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Growing threat of viral haemorrhagic fevers in the Eastern Mediterranean Region: a call for action

The emergence of viral haemorrhagic fevers is a growing concern worldwide and in the Region, with social and environmental factors contributing to their wide spread in some countries. This paper discusses the factors contributing to the rising burden and the challenges facing early detection, laboratory confirmation and rapid response to outbreaks and proposes strategic directions for prevention and control.

The Regional Committee is invited to discuss regional and national action to prevent and control the spread of viral haemorrhagic fevers.

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Executive summary

Viral haemorrhagic fevers (VHF) are among the important public health emergencies of international concern as defined by the International Health Regulations (2005). They are characterized by sudden onset, muscle and joint pain, fever, bleeding and shock from loss of blood. In severe cases, a prominent symptom is bleeding, or haemorrhaging, from orifices and internal organs. Since VHF share symptoms with many other diseases, positive identification of the disease relies on laboratory evidence of the viruses in the bloodstream, such as detection of antigens and antibodies or isolation of the virus from the body. The most important VHF in the Eastern Mediterranean Region are yellow fever, Rift Valley fever, dengue haemorrhagic fever, Crimean–Congo haemorrhagic fever and Ebola haemorrhagic fever.

The emergence and re-emergence of VHF is a growing concern worldwide. They are associated with occurrence of major epidemics with high case-fatality rates. Lack of timely laboratory diagnosis and functional epidemiological surveillance, inadequate infection control practices at health care facilities and weak vector control programmes could result in prolonged outbreaks of VHF. In the past two decades, the Region has witnessed several major outbreaks of different VHF. To date VHF have been reported from more than 12 countries in the Region. Most VHF occur in remote areas with limited or non-existent medical services.

The Regional Office has identified strategic directions to prevent and control the spread of viral haemorrhagic fevers in the Region. These include establishing high-level national intersectoral committees for VHF, strengthening epidemiological and laboratory surveillance capacities and initiating or strengthening implementation of adequate infection control practices in health care settings through development of an institutional safety climate and strong training programmes on infection control. As well, countries need to strengthen national vector control programmes as a key strategy in the framework of integrated vector management for VHF. Other strategic directions are social mobilization, which must be an integral component of containment of VHF; vaccination against yellow fever; development of guidelines for management of VHF; capacity-building for health care workers; and promotion of operational research in the field of VHF.

1. Introduction

Viral haemorrhagic fevers (VHF), ICD-10 (A96-A99), a potentially fatal group of emerging diseases, are among the important public health emergencies of international concern as defined by the International Health Regulations (IHR) 2005. They are characterized by sudden onset, muscle and joint pain, fever, bleeding and shock from loss of blood. In severe cases, a prominent symptom is bleeding, or haemorrhaging, from orifices and internal organs. Since VHF share symptoms with many other diseases, positive identification of the disease relies on laboratory evidence of the viruses in the bloodstream, such as detection of antigens and antibodies or isolation of the virus from the body.

Several distinct families of viruses cause VHF: *Arenavirus*, *Filoviridae*, *Bunyaviridae* and *Flavivirus*. There are 14 distinct viruses associated with haemorrhagic fever in humans. Some of these viruses cause relatively mild illnesses, while others can cause severe, life-threatening disease. Most VHF are zoonoses with animal reservoirs; the only exception is the four dengue viruses, which may circulate continually among humans. Viruses are transmitted from a reservoir population to humans by vectors, thus, VHF can be classified according to primary mode of transmission. The causative viruses can be transmitted to humans by mosquitoes, ticks or rodents, but in the case of the African haemorrhagic fevers, Ebola and Marburg, the animal carrier is unknown. Examples of other VHF include Lassa fever, Bolivian haemorrhagic fever and Korean haemorrhagic fever.

Although haemorrhagic fevers are regarded as emerging diseases, they have probably existed for many years. This designation is not meant to imply that they are newly developing, but rather that human exposure to the causative viruses has been increasing to the point of concern.

