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Full length Research paper

A qualitative risk assessment of factors contributing to spread of foot and mouth disease through Cattle markets in western Kenya

Onduso R[1], Onono JO[1], Ombui JN[1] and Ochami AE[2]

[1]Department of Public Health, Pharmacology and Toxicology, College of Agriculture and Veterinary Sciences, University of Nairobi, P.O. Box 29053 – 00625.
[2]Department of Animal Science, School of Agriculture and natural resources management, Kisii University, P.O. Box 408 – 40200.

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There has been a surge in the number of Foot and Mouth Disease (FMD) outbreaks in western Kenya between the years 2016 and 2018. A qualitative risk assessment was done to investigate the role played by cattle markets in maintenance of these outbreaks. The specific objective of the study was assessment of factors contributing to spread of FMD through cattle markets in Western Kenya. Both qualitative and quantitative data were collected using a semi-structured questionnaire. Additional data collection was done through focus group discussions guided by checklist questions and secondary data obtained through review of published and grey sources of literature. The World Organization for Animal Health (OIE) framework was adapted for this study. The conduct of selected cattle markets was assessed to determining the risk for release and exposure of FMD virus during cattle trade. The study shows there was high risk of spreading FMD virus through cattle marketing activities. Inadequate facilitation of veterinary department, trade on non-vaccinated cattle, cattle evaluation practices, cattle movement without permits, trekking cattle for long distances, lack of isolation of traded cattle at farms and visiting of many livestock markets within short period, were identified as risk practices which could increase the risk of FMD spread. This study recommend that some risk management measures' needs to be put in place, these include adequate resource allocation to the veterinary department, subsidizing of the strategic cattle vaccinations, provision of market place facilities and creation of awareness among traders on the roles they play in cattle disease control and management.

Key words: Risk assessment, Foot and Mouth Disease, Market conduct, Western Kenya.

INTRODUCTION

Foot and mouth disease is a highly contagious, viral disease of domesticated and wild ruminants, characterized by high morbidity and low mortality (Coetzeret al., 1994). It has huge global economic impact due to large number of animals affected. These impacts include direct losses as result of reduced production and change of herd structure as it causes abortions and infertilities, while indirect losses are due to control costs and limited access to markets (Knight Jones et al., 2013). The disease has a global distribution and is endemic in many parts of the world, particularly Africa, Asia and regions of South America (Knowles et al., 2003). The disease is caused by a single-stranded RNA virus of the family picornaviridae, a member of the genus Aphthovirus (Belsham et al., 1993). The virus is genetically highly variable (Mertinez. salas et al., 2011) and has seven immunologically distinct serotypes; Southern African Territories, SAT 1, SAT 2, and SAT 3, serotypes, A (Allemagne), C (Island Riems), O (Oise) and Asia 1 (OIE 2004). Within each serotype there are numerous strains

(Van regenmortel et al., 2000). The incubation period for FMD virus is between 1 - 14 days depending on virus strain and dose, as well as site of infection (Artz etal., 2011). The virus is highly infectious, and it is produced in high titer in respiratory secretions and in large volumes, it is stable in natural environment and replicates rapidly. Foot and mouth disease virus spread rapidly in susceptible population. Infection of any one of the serotypes does not cause cross immunity against the other strains thus complicating the control of the disease during outbreaks (Sellers et al., 1971). In Kenya FMD is endemic with type A, O, C, SAT 1, SAT 2 and SAT 3 serotypes being the most common strains (Vosloo et al., 2002), and has a prevalence of 52% in Kenya and almost 100% in Western Kenya (Kibore et al., 2013). Foot and mouth disease outbreaks are associated with many risk factors, these include; farm management, animal husbandry, animal trade, herd immunity, and human activity (Bronsvoort et al., 2005). While the virus can be transmitted from infected animal to susceptible animal in a number of ways; aerosol transmission which occurs mostly during physical or close animal to animal contact often following animal movement is the most common. This is closely followed by ingestion of contaminated materials; that can occur when there is consumption of contaminated water, concentrates or pastures (Donaldson et al., 2001). Long distance spread can also occur through aerosol and fomite, or contaminated inanimate objects especially, motor vehicles, clothes and skin of animal handlers such as farmers and traders. Foot and mouth disease infected animals have high fever of between 39.4-40.6°C (103-105°F), that declines rapidly after two or three days, they develop vesicle lesions on dental pad, gums, soft palate, nostrils, inter-digital space, coronary bands, muzzle, teat, and on the tongue (Woodbury et al., 1995) which later raptures leading to copious discharge of contaminated saliva (foamy saliva and which is drooling), nasal discharge, smacking of lips, grinding of teeth, kicking of feet and lameness. Infected adult animals often lose weight, are anorexic, mature males develop swelling in the testicles, and in milking cows, there is significant decline in milk production. Most affected animals recover, a few, especially newborn ones, may develops myocarditis and eventually die (stenfeldt et al., 2014). Cattle farmers when faced with household financial need would sell their animals to meet these needs (African Union 2010). In livestock trade, animals are moved from different production system and long distances to the market where they interact with animals from various sources and to different destinations. Sometime animals are moved through many markets before they get a buyer or before they are to their final slaughter destination. Production systems which bring in animals from other farms have been found to be 2.2 times more likely to experience FMD outbreaks compared to farms which do not bring in animals from other farms (Bronsvoort et al., 2005). A study in Equador by Lindholm et al. (2007) reported that farms purchasing cattle from cattle market are 10.9 times more likely to have FMD outbreaks compared to herds which have not purchased cattle from markets. Allepuzet al. (2013) in their study in Tanzania had a similar finding in which they reported that FMD occurrence has a higher correlation with animal movement and human activities and related this to proximity to public roads and railway lines. Kenya has an estimated cattle population of 17.5 million and with an estimated annual off take of 2.9 million heads of cattle. The contribution of cattle to Kenyan GDP is estimated to be Ksh. 356.217 billion, of which Ksh.53.960 billion is derived from domestic farming (Behnke and Muthami 2011). In 2009, Kenya National Bureau of Statistics (KNBS) estimated that livestock provide about 45% of the total agricultural GDP in Kenya (GOK, 2012). Furthermore, it is estimated that the agricultural sector contributes about 26% of Kenya's GDP, and employs about 75% of the population (GOK 2005). In Kenya, beef production is mainly practiced by the pastoralist community who own about 12.2 million head of cattle and produce about two thirds of the Country's red meat (Behnke and Muthami 2011, Farmer et al., 2012). In Western Kenya, cattle farming is practiced under small scale mixed farming system (Paul et al., 2016). Semi-intensive management is the preferred management system with animals communally grazed on open grazing fields. In case of disease outbreaks under such management systems, the effect would be huge since many cattle would be exposed within a short time, and huge costs would be incurred by the government and farmers to effectively control such outbreaks, hence the need for enhanced disease surveillance systems within the connected markets. Therefore, the objective of this study was to identify the risk cattle trading practices in the region which is crucial for designing an efficient disease control program and surveillance system.

