Prevention and Control of Viral Zoonoses, Ethiopian Perspective: A review

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Abstract: Zoonotic diseases are contagious diseases that can spread between animals and humans which are caused by viruses, bacteria, parasites and fungi that are harbored by animals and insect vectors. Most of the new diseases affecting human over the past decades were associated with pathogens originating from animals or products of animal origin. A new virus has been emerging almost every year since the last two decades. Although viruses and prions represent just fewer than 5% of the total list of human pathogens, there have been a disproportionate number of infections (37%) caused by RNA viruses resulting in emerging and/or remerging diseases. Some of viral zoonotic diseases have been expanding which include Ebola, Severe Acute Respiratory Syndrome, Avian Influenza, and Hantavirus. Future occurrences of newly emerging diseases are most likely to erupt at intensifying interfaces. Developing countries including Ethiopia have a higher incidence and prevalence of zoonotic diseases and this is attributed to lack of adequate control mechanism, inadequate infrastructure and absence of adequate information exchange on their importance and distribution. Moreover, the prevention and control of these diseases impose a unique and often heavy burden on public health services, particularly in under developed nations. In Ethiopia, a list of 43 zoonotic diseases were prioritized by using different prioritization tool, some of which are viral zoonoses namely Rabies, Avian Influenza, Rift Valley Fever, West Nile Fever, Hendra Virus Disease, Hanta Virus Pulmonary Syndrome, Middle East Respiratory Syndrome, Eastern Equine Encephalitis, Dengue Fever, MERS-CoV, Lassa Fever, Ebola Virus Disease. There are risk factors for the emergence, re-emergence, and spread of these microbial threats that can create an environment in which they are maintained in the society. The increasing interaction of domestic animals, wildlife and humans is critical and progressively important factor within the dynamic of emerging diseases particularly of viral zoonoses and the transmission of zoonotic pathogens. Preventing and controlling the occurrence and spread of these diseases is crucial as it is virtually impossible to predict when and where the next outbreak will occur. In conclusion, it is now time for medical and veterinary communities to work jointly in clinical, epidemiological, public health and research settings so as to strengthen the collaboration between them implementing one health and early warning and emergency preparedness plan should be set at national level both in public and animal health aspects.

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Introduction

Zoonotic diseases are contagious diseases that have the ability to spread between animals and humans. These diseases are caused mainly by viruses, bacteria, parasites and fungi that are carried by animals and insect vectors (Tesfahunegny, 2016). Out of the total 1415 microbial diseases affecting humans, 61% are zoonotic and among emerging infectious diseases, 75% are zoonotic with wildlife being one of the major sources of infection. Among the new diseases affecting humans over the past decades, 75% has been associated with pathogens originating from animals or products of animal origin (WHO, 2016).

A new virus has been emerging almost every year since the last two decades. Of the 534 zoonotic viruses belonging to 8 families identified, 120 cause human diseases with or without the involvement of intermediate host (Venkatesan *et al*., 2010). Viruses and prions represent just fewer than 5% of the total list of human pathogens. However, there have been disproportionate number of infections (37%) caused by RNA viruses resulting in emerging and/or remerging diseases. The RNA viral families, Bunyviridae, Flaviviridae, Togaviridae and Reoviridae contain viruses which represent more than half of the defined viral zoonoses (Woolhouse and Gowtage-Sequeria, 2005).

Some of viral zoonotic diseases have expanded their host range and increased in incidence and are named as emerging zoonoses of which Ebola, Severe Acute Respiratory Syndrome, Avian Influenza, and Hantavirus (Tayler *et al*., 2001) can be mentioned. Interestingly, a characteristic of most zoonotic viral pathogens is that they are not readily transmissible from humans to humans. In most of the cases, humans are dead-end hosts (Weiss and McMichael, 2004) although there are important exceptions in which case a virus will require certain genetic adaptations from human adapted viruses for new variants within the new human host to persist and to become successful in human-to-human spread (Martinez *et al*., 2005). Emerging and re-emerging diseases are causing devastating impacts internationally, with millions infected and billions spent. Different diseases have become pandemic, spreading from one continent to another causing massive mortality and affecting global economies and livelihoods (Obi *et al*., 2010).