Outbreaks of VHF have been reported from many countries in the Eastern Mediterranean Region, with social and environmental factors contributing to their wide spread in some countries. Health authorities in Member States need to initiate some activities that could lead to early detection, verification of and timely response to these outbreaks and thus greatly reduce their morbidity and mortality. At its Fiftieth Session, the Regional Committee for the Eastern Mediterranean, in resolution EM/RC50/R.11 Main challenges in the control of zoonotic diseases in the Eastern Mediterranean Region, requested Member States to ensure the establishment of empowered national intersectoral committees charged with responsibility for coordinating and advising on surveillance and control of zoonoses including VHF.

The objective of this paper is to draw the attention of the Regional Committee to the growing serious threat to human health associated with VHF in the Region and to the need for regional and national strategies and actions to prevent and control their spread. The paper describes the magnitude of VHF in the Region and highlights the public health importance in terms of morbidity and mortality as well as economic and social implication. The paper discusses the factors contributing to the rising burden of the different types of VHF and the challenges facing early detection, laboratory confirmation and rapid response to outbreaks of VHF and proposes strategic directions for prevention and control.

2. Overview

2.1 Global distribution of major virus families causing VHF

Filoviruses include Ebola, which is endemic to Africa, particularly the Republic of the Congo and Sudan. No cases of VHF due to Arenaviruses have been reported in the Eastern Mediterranean Region. The *Flaviviridae* family includes the viruses that cause yellow and dengue fevers. Yellow fever occurs in tropical areas of the Americas and Africa and is transmitted from monkeys to humans by mosquitoes. In urban settings, the virus is transmitted among humans by mosquitoes. Dengue virus causes either the mild dengue fever or the more serious dengue haemorrhagic fever–dengue shock syndrome (DHF–DSS). Dengue haemorrhagic fever affects most Asian countries and has become a leading cause of hospitalization and death among children in several of them.

The *Bunyaviridae* family includes several hundred viruses but only a few are responsible for haemorrhagic fevers in humans. They include Rift Valley fever which is endemic in Africa and recently emerged in the Middle East. Rift Valley fever occurs naturally in sheep, goats, cattle, camels and buffaloes; mosquitoes are the principal mode of virus transmission between animals, and man is infected

during contact with infected animals. Crimean–Congo haemorrhagic fever is caused by *Nairovirus*. It is endemic in many countries in Africa, Europe and Asia; sporadic cases or outbreaks have been recorded in Albania, Kosovo, Islamic Republic of Iran, Pakistan and South Africa. The virus is found in hares, birds, ticks and domestic animals and may be transmitted by ticks or by contact with infected animals.

Other haemorrhagic viruses can cause haemorrhagic fever with renal syndrome, such as the hantaviruses *Hantaan*, *Seoul*, *Puumala* and *Dobrava*. Hantavirus occurs in many different parts of the world and is spread to humans from field rodents via microscopic bits of their excretions that get into the air and are inhaled. It was originally known as a disease of Asia and Europe that primarily attacked the kidneys, but a more deadly pulmonary form of hantavirus infection has more recently caused numerous fatalities in the United States, Chile and other countries. With exception of a novel virus known as *Khumra* virus, detected in Saudi Arabia, no cases of VHF caused by this group have been reported in the Eastern Mediterranean Region. Table 1 summarizes some of the epidemiological features of viral haemorrhagic fevers.

Table 1. Selected epidemiological features of viral haemorrhagic fevers

Virus	Disease	Eastern Mediterranean Region	Vector/reservoir	Incubation period (days)	Case-fatality rate (%)
Arenaviridae					
Junin, Machupo, Guanarito and Sabia	South American haemorrhagic fevers (Argentine haemorrhagic fever, Bolivian haemorrhagic fever, and Venezuelan haemorrhagic fever)	No	Rodents	7–14	15–30
Lassa	Lassa fever	No	Rodents	5–16	2–15
Bunyaviridae					
Rift Valley fever	Rift Valley fever	Yes	Unknown (Culex/*Aedes aegypti* suspected)	2–5	~ 50
Crimean–Congo haemorrhagic fever	Crimean–Congo haemorrhagic fever	Yes	*Hyalomma* ticks	20–100	15–30
Hantaan, *Seoul*, *Puumala* and others	Haemorrhagic fevers with renal syndrome	Unknown	Rodents	3–12; 9–35	5–15
Sin Nombre, Bayou, Andes, Laguna, Negra and others	Hantavirus pulmonary syndrome	No	Unknown (rodents suspected)	7–28	40–50
Filoviridae					
Marburg or Ebola	Marburg haemorrhagic fevers or Ebola haemorrhagic fevers	Yes	Unknown	3–16	25–90
Flaviridae					
Yellow fever	Yellow fever	Yes	*Aedes aegypti*	3–6	20–50
Dengue (types 1–4)	Dengue haemorrhagic fevers (DHF), Dengue shock syndrome (DSS)	Yes	*Aedes aegypti*	3–15	10–15
Kyasnur Forest disease	Kyasnur Forest disease	No	Ticks	3–8	0.5–9
Omsk haemorrhagic fever	Omsk haemorrhagic fevers	No	Ticks, voles, muskrats, waterborne or mosquito	3–8	0.5–9

