

# **Ocular manifestation of Rift Valley fever as observed in the 2006 epidemic in Kenya**

Principal Investigator: Dr. James Cheruiyo<sup>^</sup>Bett

*. i*

A dissertation submitted in partial fulfillment of the requirements for masters  
in medicine (Ophthalmology), Faculty of medicine, Department of  
Ophthalmology, University of Nairobi,

University of Nairobi



0442640 9

**UNIVERSITY of MAIFLOOI**

MfcDiLAL LiBKArtY

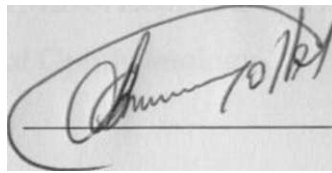
use IN t:SL

v O;LV

## DECLARATION

This research project is my original work, and has not been submitted for degree in any other University.

**Dr. James Cheruiyot Bett**

A handwritten signature in black ink, appearing to read "James 10/12/11", written over a horizontal line.

/\$111

Name

Signature

Date

## APPROVAL

This thesis has been submitted for examination with our approval as university supervisors.


Signed



Dr. Dunera Rahel Ilako.

MBChB, M.Med.(Ophth) Nbi, MBA-Health Durban , FEACO,  
Senior Lecturer, Department of Ophthalmology,  
University of Nairobi.

Signed



Dr. Jefitha Karimurio

MB ChB, M.Med. (Ophth) Nbi, M.Sc. (CEH) London, FEACO  
Senior Lecturer, Department, of Ophthalmology,  
University of Nairobi.

## DEDICATION

Dedicated to the joyful labours of my wife Anne Susan and my children.

To Dr. J.C Kibosia; and to the late Dr. G.W Griffin of Starehe Boys Centre.

## **ACKNOWLEDGEMENT**

This study would not have been without the support of many people or group of people. It is difficult to name all that participated at various stages of the study but the following deserve special mention.

I am greatly indebted to DOMU particularly Dr PM Nguku and Mr. HK Limo for invaluable assistance. The project would not have been possible had they not requested me to examine the eyes of RVF patients and provided the ground logistical support. Thank you and God bless you.

Many thanks go to the ministry health officers in Baringo district particularly Mr. Cherutich, the district disease surveillance officer, Mr C Naponi and Rahab Lekimencho. Mr. W K Tomno you were invaluable, thank you.

Christian Blind Mission (CBM) provided the financial sponsorship for the study. I am forever indebted to them for this.

My supervisors, Dr Dunera R. Ilako and Dr Jefitha Karimurio, deserve special mention for wise counsel and guidance at all stages of development and execution of the study.

## LIST OF ABBREVIATIONS

APMPPE	Acute Posterior Multifocal Placoid Pigmentary Epitheliopathy
ASAL	Arid and semiarid lands
CBM	Christoffel Blinden Mission
DMOH	District Medical Officer of Health
ELISA	Enzyme-Linked Immunosorbent Assay
GoK	Government of Kenya
IgG	Immunoglobulin G
IgM	Immunoglobulin M
KEMRI	Kenya Medical Research Institute
MOH	Ministry of health
RT-PCR	Reverse Transcriptase Polymerase Chain Reaction
RVF	Rift Valley Fever
SLE	Slit Lamp Examination
UON	University of Nairobi
VA	Visual Acuity
WHO	World Health Organization

## LIST OF TABLES

Table 1: Occupation and Sex distribution.....	22
Table 2: Mode of Exposure to RVF.....	22
Table 3: Ocular symptoms at time of data collection.....	28
Table 4: Corrected Visual Acuity.....	28
Table 5: Association between VA and Retinitis.....	36
Table 6: Association between VA and Macular oedema.....	36

## LIST OF FIGURES

Figure 1: Distribution of cases by divisions.....	20
Figure 2: Age and sex distribution.....	21
Figure 3: Type of Contact with Sick animals.....	24
Figure 4: Number of cases by date of onset of illness.....	25
Figure 5: Initial General Symptoms.....	26
Figure 6: Symptoms at examination time.....	27
Figure 7: State of the lens.....	29
Figure 8: State of the pupils.....	30
Figure 9: State of the vitreous.....	31
Figure 10: State of the macula.....	32
Figure 11: Presence of retinitis.....	33
Figure 12: State of the retinal vessels.....	34
Figure 13: State of the optic disc.....	35

## **ABSTRACT**

**Introduction:** Rift Valley fever (RVF) is a febrile viral zoonotic disease that affects ruminants primarily and humans as secondary host. It occurs in low rainfall plains after abnormally wet season and flooding which promotes mosquito breeding. Retinitis, macula oedema and transient non-granulomatous anterior uveitis are common ocular manifestation of the disease<sup>7- 9- 10-12- 18</sup>. This study aimed at finding the clinical picture during the 2006/2007 epidemic in Kenya.