Future occurrences of newly emerging diseases are most likely to increase at intensifying interfaces. Developing countries have a higher incidence and prevalence of zoonoses and this is attributed to lack of adequate control mechanism, inadequate infrastructure and absence of adequate information exchange on their importance and distribution (Smolinski *et al*., 2003). The communities most likely to be affected by such diseases are those that are poor. Such communities frequently rely on inadequate methods of medical surveillance and diagnosis as well as traditional treatment methods. As a result, it is quite likely that emerging or re-emerging zoonotic diseases including viral zoonoses with high epidemic potential may only be detected after they became established in humans or their animals when they have already spread significantly (Westbury, 2000).

Moreover, prevention and control of such zoonotic diseases impose a unique and often heavy burden on public health services, particularly in resource-limited settings. As zoonotic diseases can deeply affect animals and humans, for many zoonotic infections, medical and veterinary health sectors have a large stake in disease surveillance and control activities (Lake Miriam *et al*., 2017). However, in Ethiopia, situations to collaborate both public and veterinary sectors in order to prevent and control those emerging and re-emerging zoonotic diseases in general and viral zoonoses in particular is not strong enough to tackle this growing and alarming problems. Hence, the objectives of this article review are to highlight risk factors for the emergence and re-emergence of viral zoonoses and to indicate appropriate prevention and control measures to combat the impact of viral zoonoses.

1. Literature Review

2.1 Overview of Viral Zoonoses in Ethiopia

Over the last 15 years, our planet has faced more than 15 deadly zoonotic or vector-borne global outbreaks, in which viral zoonotic diseases such as Rabies, Hanta, Ebola, highly pathogenic avian influenza (H5N1) and recently H7N9, West Nile, Rift Valley fever, Norovirus, severe acute respiratory syndrome (SARS), Marburg, influenza A (H1N1) are included (Gebreyes *et al*., 2014).

In fear of the global situation, in the year 2015, the government of Ethiopia organized consultation work shop to prioritize a list of diseases with zoonotic potential in the country. During the workshop held from September 29-30/2015 a list of 43 zoonotic diseases were prioritized by using severity of the disease, proportion of human disease attributed to animal exposure, burden of animal disease, availability of interventions and existing inter-sectoral collaboration as a prioritization tool of which some are viral zoonoses that include Rabies, Avian Influenza, Rift Valley Fever, West Nile Fever, Hendra Virus Disease, Hanta Virus Pulmonary Syndrome, Middle East Respiratory Syndrome, Eastern Equine Encephalitis, Dengue Fever, MERS-CoV, Lassa Fever, Ebola Virus Disease etc to mention some as indicated in table 1 below (Emily *et al*., 2016).

Table 2: Some of viral zoonotic diseases prioritization in Ethiopia

Disease	Raw score	Normalized final score
Rabies	0.90	1.00
Avian Influenza	0.52	0.58
Rift Valley Fever	0.45	0.50
Japanses Encephalitis	0.44	0.49
West Nile Virus	0.36	0.41
Eastern Equine Encephalitis	0.35	0.40
Hendra Virus Disease	0.35	0.40
Hanta virus	0.29	0.32
MERS-CoV	0.26	0.30
Dengue	0.21	0.23
Lassa Fever	0.10	0.11
Ebola Virus Disease	0.08	0.09

Source: (Emily *et al*., 2016)

Most of the prioritized viral zoonotic diseases are not endemic to Ethiopia except for rabies. Canine rabies is endemic to Ethiopia; an estimated 105 dog bites/100,000 humans occur per year, and greater than 1.7 deaths/100,000 persons are reported every year (Hampson *et al*., 2015). In the country, retrospective data registered between 2001 and 2009 at one center (EPHI) showed 386 fatal human cases with annual range of 35 to 58 (Asefa *et al*., 2010). Moreover, study conducted at North Gonder of Ethiopia indicated an annual estimated rabies incidence of 2.33 cases per 100,000 humans; 412.83 cases per 100,000 dogs; 19.89 cases per 100,000 cattle; 67.68 cases per 100,000 equines, and 14.45 cases per 100,000 goats (Jumberu *et al*., 2013) and dog bite was the source of infection for almost all fatal rabies cases in the area.

2.2 Common Risk Factors for Viral Zoonoses

Common risk factors for the emergence, re-emergence, and spread of microbial threats are driven by a complex set of factors. The convergence of any number of these factors can create an environment in which infectious viral diseases can emerge and be maintained in the society. The increasing interaction of domestic animals, wildlife and humans is critical and progressively important factor within the dynamic of emerging diseases particularly of viral zoonoses and the transmission of their pathogens (OIE, 2004).

