reason but can be assumed that concentrated attention is drawn only when outbreak numbers are above 23 and vaccinations are implemented. This hypothesis needs to be explored further. However, the presence of these outbreaks to a larger extent in some districts, particularly Debark is an indication of interplay of certain environmental and human factors that are likely to trigger anthrax outbreaks like, relatively poor awareness of the disease and the soil chemistry of certain geographical regions of the land. The results of this study suggest that still now there is an annual outbreak of blackleg of cattle in Northern Gondar. Some districts investigated in the study had few blackleg outbreaks, which we rather assume that because of poor record keeping, rather than low prevalence in the areas.Themajority of blackleg cases occurredin spring which is agreement with other studies,[14] and large number of cases also occurred in summer in the study area.Increased outbreak of blackleg disease in ruminants has been associated with high annual rainfall.[18] The highest incidence may vary from spring to autumn, depending probably on when calves reach the susceptible age group. Outbreaks of blackleg in cattle have occurred following excavation of soil, which suggests that disturbance of soil, may expose and activate latent spores.[3] In the field, risk factors include rapidly growing cattle and high plain nutrition.In this study area, spring is clearly the highest risk period for blackleg, which is similar to the observation by.[14] The outbreak occurrences of both bovine and ovine pasteurellosis were low because, outbreak usually occurs, secondary to other infectious agents or management factors.[3] In this study area also similar to literature a lowest record keeping were occurred in both bovine and ovine pasteurellosis, even there was no outbreak record keeping in some district, for instance in Waegeraand Adiarkay. Generally bovine and ovine pasteurellosis have a similar pattern of outbreak occurrence in respect to year, season, agro ecology and district. This may be partly explained by the fact that the causative agents for both diseases are the same. The highest outbreaks of bovine and ovine pasteurellosis were recorded in winter, the peak being in February and in January, respectively. From the ecological point of view, all of the above diseases exhibit the same outbreak patterns, with thehighest outbreak (54. %) in the midland areas, lower in the lowland and lowest (14.17%) in highland areas. This may be due to the effect that midland is more suitable for their growth and multiplication of the causative agents than the twoextreme agro ecologies.

CONCLUSION AND RECOMMENDATIONS

Although outbreak occurrence of the common bacterial diseases follow relatively similar pattern of spatial distribution in respect to agro ecology, it had been affected by temporal and other spatial factor. Generally, highest and lowest numbers of outbreak were registered in the years 2010and 2013, and during spring and summer seasons, respectively. Outbreaks of anthrax followed by blackleg were the most frequent outbreak recorded diseases. The highest number of outbreak of anthrax was recorded in winter, with peak in February. The highest Outbreak of blackleg was recorded in spring with peak in October and of bovine pasteurellosis outbreaks was recorded in winter, with peak in February. The highest Outbreak of ovine pasteurellosiswas also recorded in winter, with peak in January. The highest and lowest numbers of outbreak were also recorded in midland and highland agro ecology respectively. Based on the above conclusion the following recommendations are forwarded:

- The animal owners and animal health service providers should give more emphasis onspring and winter seasons to prevent occurrence of common bacterial disease outbreaks.
- Veterinarian should identify the areas and seasonal occurrence of each disease for intervention.
- The government should be introducing targeted annual vaccination of livestock based on the level of disease endemicityin a peculiar temporal and spatial distribution.
- Implementing an early detection, early warning and early reaction system to limit the effects of an outbreak is required.
- Increasing public awareness as regard to public health concerns and participation in disease control practices.

- Needs for strategic vaccination for common bacterial diseases.
- Strength surveillance system.

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