**Objective:** To establish the prevalence and pattern of ocular findings in people with Rift Valley Fever during the Kenyan epidemic.

**Methodology:** All the forty seven (47) cases who tested positive to RVF virus by PCR or IgM antibodies in Baringo and Machakos districts were interviewed and ocular examination with a slit lamp done. A torch was used to assess pupillary reflexes. Binocular slit lamp funduscopy with 90 dioptre loupe and or binocular indirect funduscopy was then done with dilated pupil. The data was entered into and analyzed using the SPSS software package version 12.0.

**Results:** Of the forty seven cases seen 55.3% were males; majority of the males were herders (38.5%) and most females were domestic workers (57.1%). Initial symptoms were fever (91.5%), generalized weakness (91.5%), and headache (89.5%). Blurred vision was reported in 76.6% of the cases. The subjects gave history of mosquito bites (95.7%) and contact with animal tissues during cooking (53.2%), care of sick animals (80.9%), drinking unboiled milk (43.2%) and



delivering aborting animals (36.2%). Ocular signs attributable to RVF were mainly retinal and occurred in 43.1% of the subjects. Macula oedema (33.7%), retinitis (22.1%) and retinal vasculitis were the most significant macular and paramacular findings in the eyes. Vision was affected significantly by their presence.

**Conclusion:** There were retinal lesions in 43.1% of our cases that could be explained by RVF infection. The retinal lesions look similar to those seen in acute posterior multifocal placoid pigmentary epitheliopathy (APMPPE). The findings of this survey may justify the involvement of health workers in the initial response to the epidemic.

**Recommendations:** Eye workers need to be involved in early response to RVF epidemic, and long-term follow-up of cases that had ocular features of RVF to determine long-term sequelae and potential foveal involvement.

## TABLE OF CONTENTS

<b>DECLARATION</b> .....	»
<b>APPROVAL</b> .....	"i
<b>DEDICATION</b> .....	iv
<b>ACKNOWLEDGEMENT</b> .....	v
<b>LIST OF TABLES</b> .....	vii
<b>LIST OF FIGURES</b> .....	vii
<b>ABSTRACT</b>	
1.0 INTRODUCTION.....	1
2.0 LITERATURE REVIEW.....	3
2.1 Historical perspective.....	3
2.2 Nature of the disease.....	4
2.3 Ocular effects of Rift Valley Fever.....	10
3.0 JUSTIFICATION AND RATIONALE.....	13
4.0 OBJECTIVES.....	14
4.1 General Objective.....	14
4.2 Specific objectives.....	14
5.0 METHODOLOGY.....	15
5.1 Study design.....	15
5.2 Study period.....	15
5.3 Study area.....	15
5.4 Study Logistics.....	16
5.4 Case definition.....	16
5.5 Study population.....	16
5.6 Inclusion criteria.....	17
5.7 Exclusion criteria.....	17
5.8 Sample size.....	17
5.9 Data collection and analysis.....	17
5.10 Examination methods.....	17

5.11	Study limitations.....	18
5.12	Ethical considerations.....	18
6.0	RESULTS.....	19
7.0	DISCUSSION.....	37
7.1	Age and sex distribution.....	37
7.2	Geographical distribution.....	38
7.3	Occupation.....	38
7.4	Exposure to RVF.....	38
7.5	Symptoms.....	39
7.6	Ocular signs.....	39
8.0	CONCLUSSION.....	44
9.0	RECOMMENDATIONS.....	45
10.0	REFERENCES.....	46
	APPENDIX.....	49
	APPENDIX 1: WHO GRADING OF VISUAL ACUITY.....	49
	APPENDIX 2: WORLDWIDE DISTRIBUTION OF RVF EPIDEMICS.....	50
	APPENDIX 3: AEDES MOSQUITO.....	51
	APPENDIX 4: MAP OF BARINGO DISTRICT.....	52
	APPENDIX 4: MAP OF MACHAKOS DISTRICT.....	53
	APPENDIX 5: QUESTIONNAIRE.....	54
	APPENDIX 6: CONSENT FORM.....	58

## 1.0 INTRODUCTION

Rift valley fever is a febrile viral zoonotic that generates quite some interest every time it is reported in the various regions of the world. The epidemic is cyclical with intervals between one and the next being ten to twenty years<sup>1-2</sup>. Chances to study RVF are small and far apart because some epidemics pass without being identified while others are identified in the late phases. High index of suspicion should be present since the signs and symptoms of RVF are non-specific in both its human and ruminant forms'.