2.2 Transmission of haemorrhagic fever viruses

Viruses causing haemorrhagic fever are initially transmitted to humans when the activities of infected reservoir hosts or vectors and humans overlap. The viruses associated with arthropod vectors are spread most often when the vector mosquito or tick bites a human, or when a human crushes a tick. However, some of these vectors may spread virus to animals, livestock, for example. Humans then become infected when they care for or slaughter the animals. The viruses carried in rodent reservoirs are transmitted when humans have contact with urine, fecal matter, saliva, or other body excretions from infected rodents.

Some viruses that cause haemorrhagic fever can spread from one person to another, once an initial person has become infected. Ebola, Marburg, Lassa and Crimean–Congo haemorrhagic fever viruses are examples. This type of secondary transmission of the virus can occur directly, through close contact with infected people or their body fluids. It can also occur indirectly, through contact with objects contaminated with infected body fluids. For example, contaminated syringes and needles have played an important role in spreading infection in outbreaks of Ebola haemorrhagic fever and Lassa fever.

2.3 Treatment

There is usually no specific treatment to combat the viruses that cause haemorrhagic fevers. An exception is the drug ribavirin, which has been effective in treating Lassa fever. Treatment generally consists of such supportive measures as the replacement of lost blood, the maintenance of fluid balance and the alleviation of symptoms. Survival depends largely upon the virulence of the virus strain and the quality of treatment.

2.4 Prognosis

Recovery from some VHF is more certain than from others. The *filoviruses* are among the most lethal; fatality rates for Ebola range from 25% to 90%, while DHF–DSS cases result in a 10%–15% fatality rate. Whether a case occurs during an epidemic or as an isolated case has a bearing on the outcome as well. For example, isolated cases of yellow fever have a 5% mortality rate, but 20%–50% of epidemic cases may be fatal.

Permanent disability can occur with some types of haemorrhagic fever. About 10% of severely ill Rift Valley fever victims suffer retina damage and may be permanently blind, and 25% of South American haemorrhagic fever victims suffer potentially permanent deafness.

In cases of DHF–DSS, fatality can be reduced to less than 2% with adequate medical care. For individuals who survive haemorrhagic fevers, prolonged convalescence is usually inevitable. However, survivors seem to gain lifelong immunity against the virus that made them ill.

2.5 Prevention

Haemorrhagic fevers can be prevented through vector control and personal protection measures. Attempts have been made in urban and settled areas to destroy mosquito and rodent populations. In areas where such measures are impossible, individuals can use insect repellents, mosquito netting, and other methods to minimize exposure. Vaccines have been developed against yellow fever, Argentinean haemorrhagic fever and Crimean–Congo haemorrhagic fever. Vaccines against other haemorrhagic fevers are being researched.

3. Viral haemorrhagic fevers in the Eastern Mediterranean Region

3.1 Outbreaks

In the past two decades, the Eastern Mediterranean Region has witnessed a number of outbreaks of VHF, including outbreaks of Rift Valley fever, Crimean–Congo haemorrhagic fever, dengue haemorrhagic fever, Ebola haemorrhagic fever and yellow fever.