The factors that drive and/or contribute to the emergence of new diseases can be usefully classified into those that occur in one of three environments: (1) In human living environments that is changing consumer demand and dietary habits, urbanization, human and animal population density, the proximity of humans and livestock, changing demographics, increasing mobility, rates of poverty and the deteriorating state of public health and veterinary services all serve as drivers of emerging and re-emerging zoonotic diseases. (2) In food and agriculture systems, the number of livestock, the spatial concentration of livestock production, existence of mixed bio security regimes, growth in the export of animal products, inappropriate vaccination and exploitative farming systems are prominent factors. (3) In natural ecosystem that is the effects of human encroachment and adverse land use such as deforestation, poaching, and trade in live animals and bush meat carry considerable consequences in terms of habitat fragmentation, biodiversity loss and climate change (World Bank, 2010).

The main drivers behind the transmission of animal infections to people (known as 'spillovers') and the subsequent spread of the infection relate to where and how people live and the contact people have with animals, both wild and domestic. These drivers have intensified rapidly in recent decades as previously inaccessible natural habitat is converted into farm land or settlements and wild life is exploited for food. The likelihood of disease spillover is also increasing as climate change affects habitats, wild life populations and the distribution of the organisms that carry these viral diseases from one animal to another ('vectors'). In addition, the massive growth of human population in urban areas combined with the greater connectedness of cities around the world make a global pandemic resulting from a geographically remote spillover event a real possibility as seen recently (IDS, 2013).

Moreover, it should also be noted that the use of zoonotic agents for bioterrorism purposes by deliberately introducing an infectious agent into wild life has been raised as a concern. Agents Such as mosquito vectors and dengue, smallpox as well as viral hemorrhagic fever are used as potential weapon for bioterrorism and points to the need for dynamic assessment for this particular risk characteristic from a global health security stand point in concert with global public health approaches (Bossi *et al.,* 2004; Rigaudean *et al*., 2005).

2.3 Approaches for Prevention and Control of Viral Zoonoses

In the past years there has been a rise in outbreaks of viral zoonotic diseases worldwide. Preventing and controlling the spread of these diseases is crucial as it is virtually impossible to predict when and where the next outbreak will occur; a plan needs to be developed in order to act fast at the first sign of an outbreak (Chomel, 2013). To achieve effective prevention and control of such diseases, collaboration between public and animal health sectors is pivotal but need dedicated planning and well-exercised coordination of activities (Lake Miriam *et al*., 2017). Viral zoonotic diseases need quite different approaches to be prevented and controlled efficiently as a result measures to be taken in order to do so for some viral zoonotic diseases in Ethiopia is reviewed here under.

2.3.1 Rabies

Since dog is the main source of rabies in humans, principal method of dog rabies control is mass vaccination and has been successfully used to eliminate human dog-mediated rabies in countries like Malaysia, Philippines, Tunisia, Western Europe and North America among others. According to the World Health Organization (WHO) and the World Organization for Animal Health (OIE) recommendations, the critical percentage of dogs to be vaccinated to prevent rabies cases should be at least 70% (WHO and OIE, 2005). This target coverage has been supported by empirical evidence and theoretical observations worldwide investigating the relationship between vaccination coverage and reduction in rabies incidence. A study conducted in Tunisia indicated that 70% dog vaccination coverage through parenteral vaccination in most regions of the country resulted in the elimination of the disease (Jibat *et al*., 2015). However, empirical evidence indicated that even in regions with less than 70% immunization coverage, rabies has still been eliminated (Van der poel *et al*., 2006).

Different strategies were applied to eliminate rabies in different counties of the world. For instance in America, progressive elimination of rabies in wildlife has been a general strategy and the common campaign tactics are Trap Vaccinate Release (TVR), Point Infection Control (PIC), and Oral Rabies Vaccine (ORV) and these tactics have proven crucial to eliminate raccoon rabies in Canada and to maintain ORV zones for preventing the spread of raccoon rabies (Sterner *et al*., 2009).