Recorded disease outbreaks were confined to the Rift Valley province of Kenya; wherefrom it got its name<sup>1-2-3</sup>. The first outbreak outside Kenya was in 1950 and 1951 in South Africa. The disease remained sub-Saharan with further epidemics in South Africa, Madagascar and animal epidemics in Zambia and Zimbabwe<sup>1</sup>. The first outbreak north of Sahara occurred in Egypt in 1977 following the completion of Aswan high dam on the Nile<sup>1-4</sup>. Further dam-related outbreaks occurred in Senegal and Mauritania; becoming the first West African epidemic in 1987<sup>1</sup>. The typical features of areas affected by RVF are dry flat lands that are susceptible to seasonal/ periodic flooding<sup>1-2-3,5,6,7</sup>.

The effects of RVF epidemics can be far reaching. Affected areas are places rich in livestock, which play the role of intermediate host. Livelihoods in these areas depend on animals, animal products and animal related trade and traditions. The repercussions of RVF are felt in distant countries due to restriction of import of animals and its products from affected regions, which could be thousands of kilometers away<sup>1-8-9</sup>.

The 2006-2007 outbreak in Kenya cost millions of shillings to pastoralists, traders, government and development partners. The losses occurred due to banning of livestock movement out of affected areas, prohibition of slaughtering of animals and freezing of harvesting of animal products. There was loss of animals through deaths and abortions related to RVF<sup>9</sup>.

Fear and misinformation in the non-affected areas also eliminated animal products from the dining table and business premises. Diversions of attention from other spheres of preventive and curative health left the programmes vulnerable long after RVF epidemic was gone<sup>9</sup>.

Human losses do occur due to RVF. Sometimes it includes highly trained professionals forming part of the outbreak response like veterinary officers; and many people are left with long-term complications<sup>9</sup>.

This study aims at elucidating findings in the eyes of those infected by RVF. Studies have shown vision loss, anterior segment pathology and posterior segment involvement in this zoonosis<sup>8-10,11</sup>. No Kenyan study has been done to document the effect of RVF on the ocular structures.

## **2.0 LITERATURE REVIEW**

Rift valley fever is a zoonotic infection transmitted from animals to animals through bites by arthropods<sup>1- 12</sup>. The causative agent of RVF is found in both vertebrates and invertebrates. Aedes mosquito is the main invertebrate host, with domestic and wild ruminants as well as human beings forming the vertebrate hosts. Of the domestic animals, indigenous African cattle breeds are less affected with abortions being the main presentation; and imported species having mass deaths<sup>1-4-7</sup>.

### **2.1 Historical perspective**

Rift valley fever epidemic was first reported in Rift Valley province of Kenya in the year 1931 as a disease causing mass abortions and hepatic deaths among livestock<sup>1</sup>. The causative organism was later identified as a virus. The virus was subsequently characterized from the outbreak in a white settler's farm in the same province and named Rift valley Fever Virus<sup>1-6</sup>. Other outbreaks may have occurred earlier but were not documented<sup>1</sup>.

Sub-Saharan Africa remained the site of epidemics till 1977, with South Africa was affected in 1950-51 and in 1973-74. Zambia and Zimbabwe had an animal epidemic during this period<sup>1</sup>.

The first outbreak outside the sub-Saharan region was in Egypt in 1977, six years after the completion of Aswan High Dam. Eighteen thousand people were infected and 598 deaths reported. Abortion and deaths of thousands of ewes went with the human loses during the epidemic<sup>1,3</sup>.

Mauritania and Senegal reported the first West African epidemic in 1987 a year after the completion of Diam dam on River Senegal. The northern region of Senegal and Mauritania experienced a human epidemic<sup>1-5</sup>.