MATERIAL AND METHODS

Description of study area

The study was conducted in Bungoma and Busia Counties of Western Kenya. The counties were purposively selected for the study because of their geographical location; they lie at transit line of beef cattle from producing counties; Turkana, West Porkot and Keiyo Marakwet to urban and peri-urban beef markets at Kakamega, Kisumu, Bungoma and Busia towns (Figure. 1). Busia County is at the Kenya Uganda border with two border crossing points at Busia and Malaba towns, and the communities staying in this county have their relatives in Uganda. Bungoma County borders Uganda and is home to Mt. Elgon national park, which is associated with

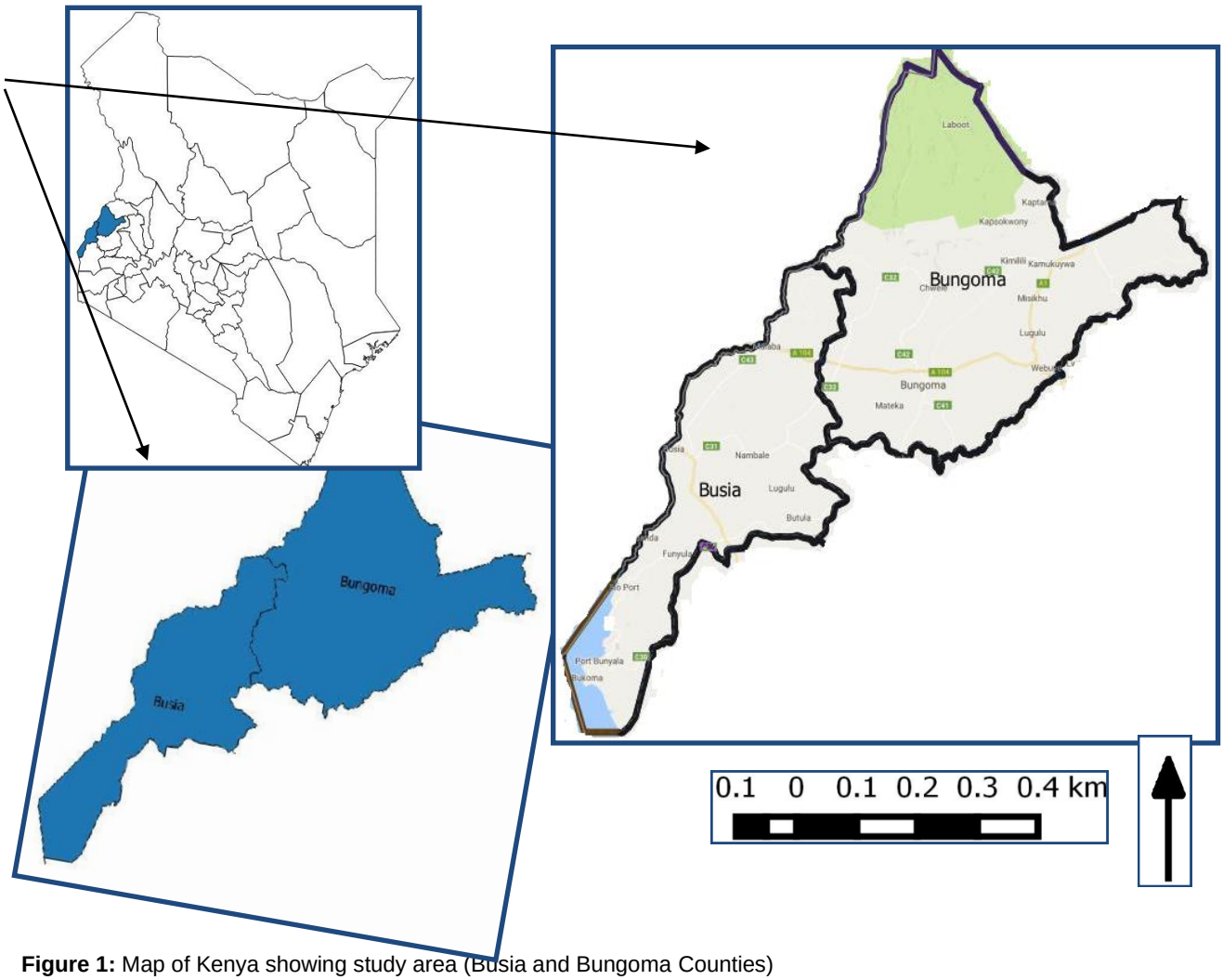


Figure 1: Map of Kenya showing study area (Busia and Bungoma Counties)

FMD outbreaks in the region. Busia county is estimated to have a surface area of 1,695 square kilometers (Km2) and a population of 816 452 people while Bungoma County has a population of 1,375,063 people and a surface area of 2,069 km². The economy of the two counties depends on agriculture, centering on livestock keeping and cultivation of sugarcane, maize and cassava. The Zebu and their crosses are the predominant breeds of cattle kept in the region (Wanjara and Njehia 2014). There are three major livestock marketing channels recognized in the region, which include butchers, speculators and dealers. Other actors in these markets are farmers, brokers (middlemen), transporters, revenue collection officers, and officers from veterinary office who issue movement permits.

Study units

A total of six markets were considered in the study, these markets were Bumala, Funyula and Amukura in Busia county and Kamukuywa, Chwele and Kimilili in Bungoma county. These markets were purposively selected. Funyula and Amukura were considered as major markets along Kenya Uganda border, Kamukuywa, Bumala, Kimilili and Chwele markets were considered as major markets located on cattle transit routes from Northern Kenya: Kenya Ethiopia border, Kenya Uganda Border through Turkana and West porkot Counties to major urban centers in western Kenya; Kakamega, Bungoma, Busia and Kisumu, in search of better market prices for their cattle.

Data collection

This was a cross-sectional study in which data was collected within a single period of time from the study area. This design was chosen because it was considered less expensive and required less time to collect data using participatory epidemiological tools. The data collected from this study allowed easy computation of the statistics from which interpretations were easily made. Data was obtained on the following key areas; animal

Table 1: Variables together with their measurements

Variable	How variable was measured