In Europe, the elimination of rabies was demonstrated following oral vaccination of foxes in Western part where red foxes are the reservoir host (Reisner and Taheipour, 2007). The strategy has brought many changes and accomplishments in rabies prevention and control since the first International Conference on Rabies in Europe (Meslin and Briggs, 2013). Few countries in the Central and Eastern Europe are rabies free and several others are close to being rabies-free (Van der poel *et al*., 2006). In Germany, oral rabies vaccine of foxes using modified-live-virus vaccines offered a new method of rabies control in wildlife. Owing to oral rabies vaccination in foxes, the incidence of the disease drastically decreased during the past 16 years from 10,484 rabies cases in 1983 to 56 in 1999; the lowest number of rabies cases ever reported in Germany at the time (Müller *et al*., 2005).

In Japan, no rabies case has been reported for about 50 years since 1957. Japan has successfully eradicated human and animal rabies through registration, confinement and compulsory vaccination of family dogs and elimination of stray dogs. After eradication of rabies from the country, the last recorded case of imported rabies was seen in 2006 where two cases of human rabies were imported into Japan from the Philippines next to the one identified during 1970 when a college student died in Tokyo after a trip to Nepal where he had been bitten by a stray dog (Lembo *et al*., 2010).

In Ethiopia, People have clear understanding on the danger of the disease but believe to cure with different traditional and religious treatment rather than seeking for effective post exposure prophylaxis. Most people use a wide variety of traditional treatments in cases of bite by animals (mostly dogs) believed to be rabid. The significance of the disease is evident from the continued existence of traditional specialists in rabies treatment within the community (Knobel *et al*., 2005). This has significant impact on the effort of rabies prevention and control and need to work on awareness creation about the danger of the disease unless effective PEP was given following exposure. Strategies for the prevention of human rabies are aimed at protecting those at highest risk of exposure, post exposure treatment and supportive management for the clinically ill.

Moreover, in Ethiopia a number of obstacles prevent a coordinated approach to the global elimination of canine rabies; including a lack of awareness and education of the public health and veterinary sectors, the absence of diagnostic facilities, inadequate surveillance and reporting systems, limited access to modern vaccines and failures of responsible dog ownership (Zhang *et al*., 2011). But, still elimination of canine rabies from Africa including Ethiopia is epidemiologically and practically feasible, provided mass vaccination and enforcement of responsible dog ownership (Lembo *et al*., 2010). The lack of effective control of canine rabies in developing countries is often attributed to low prioritization, epidemiological and operational constraints and insufficient financial resources. From other countries experience view point, it is possible for Ethiopia to apply one of the strategies to prevent and control the disease by selecting the most feasible approach in a coordinated manner.

There was a program called a comprehensive (umbrella) approach for rabies prevention and control in Ethiopia which has been designed to ensure that the basic principles necessary to successfully control canine rabies could be enacted simultaneously in a coordinated manner and considered to be successful. Engaging animal and human public health sectors in the implementation of a comprehensive, multi-sectoral rabies prevention and control program has a greater and more rapid impact on humans than does using a stand-alone PEP program (Lembo *et al*., 2010). A comprehensive rabies prevention and control program should focus not only on the stockpiling of human rabies vaccine for PEP but also on dog population control, mass canine rabies vaccination, community education, laboratory diagnostic testing and establishment of joint animal–human rabies surveillance and response systems (Meslin and Briggs, 2013; Fooks *et al*., 2014). Applied in this way, it is possible to prevent and control the case with no doubt. This approach if applied properly at national level may result in effective prevention and control of this deadly disease in the country.

2.3.2 Avian influenza

Since there is no effective treatment to this disease both in animal and human, it is necessary to take appropriate measures to prevent the occurrence of the disease and to control if it happened in the country before it causes devastating impact to the public health and the economy of the country. Such measures include avoiding contact with sick or dying birds, or birds that have died of unknown causes. Mean while washing hands with soap and water after contact with any sick or dying birds, or with objects that may have been contaminated by the birds, such as soil, cages and eggs. Use of personal protective equipment like masks, gloves, etc. while handling suspected cases and culling or disposing of birds are some among many to prevent and control the spread of this fatal disease (WHO, 2014).

As community participation plays vital role in the prevention and control of zoonotic diseases in general and avian influenza in particular, it is important to aware the community so that they can report immediately to local veterinary authorities when they come across with birds or chickens that suddenly fall sick and start dying. It is also important to aware the community to allow poultry manure to decompose for several weeks particularly in the rural areas before applying it to fields in order to combat the spread of the disease. Moreover, strict care should be taken while importing poultry and poultry products in order to avoid introduction of the disease into the country. It is also important to ensure good sanitary practices in markets, especially live bird markets and establishing rapid information sharing mechanisms between animal and/or agricultural sectors and human health authorities (Heyman, 2008: WHO, 2013).