Rift Valley fever

Rift Valley fever is one of the most important emerging diseases in the Eastern Mediterranean Region. Since its discovery, Rift Valley fever has been endemic in many countries of sub-Saharan Africa, with

recurrent epizootics and epidemics. The potential of the Rift Valley fever virus to establish transmission and cause disease in new areas was first documented in Egypt in 1977 when there was an epidemic of some 18 000 human cases, resulting in 600 deaths and heavy economic loss. The largest epidemic ever reported affected Somalia and was part of a wider epidemic in East Africa in 1997–1998. In the outbreak of 1998 that occurred in Somalia and northern Kenya, livestock losses were considerable in the affected regions. There were an estimated 89 000 human cases in north-eastern Kenya and southern Somalia with 200–250 human deaths. Preliminary estimates of infections and deaths among animals and humans suggest this may be the largest such outbreak ever reported. The outbreak that affected Saudi Arabia and Yemen in 2000 was the first documented evidence of Rift Valley fever virus transmission outside Africa [1,2]. Saudi Arabia reported 882 human cases and 124 deaths. In Yemen, 1328 cases and 166 deaths were reported [3,4]. Recurrence of outbreaks is now documented in Egypt and the Arabian Peninsula. There were reported outbreaks in Egypt in 1993 and 2003.

Crimean–Congo haemorrhagic fever

Crimean–Congo haemorrhagic fever has been endemic in the Islamic Republic of Iran, Iraq and Pakistan since the 1970s with sporadic cases and localized outbreaks reported every year. It was first identified in Afghanistan in 1998, since when several outbreaks have been reported. Crimean–Congo haemorrhagic fever outbreaks have also been reported in other countries of the Region including the United Arab Emirates (1979 and 1994–1996) [5–8], Bahrain, Kuwait (1983) [9], Oman (1995) [10], Pakistan (1976–2003) [11–19], Islamic Republic of Iran (2000 and 2002) [20,21], Afghanistan (2000, 2006) [22], Iraq (1981) [23] and Saudi Arabia (1989–1990) [24]. Serological evidence of Crimean–Congo haemorrhagic fever has also been identified in Sudan.

Dengue haemorrhagic fever (DHF)

Outbreaks of dengue fever have been documented in several countries, including Djibouti, Pakistan, Saudi Arabia (1994–2006), Somalia, Sudan and Yemen (2000–2006). Dengue fever and dengue haemorrhagic fever constitute a frequent public health problem in some areas of Saudi Arabia, particularly Jeddah. Somalia witnessed the Region's first confirmed outbreak of dengue in 1982 and a number of confirmed outbreaks have occurred since. There was an epidemic in Djibouti in 1991–1992 with more than 12 000 cases reported. In Pakistan, geographically adjacent to the endemic area of Asia, epidemics were reported in Baluchistan and Karachi in 1994–1995 with high case fatality rates resulting from dengue haemorrhagic fever and dengue shock syndrome. A large epidemic of dengue/dengue haemorrhagic fever affected Sudan during 2005–2006. Another epidemic occurred in 2006 in the same area of Karachi, Pakistan. The *Aedes* mosquito is present in several countries of the Region, so the possibility of emergence or re-emergence of dengue/dengue haemorrhagic fevers in these countries cannot be ruled out.

Ebola haemorrhagic fever

Ebola virus infections were first recognized in 1976, in West Equatoria, southern Sudan [25]. Another, smaller, outbreak affected the same area in 1979. After a long period of latency, Ebola haemorrhagic fever emerged again in southern Sudan in 2003–2004 [26].

Yellow fever

After several decades of disappearance, two outbreaks of yellow fever have affected Sudan during the past 4 years (2003 and 2005).

Other viral haemorrhagic fevers

In Saudi Arabia a novel virus has been reported known as *Khumra* virus.

3.2 Public health challenges

The frequent outbreaks of viral haemorrhagic fevers in the Region raise a number of issues of importance for development of a regional strategy for prevention and management of outbreaks. These include the need for strong, long-term human, animal and vector surveillance, protocols for monitoring animal infection and immunization, and a long-term strategy for preparedness, prevention and control of

outbreaks. Problems include weak capacity of public health laboratories, particularly their inability to confirm VHF requiring a bio-safety level 3 or 4 laboratory, in addition to the problem of securing the necessary reagents and trained laboratory staff. Intersectoral and cross-border collaboration, coordination of activities and the limited availability of trained human resources in the area of surveillance and response are also important issues.