FMD prevalence	Expressed in percentage (%) from previous study findings
FMD serotypes	Expresses in No. of FMD strains reported to have been confirmed in the country by previous studies
Virus characteristics	As described by other studies
Market bio-security	Described by observing various market place parameters and traders' activities
Confirmed FMD cases	No. of FMD confirmed cases as obtained from FGD
Movement during Quarantine	Categorized into two levels, 1) Yes, traders were able to move animals through quarantine area and, 2) No, traders were not able to move animals through quarantine area
Presence of quarantine	Traders were asked if there has been any quarantine in their area of operation andCategorized into two levels, 1) Yes, 2) No.
Mode of transport	Trade animals were transported to and from the market by, 1) Trucking 2) Trekking
Movement permit	Traders were grouped into 1) Yes, those who obtained animal movement permit and, 2) No, those who did not obtain movement permit
Origin of animal	Categorized into 4 levels depending on where animals traded were coming from. 1)Same county, 2) Neighbouring county, 3)Distant county and 4) Uganda
Animal destination	Categorized into 3 levels based on where animals bought from study markets were to go. 1) Same county, 2) Neighbouring county and, 3) Distant county.
Time to resale	Traders were categorized into 3 levels depending on the time they take to resale the animals they bought from study markets, 1) 1-2 days, 2)3-4 days, 3) 5and above days
Source of animal	Animals brought for sale were obtained either from 1) Farm or 2) other Markets
Purpose of buying	Animals bought from study markets were either for 1) Resale, 2) Slaughter, 3) Breeding or 4) Others
Animal evaluation	Animals were evaluated to estimate their value by 1) Weight, 2) Visual or 3) both
Isolation at farm	Traders are supposed to isolate their trade animals from other animals at their farms. There were two groups, 1) Yes, isolates trade animals at their farms. 2) No, do not isolate trade animals from other animals at their farms
Management system	This was based on the findings of other studies in the region
Veterinary stuffing, network and funding	These were based on how they were described by the FGD
Vaccination coverage	This was based on information from the veterinary records and information from FGD
Heard immunity	Assessed by considering the vaccination program in placeand turn out to those vaccinations
Response time to outbreak	This is days taken from when an outbreak is confirmed to when an appropriate action is taken.

movement, disease control activities, livestock trading activities, cattle pricing practices and characteristic of respondents using a structured questionnaire and focus group discussions (FGD) which were guided by checklist questions.