2.3.3 Rift valley fever

There is an integrated strategy for the prevention and control of rift valley fever outbreaks which involves an active collaboration between sectors, disciplines and partners facilitated by the development of a strategic framework. This strategic framework was based on the one developed by WHO for the management of severe diseases such as Ebola and Marburg and this has been adjusted for RVF. Despite the recognized diversity of epidemiological patterns of the disease, the development of an outbreak follows schematically the same chronology of events. Following unusually heavy rains and/or flooding; the activity of the virus increases, with the abundance of competent mosquito populations feeding mainly on animals. The first phase of the outbreak therefore affects livestock or wild ruminants. It may not be easily detected when in remote areas and in the past, humans have often played the role of sentinels (Fomenty *et al*., 2012).

Period 1– Before: Forecasting and preparedness: Risk factors include unusually heavy rains in areas known to be favorable for RVF. The risk is higher if the last circulation of the virus was several years or more before and the animal population is immunologically naive, as natural infection (or vaccination with a live modified vaccine) provides life-long protective immune response. When risk factors are increasing, action should be oriented to (FAO, 2002):

- Monitoring risk factors, to assess the probability and potential timing of emergence;
- Monitoring the populations of vectors;
- Assessing the opportunity for mass livestock vaccination.

Rift Valley fever outbreaks in East Africa have been associated with the warm phases of the El Niño/Southern Oscillation, which usually result in very heavy rainfall after a few weeks of drought. On several occasions, a system based on remote sensing data, developed by NASA's Goddard Space Flight Center, succeeded in identifying conditions of RVF emergence in different parts of Africa. By analyzing rainfall and anomalies in the activity of the vegetation, this system makes it possible to predict epizootics between two and five months in advance, enabling the dissemination of warning messages (FAO, 2006). When the risk of RVF emergence is confirmed, authorities should focus on the early detection of the virus circulation in livestock and preparedness measures to limit its extension, protect people at risk and manage the human cases.

Period 1 can start as early as four months before the RVF outbreak begins in animals and it stops when the first suspected cases are reported in animals. The timing of animal vaccination should be carefully considered, as mass animal vaccination campaigns may intensify the dissemination of the virus in certain circumstances, e.g. the use of multi-dose vials and the re-use of needles will increase virus spread if some animals in the herd are already infected and viraemic (Rocque and Fornenty, 2014).

Period 2- Alert: If the surveillance system reported RVF-suspected cases in animals or humans, a multidisciplinary team must be sent to the site immediately equipped with the necessary personal protective equipment to investigate the rumor, evaluate the risk of an outbreak, collect specimens and send them to a national or international reference laboratory and begin initial control measures pending the laboratory results. Collaboration and coordination between public health and animal health sectors is critical during this period to ensure rapid confirmation of the RVF outbreak and to assess local resources and requirements (Rocque and Fornenty, 2014).

Period 3– During: Outbreak Control: As soon as the circulation of the virus is confirmed in animals and/or humans, the control strategy should be urgently implemented, respecting the key principles below (Rocque and Formenty, 2014):

- Trans-sectoral coordination of prevention and control activities and resource mobilization;
- Enhanced surveillance systems for human and animal case detection;
- Control of animal movements;
- Promotion of a social & behavioral intervention program aimed at informing the public and promoting the adoption of practices reducing community transmission;
- Clinical management of RVF cases in the affected areas in health care units and hospitals.

Period 4– After: Post-epidemic phase: Once the epidemic is over, surveillance activities of the pre-epidemic phase should be resumed, as sporadic cases may still be reported. The authorities should conduct an evaluation of the outbreak management and produce an end-of-epidemic report proposing improvements on the basis of lessons learned. Experience and data should be shared with the international community to improve preparedness and facilitate additional research on the disease. Finally, proper assessment of social, economic and public health impacts should be conducted (Rocque and Fornenty, 2014).

Based on the experience gathered during the 2006 to 2007 outbreak of RVF in the Horn of Africa, the International Livestock Research Institute and FAO developed chronologically organized guidelines for decision-making in the animal sector (ILRI and FAO, 2009). The sequence of actions described in these guidelines is more or less similar to the framework developed jointly by WHO and FAO during several outbreak responses between 2006 and 2012 in various countries (including countries in other parts of Africa). It covers both the veterinary sector and the human health sector and describes the action they can take, either separately or in conjunction with each other. So in situation when there will be RVF epidemic in Ethiopia, similar actions can be taken to contain the disease before it spreads and causes devastating impact to both humans and their livestock.