In 2000, Saudi Arabia opened the world's biggest slaughterhouse, where 10 000 workers slaughter 200 000 animals a day during the pilgrimage season in keeping with Islamic tradition. As sheep are imported from different countries, there is need for continuous active surveillance for early detection of VHF among workers.

Transmission within health care settings has been noted for a number of haemorrhagic fever viruses, including Ebola, Marburg, Lassa, Machupo, and Crimean–Congo viruses. Nosocomial and household transmission most often has been associated with contact with infected blood or body fluids. In some instances, transmission has resulted from reuse of needles or needlestick injuries. In one situation, investigators postulated that a health care worker became infected with Ebola virus after touching her eyes with a contaminated glove. Person-to-person airborne transmission of Ebola, Marburg, Lassa, Machupo and Crimean–Congo viruses appears to be rare; one patient with Lassa fever who had extensive pulmonary involvement may have transmitted the virus by this route. Airborne transmission of Machupo virus presumably occurred in one situation where a nursing student became infected after watching an instructor change the bed linens of an infected patient; the student had no direct or close contact with the patient or with any associated fomites. Although person-to-person airborne transmission appears unlikely, the potential for airborne transmission of haemorrhagic fever viruses in the health care setting cannot be excluded. Contact with cadavers has been shown to be a source of exposure during outbreaks of Ebola haemorrhagic fever.

There are remarkable disparities between countries of the Region with regard to availability of human capacities, compounded by high and rapid turnover of trained staff, and insufficient allocation of funds at the national level to run surveillance activities. There is serious need to share experience between countries and make use of other global and regional resources through networking, publishing field experiences in bulletins and periodicals and holding scientific meetings. Involvement of the private sector has surfaced as a big challenge in many countries.

Some countries have established early warning and response networks such as Pakistan, Somalia and Sudan. These systems have proved to be very successful in improving disease surveillance in geographical areas which are difficult to reach, conflict zones or among displaced populations, areas with weak infrastructure, and in cross-border or other hard-to-reach areas.

Although major outbreaks of viral haemorrhagic fevers have tended to occur in certain countries, no country is immune. Imported cases have been reported in many countries. Timely and appropriate national, regional or global response and containment of outbreaks of viral haemorrhagic fevers may not be as successful as desired for many reasons. The following are required.

- National preparedness plans for early detection and response to viral haemorrhagic fever. Countries that have experienced outbreaks have not always fully documented the lessons learnt from the outbreaks. These experiences have often been lost because of the high turnover of the staff that dealt with the outbreaks.
- Timely, effective and well targeted activities to increase the level of public awareness through appropriate outbreak communication and associated social mobilization efforts.
- Opportunities to ensure adequate training on infection control.
- Coordinated intersectoral collaboration in surveillance and response activities for zoonotic diseases, and strengthening ties between different disciplines and sectors.
- Adequate laboratory capacities (biosafety level 3 and 4) to ensure early and accurate diagnosis of viruses responsible for outbreaks of viral haemorrhagic fevers. Recent emerging outbreaks of avian

influenza and the threat of pandemic human influenza have improved the laboratory capacities for viral diseases.

- Adequate transparency in reporting outbreaks.
- Training in outbreak investigation and management.
- Strategies to ensure vaccination against yellow fever in countries where there are favourable conditions for emergence of outbreaks.
- Research in the field of viral haemorrhagic fevers in the Region.

Transparency in reporting is an important issue. Factors that could contribute to inadequate transparency on the part of Member States may include one or more of the following: delayed diagnosis, a relatively weak epidemiological surveillance system, insufficient human capacity capable of analysing data for evidence-based decision-making and poor communication with the Ministry of Agriculture, among other partners. Concerns over negative economic repercussions of reporting persist in some countries. Some Member States believe that only laboratory-confirmed cases should be reported.

The International Health Regulations (IHR) 2005, a legally binding agreement in the fight against public health emergencies of international concern, have a significantly broader scope of application compared to the IHR (1969), which were limited to the notification and response to cases of cholera, plague and yellow fever only. Under the IHR (2005), States Parties must notify WHO of all events that may constitute a public health emergency of international concern in accordance with the decision instrument in annex 2 of the Regulations. States are also obliged to report evidence of public health risks outside their territory that may cause international disease spread. Notifications and reports are communicated to WHO through the National IHR Focal Point.