The questionnaires were administered to traders who bought cattle from study markets, on one-on-one interviews with the respondents. Members of the focus group discussions comprised of; two traders, two farmers, county revenue collection officer and a staff from the sub-county animal production office. Data obtained from these key variables were on the sources and destination of traded animals, knowledge on FMD outbreaks in the region, if traders had been able to buy or sell cattle during quarantine periods, how movement permits were issued and their uptake by livestock traders, mode of transporting of trade cattle and average time taken to resale animals they buy, on isolation of traded animals at traders own farms and how cattle evaluation was done (table 1). More information was obtained from published and grey literature on the prevalence and strains of FMD in the region, structure and disease surveillance of veterinary department and on livestock management system in Western Kenya.

Data analysis

Questionnaire data were entered in Microsoft Excel spreadsheet then exported to statistical package on Social Package for Social Sciences (SPSS 20 Version) for analysis, while data obtained from oral discussions was transcribed into Microsoft word for further analysis. Qualitative risk assessment for the spread of FMD in connected cattle markets and farms was performed. The OIE risk assessment framework (OIE 2004) and the guidelines of Zepeda (1998) were used to do the qualitative risk assessment. The OIE risk assessment framework entails: hazard identification, release assessment, exposure assessment, consequence assessment and risk estimation. The following variables were evaluated and their risk ranked; organization of the veterinary structure, conduct of cattle traders, status of FMD in the region, cattle movement and epidemiological surveillance systems in place. The overall risk of release, exposure or consequences was determined using a combination matrix (Table 2). The descriptive scale developed by Zepeda, (1998) was used to rank the risk of occurrence of each event (Table 3).

Table 2: Combination matrix table used when two parameters are considered (Zepeda Sein 1998)

Risk of parameter I	Risk of parameter II			
	Negligible	**Low**	**Moderate**	**High**
Negligible	Negligible	Low	Low	Moderate
Low	Low	Low	Moderate	Moderate
Moderate	Low	Moderate	Moderate	High
High	Low	Moderate	High	High

Table 3: Interpretation of Qualitative risk ratings (Zepada sein 1998)

Term	Meaning on event occurrence	Meaning for consequence
Negligible	Occurrence of the event is possible Only on exceptional circumstances	Low or no impact
Low	Occurrence of an event is a possibility in some cases	Minor impact
Moderate	Occurrence of the event Is a possibility	Average impact
High	Occurrence of the event is Clearly a possibility	Serious impact

The study questions

This study was attempting to answer the question of what is the risk of spreading FMD virus through cattle markets if infected animal is selected for sale in western Kenya markets (Figure. 2). The overall risk for the spread of FMD through cattle markets in the study area was assessed as a function of the risk of occurrence of the hazard and the consequences of that hazard occurring.

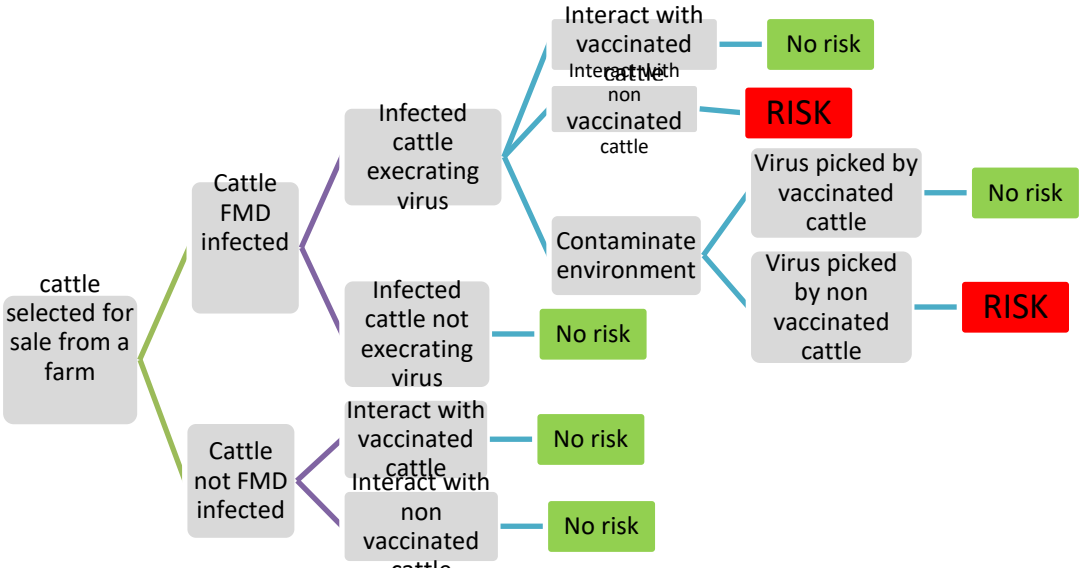


Figure 2: risk assessment framework for the spread of foot and mouth disease through cattle markets in western Ken