2.3.4 West Nile fever

The lack of a human vaccine for and prophylaxis or specific treatment of West Nile Fever, in combination with the presence of the Culex mosquito vector in large parts of the WHO European Region make it necessary to avoid exposure in risk areas as a key measures to prevent the disease. The only way to reduce infection in humans is to raise people's awareness of the risk factors and educate them about the measures they can take to reduce their exposure to the virus. Efforts to prevent transmission should focus first on individual and community protection against mosquito bites through the use of mosquito nets, insect repellent and light colored clothing (long-sleeved shirts and trousers) and by avoiding outdoor activity at peak biting times; many mosquitoes are most active at dusk and dawn. To reduce the risk of animal-to-human transmission, gloves and other protective clothing should be worn while handling sick animals or their tissues and during slaughtering and culling procedures (WHO, 2014).

The effective prevention of human WNV infection depends on the development of mosquito surveillance and control programs in areas where the virus occurs. Research should identify local mosquito species that play a role in WNV transmission, including those that might serve as a bridge from birds to humans. The emphasis should be on integrated control measures, including broad insecticide spraying and the destruction of mosquito breeding sites, with community participation. Health-care workers should be informed about the possibility of WNV infections during a likely epidemic period and about ways of detecting them. Workers providing health care to patients with suspected or confirmed WNV infection, or handling specimens from these patients or animals, should take standard infection-control precautions and work in suitably equipped laboratories (WHO, 2014).

2.3.5 Middle East Respiratory Syndrome (MERS-CoV)

It is not possible to give specific advice on prevention and/or control of infection with MERS-CoV as the source of infection and mode of transmission for the disease are not yet clear. However, it is advisable to apply basic hygienic measures that may include frequent hand washing with soap and clean water, avoiding contact with sick animals and food that may be contaminated with animal secretions unless they are properly washed, peeled, or cooked (WHO, 2014).

MERS-CoV infections that may be acquired in health-care facilities illustrate the need to continue to strengthen prevention and control measures. Health-care facilities that provide care for patients with suspected or confirmed MERS-CoV infection should take appropriate measures to decrease the risk of transmission of the virus to other patients, health-care workers and visitors. Education and training for infection prevention and control should be provided to all health-care workers and regularly refreshed. It is also advisable to aware the general community about the impacts of the disease so that it is possible to prevent or bring down the spread of the disease in a given locality (WHO, 2014).

2.3.6 Dengue fever

The effective control and prevention measure of this disease relies mainly on control of the vector for the disease. The approach depends mainly on prevention of mosquitoes from breeding, draining of water from window air coolers (when not in use), tanks, barrels, drums, buckets, *etc*., and all objects containing water be removed from the house or discarded. In case it is not possible to drain water that has been collected or to cover receptacles fully, use temephos (an insecticide) according to local guidelines to prevent larvae from developing into adults. Moreover, it is necessary to use mosquito repellents and mosquito coils and electric vapor mats during the daytime to prevent mosquito bites so that the disease can easily be prevented and brought under control (WHO, 2014).

2.3.7 Ebloa

Several concurrent strategies can be employed to prevent the spread of Ebola virus. Strict infection control measures and the proper use of personal protective equipment are essential to prevent transmission to health care workers. In addition, individuals who have been exposed to Ebola virus should be monitored so that they can be identified quickly if signs and symptoms develop. During the 2014 outbreak, kits were put together to help families treat Ebola disease in their homes, which include protective clothing as well as chlorine powder and other cleaning supplies. Education of those who provide care in these techniques and the provision of such barrier-separation supplies has been a priority of health professionals without borders. Ebola virus can be eliminated with heat (heating for 30 to 60 minutes at 60°C or boiling for 5 minutes). To disinfect surfaces, some lipid solvents such as some alcohol-based products, detergents, sodium-hypochlorite (bleach) or calcium hypochlorite (bleaching powder) and other suitable disinfectants may be used at appropriate concentrations (Peters, 1998; EPHI, 2014).

Bush meat, an important source of protein in the diet of some Africans, should be handled and prepared with appropriate protective clothing and thoroughly cooked before consumption. If a person with Ebola disease dies, direct contact with the body should be avoided. Certain burial rituals, which may have included making various direct contacts with a dead body, require reformulation such that they consistently maintain a proper protective barrier between the dead body and the laving (CDC, 2014).