Kenya has been affected by human and animal epidemics severally since the first documented episode. El-Nino rains that pounded the country in 1997-1998 led to both human and animal outbreak. Flooding in Northeastern Province in that El Nino year gave rise to the most important epidemic of RVF ever recorded<sup>7</sup> The greater than normal rainfall caused the combined flooding of two rivers in Somalia, and further flooding in Kenya, creating a huge inland lake and setting up the conditions for an outbreak of RVF that affected 89,000 people in Kenya and Somalia and caused 250 deaths<sup>1\*-7</sup>.

The latest outbreak in Kenya was first reported in early December 2006 in the Northeastern province of the country. This was after rainfall 60-100 times the expected pounded the area. The resultant flooding was the breeding ground for vectors of RVF virus<sup>2-6-7</sup>

## **2.2 Nature of the disease**

### **2.2.1 Epidemiology**

Flooding is the greatest risk factor for RVF. Stagnant or slow moving water is the ideal setting for hatching of Aedes mosquito ova that were preserved in soil. It is also the breeding ground for a new generation of mosquitoes. Irrigated lands of arid areas provide breeding places for mosquitoes and other blood-sucking insects. Outbreaks of RVF have been observed to occur in cycles of 5-20 years, after heavy rainfall and flooding.<sup>1-2-4..i3</sup>

### 2.2.2 Aetiology

Rift valley fever virus is an arbovirus of the *Bunyaviridae* family of viruses that contains five genera; four of which infect vertebrates, while the remaining genus, *Tospovirus*, contains a group of plant viruses. Three of the vertebrate-infecting genera, *Bunyavirus*, *Phlebovirus* and *Nairovirus* are associated with arthropods, while the last genus, *Hantavirus*, has no known association with invertebrates. Rift Valley fever virus, in physical, chemical and morphological terms, is a typical member of the *Bunyaviridae* of the genus *Phlebovirus*. This genus also includes the sandfly fevers. Rift Valley fever virus is an enveloped spherical virus of up to 120 nm in diameter, and has a single stranded ribonucleic acid (RNA) genome<sup>1,2,3,7,13</sup>.

### 2.2.3 Transmission

Female of *Aedes* mosquito feeds on blood to aid in egg development. It transmits the viruses that cause rift valley fever, yellow fever, dengue and encephalitis. Unlike anophelids, it holds its body parallel to the surface with the proboscis bent down and its wings are uniformly coloured. Anophelids mosquitoes can be distinguished from other mosquitoes by the palps, which are as long as the proboscis, and by the presence of discrete blocks of black and white scales on the wings<sup>14,15,16</sup>.

In sub-Saharan Africa, RVF is endemic because of transovarial transmission in *Aedes Neomelanicus*. With this, infected eggs of *Aedes* mosquitoes remain desiccated and preserved during dry seasons and hatch during floods. The arising infected mosquitoes then bite vertebrates, which with sufficient levels of viremia become the basis of transmission to other animals by biting insects and by contact with body fluids<sup>1</sup>. Man enters the cycle either directly via insect bites or via contact with tissues and fluids of infected animals. The people at high risk of infection include herders, butchers, veterinary, women and laboratory



workers<sup>1-4</sup>. In the rest of Africa, inter-epizootic survival depends on transovarial transmission of the virus and/or venereal transmission between mosquitoes with low-level circulation in livestock. In Egypt, new outbreaks were the result of infected adult mosquitoes coming out of hibernation, re-introduction of the virus via the transport of infected animals and wind-borne transmission from infected neighbouring countries. The latter is thought to have occurred in 1977 in Egypt, when unusual southerly winds were documented<sup>1,3,4</sup>.

#### **2.2.4 Mode of infection**

Human exposure to the virus is often occupational, either through handling infected ruminants or their products or by breathing in aerosols released at slaughter. Blood is thought to be the most infectious while venereal transmission in man has not been documented. Mosquito bites and the consumption of raw milk have been documented as routes of exposure. Man may be an amplifying host, because humans may develop viremia, enabling biting mosquitoes to transmit the virus to additional hosts. Laboratory workers may get infection by aerosol spread<sup>1-3,4</sup>.

#### **2.2.5 Incubation period**

Various studies have reported different period between inoculation and appearance of first signs of RVF. Two to seven days, with limits for other vector-borne diseases being 7-21 days is the most accepted incubation period<sup>1-13</sup>.

#### **2.2.6 Susceptible species**

RVF is highly pathogenic for human, sheep and cattle. Goats, buffalo and camels are also important hosts. Donkeys, horses, dogs and rodents have been infected during outbreaks but they are not likely to play a major role during RVF epizootics<sup>1-4-13</sup>.