The risk of occurrence of hazard was considered a product of the risk of release of FMD virus from infected animal in the market, the exposure of susceptible animal to FMD virus and the extent of spread of the FMD pathogen (Figure 3). Consequence assessment was done by considering the economic and public health impact of the disease to the local economy. The economic assessment was done by considering the predominant cattle breeds in the region, cattle uses, FMD status in the region and resources used in disease control in case of outbreak. Public health impacts were done by considering the zoonosis of the disease and challenges of disposing animals dying from the disease. The risk assessment in this study focused on the spread of the FMD virus through trade of live cattle activities. Spread through cattle products and other animal species (sheep and goats) were not considered in this study though it is a possibility.

RESULTS

Demographic characteristic of respondents and Hazard identification

A total of 250 out of 271 questionnaires were administered and completed by the respondents. Twenty-one (21) questionnaires were not fully completed and were therefore not used in the final analysis. Of the 250 traders who were interviewed, their distribution in the study markets, age and level of education is as given in table 4 and 5.

Table 4: Distribution of respondents and the number of animals they traded.

No.	Cattle market	No. of sampled Traders	No. Of cattle Traded
1	Funyula	18	93
2	Bumala	20	141
3	Amukura	15	73
4	Chwele	40	347
5	Kimilili	76	677
6	Kamukuywa	80	721
	Total	250	2052

Table 5: Demography of the respondents.

Demographic factor	Demographic category	frequency (n=250)	Percentage (%)
Age	0 – 30 years	56	22.4
	30 – 50 years	141	56.4
	50 and above years	53	21.2
Education	No formal education	40	16
	Primary education	96	38.4
	Secondary education	84	33.6
	Post- secondary education	30	12

Prevalence of FMD virus in the region, practices of cattle traders and disease surveillance systems in place were considered in hazard identification. Data from the study area of 2 - 4 confirmed FMD outbreaks, positive response (98.4%) of traders on quarantine imposed in the area for the last two years and other risk practices of traders such as trading and moving animals during the quarantine period (26%) and previous study findings on FMD prevalence, serotypes, virus characteristic and market biosafety confirms the presence of FMD virus in the study area,(table 6A, presence of quarantine, movement during quarantine, confirmed FMD cases and FMD prevalence)

Release assessment

Risk of release of FMD virus into the cattle market environment after introduction of an infected animal was examined by considering four parameters namely; risk of infected cattle moving through the livestock markets, survival capacity of the virus in the environment, practices related to cattle marketing in the region and volume of cattle traded in the study markets.

The risk of infected cattle moving through the market unnoticed is a function of the risk of occurrence of FMD in the region. This is dependent on; prevalence of FMD virus in the region, efficiency of the surveillance systems and FMD vaccination coverage. Prevalence of FMD virus in the region as discussed on hazard identification above was rated as high. The veterinary network in Kenya is well structured at both the national and county level. At the national level, there is the Director of Veterinary Services (DVS), who at the county level, is represented by the County Director of Veterinary services (CDVS). Sub-counties are under the Sub-County veterinary officer (SCVO), assisted by animal health assistants at the ward level. The CDVS are in charge of all disease control activities in their territories. Acute shortage of staff and funding were observed in the study, these present challenges in disease control and surveillance. Low coverage of animal vaccination was also observed, which was attributed to the fact that farmers paid for these vaccinations and most times, vaccinations were carried out long after the outbreaks had been contained, therefore farmers did not see value for this intervention. Due to poor funding whenever there was an outbreak it took time to collect and present samples for FMD confirmation and serotype identification at FMD laboratories located in Embakasi, Nairobi. The only laboratory with capacity to confirm FMD outbreaks in the whole Country, located over 400 km from the study area. The procurement of vaccines would delay the response time and at times even after the vaccine had been procured there would be further delay due to logistics of assembling the vaccination teams and transportation logistics.

The low vaccination coverage implied continued presence of FMD virus in the study area. Data from focus group discussion revealed that sometimes it took up to six months to lift the imposed quarantine, with this lifted often without any vaccination campaign organized due to lack of funds. It was concluded that there was limited capacity with respect to disease surveillance, reporting and control of notifiable diseases in the area. Based on this information i.e almost 100% sero-prevalence of bovine FMD virus in Western Kenya, low vaccination coverage, poorly funded and understaffed veterinary departments, the risk of an FMD infected cattle moving through a cattle market unnoticed was categorized as high, (table 6D, veterinary network, staffing, funding and response time to an outbreak).

In the study area cattle are mainly kept in small scale mixed farms under semi-intensive management system, in which neighbors share grazing fields and watering points (table 6C, management system). Majority of the livestock traders (87%) do not observe any bio-security measures (at their farms and market)while 61.3% trekked their traded cattle to and from the markets, animal movement permits were issued without consideration of animal disease situation in the area and some traders (26.8%) were moving animals without movement permit, (table 6B, transport mode and obtain movement permit). The survival of FMD virus in the environment was rated high.