Contact tracing is considerably important to contain an outbreak. If any of these contacts comes down with the disease, they should be isolated, tested and treated. Then the process is repeated by tracing the contacts' contacts (CDC, 2014).

Isolation and quarantine: Isolation refers to separating those who are sick from those who are not. Quarantine refers to separating those who may have been exposed to a disease until they either show signs of the disease or are no longer at risk (CDC, 2014; Lewis, 2014).

Environmental infection control: If a patient with suspected or confirmed Ebola virus disease is being cared for in a healthcare setting, specific precautions should be taken to reduce the potential risk of virus transmission through contact with contaminated surfaces. Asymptomatic persons who have had a possible exposure at any risk level should be monitored for signs and symptoms of Ebola virus disease. Monitoring should continue for 21 days after the last known exposure; the development of fever and/or other clinical manifestations suggestive of Ebola virus disease should be reported immediately (EPHI, 2014).

Breastfeeding and infant care: Ebola virus can be transmitted by close contact of infected mothers with their children. Thus, it is necessary for mothers with Ebola virus disease to avoid close contact with their infants and these infants should receive adequate care and nutrition in other ways (Kortepeter *et al*., 2011).

2.3.8 One health approach to prevent and control viral zoonoses

One Health is the collaborative effort of multiple disciplines working locally, nationally and globally to attain optimal health for people, animals and the environment. The concept of one health is a strategy with a long-overdue bias towards health promotion and disease prevention across the human, animal and environmental domains (AVMA, 2008). Events would bear out the arguments for greater collaboration between public and veterinary health sectors (World Bank, 2010).

The One Health idea is a paradigm shift in the way we think about human and animal health in the world. The agents of change giving rise to one health are a complex set of multi-factorial circumstances such as population growth, changes in nutritional, agricultural and trade practices, globalization, shifts in land use, accelerated urbanization, deforestation, encroachment on wild life and climate change. Population growth and globalization of economic networks have resulted in a rapidly changing, highly inter-connected world (UN, 2011).

One health has no set of laws: it has many concepts, which are formed by consensual agreement by all the relevant "actors". It concerns all human and animal diseases and all related ecologies. It is not owned by anyone: all are welcome to contribute if they can help the one health aims (Bousfield and Brown, 2011).

In a well functioning, effective system comprising a strong and coordinated human, animal and environmental health infrastructure, the emergence of and response to emerging infectious diseases such as viral zoonoses would be more likely to be prevented or contained early. Interventions to prevent viral zoonotic disease emergence in animal population would be implemented. Should prevention efforts fail, veterinary infrastructure would be sufficiently strong to detect emergence early. Risk communication would be instituted in such a way as to not cause panic, but to guide people on how to avoid exposure and when and where they should seek. Care when symptoms occur. Occupational surveillance systems would detect infections early in people at greatest risk of first exposure (example, people working closely with animals) to take appropriate and timely action to prevent and control the disease in question (Pappaioanou, 2010).

The opportunity to meet continuing challenges to health through the concept and implementation of new strategies is both exciting and troubling. One health has the potential to meet critical societal needs and demands. Veterinarians are well grounded in population health, comparative and preventive medicine. The profession has the potential to take a leading role in the efforts of one health approach. However, this is not the case and there is reluctance by our profession or by other health sciences to take this step and will without question, be a lost opportunity that will be picked up by any other group (AVMA, 2008).

To win the disease battles of the 21st century while ensuring the biological integrity of the earth for future generations requires interdisciplinary and cross-sectoral approaches to disease prevention, surveillance, monitoring, control and mitigation as well as to environmental conservation more broadly. "It is clear that no one discipline or sector of society has enough knowledge and resources to prevent the emergence or resurgence of zoonotic diseases in general and viral zoonoses in particular in today's globalized world. Only by breaking down the barriers among sectors, individuals, specialties and agencies can we unleash the innovation and expertise needed to meet the many serious challenges to the health of people, domestic animals, wildlife and to the integrity of ecosystems. We are now in the era of one world, one health and we must devise adaptive, forward-looking and multidisciplinary solutions to the challenges that undoubtedly lie ahead" due to the emergence and re-emergence of zoonotic diseases in general and viral zoonoses in particular (Bousfield and Brown, 2011).