WHO will coordinate the provision of international technical assistance at the request of States Parties, in support of activities such as investigating, controlling or containing public health risks and emergencies. Through the Global Outbreak Alert and Response Network, the affected Member State will have access to over 120 network partners who can provide highly qualified staff and technical supplies.

When requested, WHO will work closely and confidentially with the affected Member State on verification of a public health event and the subsequent assessment of the international risk and any public health measures to be implemented. The IHR 2005 came into force on 15 June 2007. The mandate given to Member States and WHO under the IHR 2005 has increased their respective roles and responsibilities. Following their entry into force, States Parties have an initial two-year period to assess the ability of existing national structures and resources to meet the core surveillance and response capacities requirements set out in the Regulations and to develop plans of action to ensure that these core capacities are functioning. This initial period will be followed by an additional three-year period to implement these plans of action with a view to bolstering national public health capacities. Should these five years not suffice, the IHR 2005 provide for two possible extensions of two years each until June 2016. An immense task lies ahead as States Parties develop plans to ensure that IHR 2005 implementation significantly contributes to a higher level of international health security.

3.3 Socioeconomic impact

There are no studies that document the socioeconomic impact of viral haemorrhagic fever in the Region. However, a study in Thailand assessed the disability-adjusted life years (DALYs) lost for fatal and non-fatal cases of dengue haemorrhagic fever, using data for symptomatic laboratory-confirmed dengue virus infection among the families of hospitalized patients. The financial losses and the estimated DALYs per million population indicated that dengue prevention, control and research should be considered as important as that of diseases currently given priority on the public health agenda. Tourism and animal trade were similarly affected in countries that have had outbreaks of Ebola viral haemorrhagic fever. International trade was severely affected by outbreaks of Rift Valley fever; especially in countries where animal resources constitute a significant source of national income, such as Somalia. A ban was imposed by several countries on livestock imports from Somalia, where livestock trade constitutes the main source of income for the country.

3.4 Regional response

A number of lessons have been learnt from past outbreaks of viral haemorrhagic fever in the Region. Outbreaks of viral haemorrhagic fever have highlighted the need for advanced laboratories in some countries and have provided entry points for strengthening capacity for surveillance and response. Partnership between ministries of health, agriculture, WHO, the Centers for Disease Control and Prevention (CDC, Atlanta) and others has improved the mechanisms for alerting, reporting and response in the event of suspected outbreaks, and saved time, money and lives. Expanding partnership beyond health agencies has improved reporting and geographical coverage, especially in countries with civil unrest where nongovernmental organizations have played an important role in detecting and responding to emerging outbreaks of viral haemorrhagic fever. There has been some success in countries in using limited resources to build an integrated disease surveillance system that can detect early outbreaks of viral haemorrhagic fever.

The Regional Office for the Eastern Mediterranean has held several regional meetings, and is currently building up regional response teams, and encouraging development of preparedness plans and stockpiles, conduct of serosurveys, strengthening of the network for laboratories, and translation of educational material. The Regional Office has supported a number of research activities on viral haemorrhagic fever through its small research grant schemes.

4. Strategic directions for prevention and control of viral haemorrhagic fevers in the Region

The Regional Office will support the following strategic directions for prevention and control of viral haemorrhagic fevers in the Region.

1. High level national intersectoral surveillance and response committee. A high level intersectoral technical committee for viral haemorrhagic fevers should be established to ensure:

- development of national preparedness plans for early detection of and timely response to outbreaks of viral haemorrhagic fevers;
- acceleration of implementation of the International Health Regulations (2005);
- timely sharing of epidemiological and laboratory information related to viral haemorrhagic fevers;
- identification of appropriate means of communication between the central and peripheral levels especially in countries with decentralized systems; and
- ensuring that sentinel early warning and response systems are equipped with the necessary communication equipment and appropriate transport in order to detect and rapidly investigate and respond to viral haemorrhagic fevers.

2. Epidemiological surveillance. Countries need to be able to predict occurrence of viral haemorrhagic fevers through utilization of advanced technology, close collaboration with veterinarians, appropriate entomological surveillance and cross-border sharing of information.