Cattle marketing practices which were considered include mode of transporting trade animals (61.2% trekked), time taken to resale animal bought from the market (86.6% sold their stock within four days), animal evaluation (47.6% used visual evaluation while 31.2% used both visual and weight evaluation), source, origin and destination of animals and trader's level of respect and actions with regard to quarantine measures. Based on trader's response on above factors, the risk of disseminating FMD virus by movement of trade animals was thus rated high.

On average, at each market day the 250 traders transacted a total of 2,052 animals which translates to 8 animals per trader per day. The risk of FMD spread was rated high given that hundreds of animals are traded each market day, their source and origin vary, and are destined to markets within and outside the region (table 6B, animal source, origin and destination)

Overall release assessment

The matrix proposed by Zepeda (1998) was used in the overall release assessment. The risk of FMD virus release from infected animal to the environment was a function of combination of risks relating to the risk of an infected animal moving through the livestock market chain which was rated high, the risk of FMD virus survival in the environment which was rated high, risks due to trader's marketing activities categorized as high, and risk due to volumes of traded cattle rated as high. The risk of traded cattle contaminating the environment with FMD virus was rated as high (Figure.3A).

Exposure assessment

The parameters considered in determining the risk of exposure were; risk of market animals making infectious contacts, risk of cattle from markets not being quarantined and risk of FMD transmission within and between the farms.

Herd immunity is a function of vaccination coverage and vaccine efficacy. Vaccination coverage depends on vaccination campaign efficiency and commitment of farmers to present their cattle for vaccination. Data

Table 6: Summary table of responses of themes and variables as obtained from the study

Theme number	Theme	Variables	Response frequency and percentage (n=250)	Variable rating	Source
A	FMD prevalence and virus characteristic	Presence of quarantine	Yes – 246 (98.4)	High	Traders
		Movement during quarantine	No – 4 (1.6		
		Confirmed FMD	Yes – 65 (26)	High	Traders
		FMD prevalence	No – 185 (74)		
		FMD serotypes	2 – 4 outbreaks	High	FGD
		Virus characteristics	(50 -100%)	High	Kibore et al. (2013)
		Market bio-security	Six strains	High	Vosloo et al. 2013
			No cross immunity	High	Sellers et al.1971
			Two out of six markets fenced, cattle randomly mixed in the market	High	Traders
B	Animal movement	Mode of transport	Truck – 97 (38.8)	High	Traders
			Trek – 153 (61.2)		
		Movement permit	Yes – 183 (73.2)	High	Traders
			No – 67 (26.8)		
		Origin of animal	Same county -763 (37.1)	High	Traders
			Neighbouring county – 697(33.9)		
			Distant county- 507(24.7)		
			Uganda – 85 (4.1)		
		Animal destination	Same county – 780 (38)	High	Traders
			Neighbouring county – 676 (32)		
			Distant county – 596 (29)		
		Time to resale	1 – 2 days – 139 (55.6)	High	Traders
			3 – 4 days – 75 (30)		
			5 days and above-36 (14.4)		
		Source of animal	Farm – 54 (21.6)	High	Traders
			Market – 196 (78.4)		
		Purpose of buying	Resale – 102 (40.8)		
			Slaughter – 76 (30.4)	High	Traders
			Breeding - 52 (20.8)		
			Others – 20 (8)		
				High	Traders
C	Trader practices	Animal evaluation	Weight – 53 (21.2)	High	Traders
			Visual estimation – 119 (47.6)		
			Both – 78 (31.2)		
		Isolation at farm	Yes – 219 (87)	High	
			No – 31 (13)	High	
		Management system	Community grazing		Traders
					Paul et al. 2016
					Wanjala & njehia 2014
D	Surveillance capacity	Veterinary network	Good	Low	FGD
		Veterinary staffing	Understaffed	High	FGD
		Veterinary funding	Underfunded	High	FGD
		Vaccinationcoverage	Poor	High	FGD
		Herd immunity	Low	High	FGD
		Response to outbreak	Up to 6 months	High	FGD and Traders

obtained in the study revealed that farmers were not willing to present their animals for vaccination, likely because of limited resources, but also because they did not see the value of this intervention since their animals were not always sick at the time of the vaccination, (table 6D, Vaccination coverage (poor) and herd immunity (low)). The study observed that veterinary departments do not have enough resources to carry out regular vaccinations, sometimes vaccinations were carried out long after the outbreaks had been contained. Generally, vaccination coverage was low. Based on the fact that there are seven immunologically distinct serotypes each with numerous strains and given that infection with any one of the serotypes does not confer immunity of the other serotypes, a large proportion of cattle population were susceptible to the disease (table 6A, FMD serotypes and virus characteristic). In the market, each trader or a group of traders grouped their animals together. Market grounds were often used as grazing fields by the surrounding community during non-market