2.3.9 General approach to prevent and control viral zoonoses

Effective prevention and control measures can be achieved through proper diagnosis and prophylactic aids to curtail further spread in most of zoonotic viral diseases. Improved sanitary conditions such as proper treatment and disposal of human waste, higher standards for public water supplies, improved personal hygiene procedures and sanitary food preparation are vital to strengthen the control measures. A clear understanding of epidemiology of the diseases with wildlife as reservoir namely the virulence and transmissibility of many zoonotic viral diseases could help in understanding the severity and thereby to take appropriate measures in eradication of such dead full diseases. Research should focus on molecular biology of these viruses so as to develop diagnostics and prophylactics in a modern way to combat these infections in short time (Venkatesan *et al*., 2010).

To safeguard the public from pathogens of zoonotic viral infections, application of skills, knowledge and resources of veterinary public health is essential. It is time to combat viral zoonoses with a combined effort of veterinary and public health specialists. A better understanding of avian migration patterns and their infectious diseases would be useful to forecast disease outbreaks due to emerging zoonotic infections like avian influenza. Further, the control measures for emerging and re-emerging viral pathogens are demanding, as there is population explosion. Novel, highly sensitive and specific techniques comprising genomics and proteomics along with conventional methods would be useful in the identification of emerging and re-emerging viruses, there by prophylactic and /or preventive measures would be applied on time (Venkatesan *et al*., 2010).

The first line of measure to control any disease is surveillance. Control and prevention strategies should be designed based on transmission pattern and characteristics of virus, involvement of vectors, environment and epidemiology of the disease. The European Union (EU) has established a net work termed as Med-Vet-Net to develop a network of excellence for the integration of medical, veterinary and food scientists in order to develop food safety measures and to improve research on the prevention and control of zoonoses including viral zoonoses. The network will also consider the concerns of consumers and other stakeholders throughout the food chain. Another system the Hazard Analysis and Critical Control Point (HACCP), which aims at analyzing hazards associated with food and identify preventive and control measures to check spread of food-borne diseases including viral pathogens will be considered. Similarly, sanitary and phytosanitary (SPS) measures, which are set out with WTO are to be strictly followed to have safe food in order to conserve the health of animal, human and plants due to zoonotic agents (Venkatesan *et al*., 2010).

3 Conclusion and recommendations

There is an increasing trend of zoonotic diseases emergence particularly of viral zoonoses in the last few decades and they have the potential to cause devastating effects internationally, with millions infected and billions spent. Some of the diseases have become pandemic, spreading from one continent to another causing massive morbidity, mortality and affecting global economies and livelihoods. Changes in the genetic makeup of pathogens especially of viruses due to genetic mutation or genetic re-assortment and their vectors appear to have expanded their geographic or host range as a result of global warming and other associated climatic changes. Other contributing factors may include habitat changes caused by humans; the complex interaction between environment/ecology, social and health care; spread of antimicrobial resistance; unhygienic living conditions; human demographics and behavior influences the emergence and re-emergence of viral zoonotic diseases. Emerging and re-emerging viral zoonotic diseases if occurred in developing countries like Ethiopia would result in a more devastating effect both on public and animals due to lack of awareness, poor infrastructure and resource, poor information exchange and communication and other complicated factors that make conditions more and more difficult when compared to developed world.

Therefore, based on the above facts, the following recommendations are forwarded:

- Since viral zoonotic diseases can infect both humans and animal, medical and veterinary communities should work jointly in clinical, epidemiological, public health and research settings so as to strengthen the collaboration between them implementing one health concept;
- In Ethiopia a lot of work should be done to change the attitude of the community towards the preventive measures to be taken for the deadly disease namely rabies;
- Strong active and passive surveillance system should be established so that emerging and re-emerging viral zoonotic diseases can be identified before they cause serious impact on the public and economy of the country;
- As movement of humans from one continent to the other is increasing at an alarming rate, those individuals from risky countries entering in to Ethiopia should be controlled up on their entry;
- Continuous awareness creations and educations focusing on the integrative approach for disease prevention and control should be given for responsible bodies in animal, human, and environmental health sectors;
- Early warning and emergency preparedness plan at national level should be set both in public and animal health aspects;
- Contact rates between domestic animal and wildlife should be minimized as much as possible;
- Due emphasis should be given to those factors that contribute directly and/or indirectly to the emergence and re-emergence of viral zoonotic diseases in developing countries such as Ethiopia where there is resource limitation.

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