### 2.2.7 Pathology

Human pathological studies are few thus most of the documentation is animal findings among sheep and cattle. The pathogenesis of RVF results from the spread of virus from the site of introduction to the body and initial replication sites to critical organs such as the spleen, liver and brain. The organs are damaged by the direct effects of the virus or by immune mechanisms<sup>1-13</sup>.

In animals, viremia and fever peaks in the first 3 to 4 days of infection, with leucopenia and rise in serum liver enzymes marking damage to the hepatocytes. The most severe lesions are found in aborted sheep fetuses and newborn lambs. The liver is usually enlarged, soft, friable and yellowish-brown to dark reddish-brown in colour. Irregular congested patches and haemorrhages of varying size are often present in the substance of the liver together with pale foci. Jaundice is seen in only a relatively small proportion of lambs because of the short time between the sign and death. In older sheep, the hepatic lesions are generally not so severe but jaundice may be more marked. Pale areas of cell necrosis combined with large haemorrhages give a mottled appearance to the liver. Haemorrhages and oedema of the gall bladder are common and the bile may contain blood<sup>13</sup>.

In newborn lambs, petechial and ecchymotic haemorrhages are found in the abomasal mucosa and the contents are often dark brown from the presence of partly-digested blood; the contents of the small intestine may be similar. Most mature sheep have haemorrhages and oedema in the abomasal folds and sometimes free blood in the intestinal lumen<sup>3<13</sup>.

Animals demonstrate peripheral and visceral lymph node enlargement, oedematous and may contain petechial haemorrhages and, in most, the spleen is enlarged with haemorrhages. Hepatic necrosis of varying degree is the most noticeable microscopic lesion in all animals. Lung congestion, oedema, haemorrhage and emphysema are other common findings<sup>13</sup>.

## **2.2.8 Laboratory Diagnosis**

Immunoglobulin G (IgG) antibodies are produced early in an infection, but of the available enzyme-linked immunosorbent assay (ELISA) tests, immunoglobulin M (IgM) ELISAs are favored for a rapid diagnosis. Samples taken are heparinised or clotted blood, plasma or serum and tissue samples of liver, spleen, kidney, lymph node, heart blood and brain<sup>1<sup>13</sup>.

### **2.2.8.1 *Identification of the agent***

The RVF Virus can be isolated for identification by inoculation into living experimental animal. The commonly used animals include mice, hamsters and day old lambs. Tissue culture of lamb and goat cells and embryonated chicken eggs are other inoculants that can be used<sup>13</sup>.

Viral antigens can be identified by immunofluorescence in cryostat sections or in impression smears of liver, spleen and brain. It can be done by complement fixation and immunodiffusion on tissue suspensions too<sup>13</sup>.

Viral antigen detection by reverse transcriptase polymerase chain reaction technique (RT PCR) is a commonly used method of detecting the infection. Antigen detection in blood by immunodiffusion and enzyme immunoassay are other choices available<sup>13</sup>.

### **2.2.8.2 *Serological tests***

Enzyme-linked immunosorbent assay (ELISA) for IgM is the most commonly used serological test. ELISA for immunoglobulin G is useful particularly in the first few days of infection. Virus neutralization, fluorescent antibody test, complement fixation and immunodiffusion are other serological tests that are useful<sup>13</sup>.

## **2.2.9 Clinical findings**

Four clinical syndromes have been in RVF virus infection.

### **2.2.9.1 *Mild form:***

Influenza-like illness characterized by the sudden onset of a fever that is sometimes biphasic, rigor, headache, retroorbital pain, severe muscular pain (particularly in the lower back), vomiting and loss of appetite. These symptoms generally persist for 4-7 days, followed by full recovery within two weeks<sup>13</sup>.

### **2.2.9.2 *Meningo-encephalitic RVF:***

This begins with an acute fever of about 5-10 days duration followed by hallucination, disorientation and vertigo; long-term neurological complications have been reported in some patients, although the mortality rate is low<sup>13</sup>.

### **2.2.9.3 *Hemorrhagic RVF***

This is the most severe RVF syndrome characterized by an acute fever of 2-4 days duration followed by jaundice and haemorrhages; in the following 3-6 days either death occurs or the patient begins to recover slowly<sup>13</sup>.