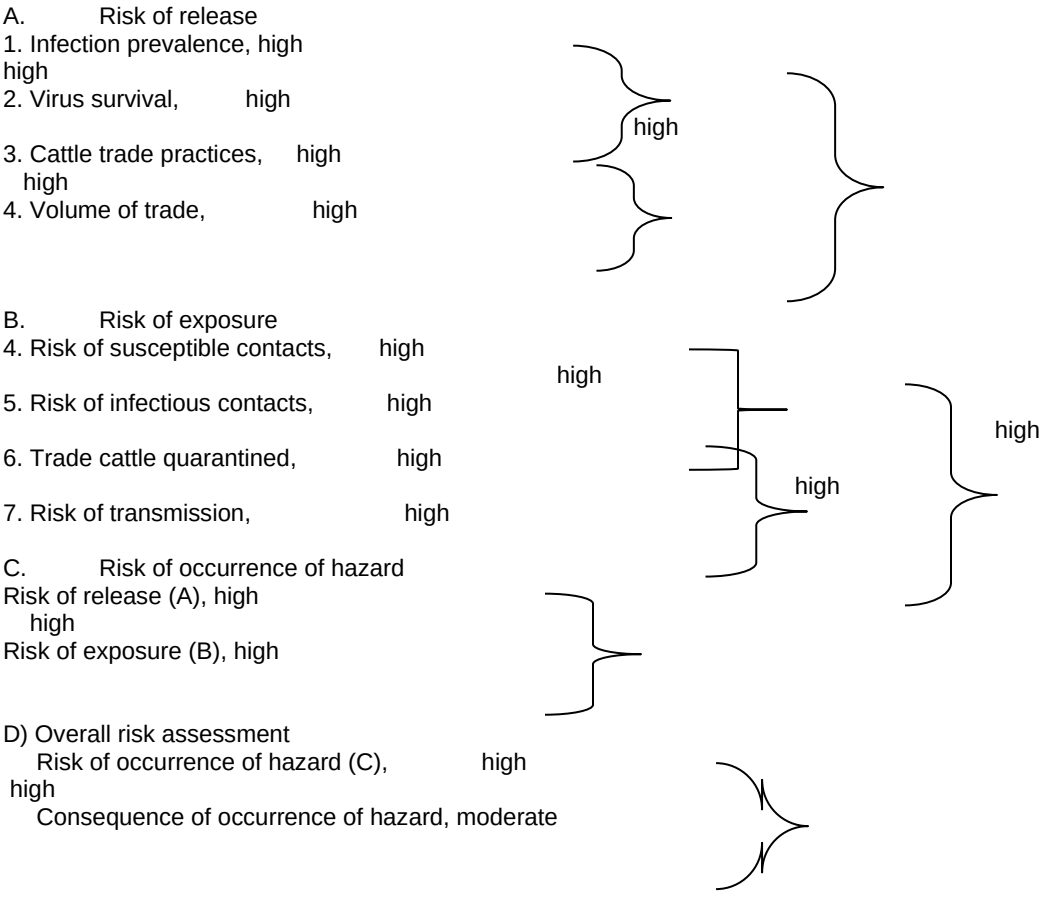
days (table 6A, market bio-security). Based on the above that there were no regular FMD vaccinations, low commitment from livestock farmers to take animals for vaccinations, and low bio-security measures observed in the market the risk of FMD infected animals making infectious contact in the study markets was considered to be high.

It is common for traders to take purchased animals to their farms, for fattening or perhaps awaiting the next market day. Animals purchased from the markets were grazed, watered and penned together with other animals in the farm without proper examination and observation for disease (table 6C, Isolation at farms). If any of the animal brought into the farm was a carrier or had sub-clinical FMD it would contaminate the whole farm and infect all susceptible animals in that farm. Effective quarantine requires complete restriction of animal movement, while being examined for development of diseases; proper restraining facilities such as fence and trained personnel were needed. Considering the setting of farms in western Kenya (Wanjara and Njehia 2014), this was not possible at farm level which implies a high risk of spreading FMD from animals bought from markets to animals found in the farms.

The risk of FMD transmission to susceptible animals was assessed by considering the mode of spread of FMD virus and the virus characteristic in terms of virus production, virus survival in the environment and infectiousness. FMD spreads rapidly through movement of infected animals or mechanically through fomites such as contaminated vehicles, visitors and animal handlers, clothing, feeds, and veterinary inputs. The virus is produced in high titer and in large volumes by infected animals, it is stable and replicates rapidly and has a short incubation period of 2 to 12 days. Additionally, it has many serotypes, and immunity against one strain does not confer immunity against other serotypes, causing challenges in the disease control, (table 6A, FMD serotypes and virus characteristic). Traders were not taking any bio- security at their farms, trade animals were not quarantined and their farms were not isolated from neighboring farms, they were moving from one market to another and were able to resale their animals within a short period of time. (table 6B, time to resale), Based on the above facts the risk of FMD virus transmissions was rated high.