3. Laboratory capacity. There is need to strengthen the capacity of laboratories in the Region through:

- strengthening the national capacity for timely diagnosis of VHF, especially in countries where outbreaks of viral haemorrhagic fevers have occurred;
- establishing a regional network of laboratories for VHF to ensure timely laboratory diagnosis and sharing of information among those who need to know;
- building human capacity in addition to transfer of technology;
- establishment of central quality control programmes and accreditation procedures in network laboratories; and
- establishing special community-based laboratory surveillance programmes for at-risk population groups.

4. Infection control activities. Adequate infection control practices in health settings should be initiated, strengthened and/or promoted through development of an institutional safety climate, strong training programmes on infection control, with special emphasis on hand hygiene, as well as provision of uninterrupted supplies of personal protective equipment.

5. Vector control activities. National vector control programmes need to be strengthened within the framework of integrated vector management (IVM) for viral haemorrhagic fevers through:

- establishing short and long-term training;
- establishing and strengthening entomological surveillance using appropriate indices and correlation with meteorological data;
- establishing national standard operating procedures for procurement and use of insecticides;
- ensuring that metropolitan areas are free from *Aedes aegypti*, especially at points of entry and during major religious congregations;
- destroying mosquito and rodent populations in urban and settled areas, where such measures are impossible, individuals can use insect repellents, mosquito netting and other methods to minimize exposure.

6. Social mobilization. Social mobilization should be an integral component of containment of viral haemorrhagic fevers and may include:

- promotion of intersectoral collaboration and coordination to develop a strategic approach for planning and implementing social mobilization interventions related to control and prevention in household communities and health care settings;
- Research to identify high risk behaviour and practices that facilitate/amplify transmission and inform culturally appropriate behavioural interventions and messages;
- capacity-building to develop a cadre of strategic social mobilization planners;
- advocacy for resources to implement these strategic activities.

7. Vaccination against yellow fever. There is need to incorporate yellow fever vaccination in the routine EPI schedule in Sudan, supplemented with campaigns, and to ensure measures are in place in all Member States to avoid falsified certificates of yellow fever vaccine.

8. Management of diagnosed cases. Regional guidelines need to be developed for management of viral haemorrhagic fever cases.

9. Capacity-building. Training of health care workers is needed at all levels including district and primary health centres to ensure early detection and reporting of cases of viral haemorrhagic fevers, especially in geographical areas where cases of VHF have been reported or are likely to occur. Also, special advocacy and health educational materials need to be developed for high-risk groups: veterinarians, farmers, workers in slaughter houses and other groups at a higher risk. These materials should clearly describe the mode of transmission of VHF and emphasize behaviour that can prevent occurrence and spread.

10. Research activities. There is need to promote and strengthen research capacities in the field of emerging diseases, including viral haemorrhagic fevers. The Region has several centres of excellence in virology that could collaborate in research activities with other leading research centres in the world. This could lead to better understanding of the epidemiology and natural history of viral haemorrhagic fevers, potential risk factors, animal reservoirs, development of new rapid diagnostic tests for early diagnosis of viral haemorrhagic fevers that could be used in remote areas with low access to laboratory services, clinical trials of new drugs or treatment regimens, and vaccine development. There is need to assess the economic impact of viral haemorrhagic fevers and the impact of viral haemorrhagic fevers on development and evaluate public health measures instituted during outbreaks.

5. Recommendations to Member States

1. Develop national preparedness plans for early detection of and timely response to emerging outbreaks of viral haemorrhagic fevers that emphasize partnerships with veterinary and entomological services, timely sharing of information and institution of joint control activities.
2. Support establishment of a network of national and regional centres of excellence with competent epidemiological and laboratory capacities capable of confirming early diagnosis and characterization of causative strains of viral haemorrhagic fevers.

3. Promote formative research studies for risk assessment to identify high risk behaviour and practices that influence transmission of viral haemorrhagic fevers, animal reservoirs and their economic impact in order to inform culturally appropriate behavioural interventions and messages.
4. Initiate, strengthen and/or promote implementation of adequate infection control practices in health care settings.
5. Ensure that urban areas are free from *Aedes aegypti*, especially at points of entry and during major religious congregations.
6. Develop national strategies to ensure wide population coverage with yellow fever vaccination.

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