### **2.2.9.4 *Ocular form***

This is the less common form of RVF, presenting initially as a fever and diminution of visual acuity between 7 and 20 days after onset<sup>1,2,7,13</sup>.

## **2.3 Ocular effects of Rift Valley Fever**

### **2.3.1 General**

Studies done during various outbreaks have shown eye diseases to be part of Rift Valley Fever. Ocular structures are affected in 0.2-20%<sup>4</sup>. The mean duration between onset of Rift Valley Fever and ocular disturbances range from 4 to 15 days (mean, 8.8 days)<sup>4-7-8</sup>. The presenting visual acuity was found to be less than 6/60 in 80% of the affected patients<sup>8</sup>.

Males are predominantly affected, most being herders, farmers, or both, most exposed through direct contact with infected animals and their body fluids. This group is also exposed to mosquito bites due to the nature of their occupation<sup>2-8</sup>.

### **2.3.2 Uveitis**

Anterior segment involvement in RVF has not been consistently reported. Anterior uveitis was reported in 31% of patients examined during the Egyptian outbreak<sup>4</sup>. The uveitis is an acute non-granulomatous anterior uveitis within three weeks of onset of RVF<sup>8</sup>. It resolved without sequelae upon follow-up and neither keratic precipitates nor synechiae were found<sup>7-17</sup>. Posterior uveitis was found in all patients with anterior uveitis. The patients were noted to have vitreous cells in 26% of all cases<sup>10</sup>. Symptoms resolved spontaneously within 2 to 3 weeks from the onset of systemic symptoms and did not result in complications such as glaucoma, posterior synechiae, or cataract<sup>8-10-12-17-18-19-20-21</sup>.

### **2.3.3 Retinitis**

Retinitis was the commonest posterior pole findings in patients with RVF in the study of Siam et al<sup>10</sup>. It presents as diffuse white macular, paramacular, and/or extramacular retinal lesions with poorly defined margins. The retinitis is thought

to be infective or inflammatory<sup>8,17,8,19,21</sup>. The retinitis is associated with retinal thickening at the site of the lesions, which is thought to represent either edema secondary to exudation or local swelling of axons. Fluorescein angiography of the retinitis areas revealed early hypofluorescence with late staining of retinal lesions and blood vessels. Spontaneous resolution of the RVF retinitis occurs within 10 to 12 weeks<sup>8</sup>.

#### **2.3.4 Optic disc oedema**

Optic disc edema was found in 15% of patients during the Saudi Arabian study<sup>8</sup>. No description or explanations were given for this finding.

#### **2.3.5 Vasculitis**

Retinal vasculitis, mainly phlebitis, and rarely arteritis, is found in 7% of affected patients<sup>8</sup>. The vasculitis can complicate as vascular exudation, intraretinal hemorrhage, or get vascular blockage resulting in ischemia and oedema or all<sup>8,10,12, 19, 20 21, 22</sup>. Fluorescein angiography generally demonstrated blockage in the area of the lesions with extensive vascular leakage and/or occlusion<sup>8,10, n\_12</sup>

#### **2.3.6 Retinal Hemorrhage**

Retinal hemorrhage was found in 40% during Saudi outbreak and was thought to be related to the vasculitis<sup>8</sup>. It could also be due to coagulopathies that occur in haemorrhagic viral infections<sup>22</sup>.

#### **2.3.7 Effects on vision**

Initial visual acuity was found to range between light perception (PL) and 6/36 in all patients; and remained the same or recorded slight improvement in all patients seen in that study<sup>8</sup>.

### **2.3.8 Orbital disease**

Involvement of the orbit in Rift Valley Fever has not been reported so far in any of the published studies. There is a report of proptosis found in patients during an outbreak in Tanzania <sup>23</sup>. Ocular adnexa have not had any reported involvement in RVF.

### **2.3.9 Long term sequelae**

Nearly half the patients experience permanent loss of visual acuity. Most active lesions spontaneously heal within 9 months of follow-up. Chorioretinal scarring, vascular occlusion and optic atrophy are some of the long-term complications of ocular RVF form <sup>8</sup>.

### **3.0 JUSTIFICATION AND RATIONALE**

Rift valley fever has been quoted as a cause of ocular morbidity and reduction in vision. This study sought to establish if patients with RVF had ocular morbidity, and if so the pattern of ocular involvement. The information gathered may guide in future response to similar epidemics.

To the best of my knowledge, no such study has been done in Kenya, very little worldwide.