Overall exposure assessment

Figure 3: Risk of occurrence of various risk factors using descriptive scale and classification matrix defined by Zepeda (considering two factors at a time)



The risk of exposure resulting from the combination of the four parameters examined: risk of an infected animal making susceptible contacts (high), risk of marketed animals making infectious contacts (high), risk of cattle from the market not being quarantined (high) and risk of FMD transmission within and between the farms (high), was thus considered to be high (Figure. 3B).

Magnitude of the consequences

Outbreaks of FMD in Western Kenya have high economic impacts to the local economy. Though farmers do not loose animals to the disease, but when livestock markets are closed, traders cannot sell or buy, thus they lose sources of their daily income (they cannot meet their family obligations such as paying school fees for their children). Furthermore, the government would spend a lot of resources for ring vaccinations to control the outbreak. There is negligible impact on public health since the disease does not affect humans and the disease has low mortality. The magnitude of the consequences was thus rated as moderate.

Overall risk assessment

The overall risk assessment for occurrence of the hazard (FMD virus spread) in western Kenya was considered to results from the combination of all perceived risk factors assessed under risks of release and exposure and both cases considered as high. Thus, the risk of occurrence was considered to be high (Figure. 3C). The overall risk was assessed as the combination of the risk of occurrence (high) and of the consequences of occurrence (moderate), thus rated as high (Figure.3D).

DISCUSSION

This study used a simple and acceptable methodology as described by world organization of animal health (OIE). It is a preliminary step in the process of building more sophisticated qualitative or quantitative risk assessment models. The data collection methods used in the study has been used by other epidemiological survey study of, risk assessment in Danish swine population (Bronsvoort et al., 2005). The study is the first of its kind in the region, therefore forms the basis of more funded and structured studies to be used in disease surveillance policy formulation. All the markets selected for the study lacked the basic facilities and adequate staff for screening cattle diseases making it possible for infected animals to go through the market un-detected. This is especially so when dealing with cattle traders whose main objective is moving from one market to another while buying and selling to make profit. This implies that FMD infected animal could be moved in more than one market before showing clinical signs of the disease, in the process infecting many animals. Most of the traded animals were trekked to and from the market, this causes more environmental contamination as the animals' graze, drink, defecate and sometimes they get into contact with other animals while on transit. Traders were not taking much consideration of the immunity status of the cattle they handled, they were estimating animal value by palpation of the animal with bare hands and generally there was lack of bio-security measures in their farms and the markets they visit which is a concern for the success of FMD control.The movement of FMD infected cattle to the market has been reported as a risk factor in the FMD virus spread during the outbreaks in Britain and Netherland (Donnelly et al., 2001).Lack of enforcement of restrictions for animal movement and trade on non-vaccinated animals were some of the factors which enable FMD infected cattle to reach the market thus making them a hub of disease transmission. Movement permits were being issued as a formality in the markets visited as opposed to being a disease surveillance tool, cattle were not being examined prior to issuance of movement permit and not all traders obtained the permit yet they were able to move their animals. The capacity of veterinary department with respect to veterinary disease surveillance, reporting and control of notifiable diseases in the area were affected by shortage of both staff and funds. This has the potential to cripple its ability to carry out effective disease surveillance. For instance, due to poor funding and staffing of veterinary department whenever there was an outbreak it took time to collect samples send them to the FMD laboratory for confirmation and serotype identification, procure vaccines, assemble a temporally vaccination team and organize transport logistics. For this reason, disease quarantine could take up to six months to be lifted in the study area, this discourages traders whose only source of income is buying and selling of cattle and in the process, they find ways to violate the quarantine law thus putting the cattle population at risk of spread of communicable diseases.

Traders confirmed as being able to trade and move animals when there was quarantine in place. This was possible as buying and selling can take place at farms and along the roads outside the market, an indication of lack of adequate reinforcement. Despite the fact that FMD was endemic in western Kenya, vaccinations were irregular and characterized by poor turnout. This was attributed to the fact that farmers paid for these vaccinations and most times, vaccinations were carried out long after the outbreaks had been contained. With poor turnout there is low vaccination coverage which results to low herd immunity and therefore a large susceptible population. The overall results for this study support the hypothesis that cattle marketing activities in Western Kenya have a potential effect on the transmission of FMD within connected farms and systems.

CONCLUSION

The study calls for adequately funding of the veterinary department to enable it improve on its capacity to conduct adequate and efficient epidemiological surveillance. Veterinary officers needs to follow due procedure in issuing of movement permit and putting in place of quarantines and law enforcement agents needs to implement them fully while farmers and traders needs to respect the quarantines. There is need to review animal movement policy in the country in order to have structures in place to trace cattle movement and to improve on the perception on movement permit and quarantines in the region, they should be regarded as tools of disease control as opposed to revenue generating tools.

There should be collaboration of the National government of Kenya and respective county governments to conduct subsidized FMD strategic vaccination programs to improve on herd immunity thus reducing the virus survival in the environment. Market place facilities need to be improved by provision of weighing scale and other bio-safety measures. Traders should be organized to form groups / cooperative and trained on roles they play on spread of cattle diseases and tracking animal movement.

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Conflict of interest

The authors declare that they have no conflict of interest on this work and its publication

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