## **4.0 OBJECTIVES**

### **4.1 General Objective**

The objective of this study was to establish the prevalence and pattern of ocular disorders in people with RVF during the Kenyan epidemic of December 2006 to April 2007.

### **4.2 Specific objectives**

To establish the magnitude of ocular disorders in patients with RVF during the epidemic in Baringo and Machakos districts of Kenya.

To document the pattern of ocular disorders in subjects with Rift Valley fever infection during the same outbreak.

## **5.0 METHODOLOGY**

### **5.1 Study design**

This was a cross sectional, descriptive study. The study was part of the larger emergency response by MoH, GoK to control the epidemic.

### **5.2 Study period**

March to April 2007.

### **5.3 Study area**

Marigat and Makutani Divisions of Baringo District, in the Rift Valley Province and Katangi division of Machakos District in Eastern Province of Kenya. Baringo district is one the arid regions in Kenya under the arid and semiarid lands (ASAL) programme. It covers an area of 8,655km<sup>2</sup> and has nine divisions. The district is ecologically divided into three regions: highlands (>2000m above sea level), midlands and lowlands (700m above sea level). The lowlands receive yearly rainfall below 600mm and was worst affected by RVF epidemic. During the season of the epidemic, the area had received three times its annual rainfall. The two divisions are also malaria endemic<sup>7</sup>.

Baringo district has a population of 289,891. Marigat division with an area of 641km<sup>2</sup> has 29,153 people. Makutani division is 583km<sup>2</sup> with a population of 8063 people. RVF cases were distributed in all the locations of the two divisions<sup>25</sup>.

Machakos District is one of thirteen districts of Eastern province of Kenya. It is mainly semi-arid, covering a total area of 6281 km<sup>2</sup> and divided into twelve administrative divisions. Katangi division, covering 568km<sup>2</sup> and with population density of 97/km<sup>2</sup> had three cases of RVF. It receives unreliable

rainfall of about 500mm annually. Long rains are expected between March and May<sup>26</sup>.

#### 5.4 Study Logistics

Permission was sought and obtained from Medical Officers of Health, Baringo and Machakos districts. An initial response team identified people in that community who had complaints similar to RVF and their blood was taken for testing at KEMRI laboratories. The house location was mapped on GPS for all samples taken and names inserted on a line lists. The GPS positioning as well as local leaders were used to identify and trace the positive cases.

The nearest facility with electricity connection was used for data collection including ocular examination. The subjects traveled an average of ten kilometers to these facilities consisting of four schools and a health centre. Informed consent was obtained from the subject or guardian accordingly.

#### 5.5 Case definition

A case was defined as a person with features of RVF and testing positive for RVF by immunoglobulin M assay and/or reverse transcriptase PCR during the epidemic and had ocular findings.

#### 5.6 Study population

All residents of the study area who tested positive for RVF (by RT-PCR or had IgM antibodies) and gave informed consent were studied. People who developed symptoms consistent with RVF had their blood tested for the virus at KEMRI. Line lists, physical contacts and GPS coordinates of those who tested positive were recorded for ease of follow-up.

### **5.7 Inclusion criteria**

Subjects who tested positive for rift valley fever by IgM or RT PCR method were all included in the study. Consent was sought from subjects or guardians for those who were underage or in coma.

### **5.8 Exclusion criteria**

Those who did not consent to the study and those who could not be traced were excluded in the study. Efforts were made to trace all subjects before exclusion from study.

### **5.9 Sample size**

The entire study population was studied.

### **5.10 Data collection and analysis**

Data were collected using a structured questionnaire administered by three data collectors who translated it from English to local language where necessary. The data collectors were trained on the study tools and the translations standardized. Data was cleaned, entered, stored and analyzed using statistical package for social sciences (SPSS) **12.0.1**. Comparisons were done using appropriate statistical tests.

### **5.11 Examination methods**

Snellen and literate E charts were used to test visual acuity in daylight. Those with vision less than 6/6 were also tested with a pinhole. Anterior segment examination was done with a slit lamp. Fundoscopy was done using a slit lamp with the aid of +90-dioptre loupe and with bifocal indirect ophthalmoscope with

+20-dioptre loupe when SLE funduscopy was not possible. Examination findings entered in the data collection tool and fundus drawings done.

### **5.12 Study limitations**

This study started late into epidemic due to the amount of time it took to identify the epidemic and logistical reasons, time may have modified the findings in the people we included in the study.

We may have missed the most severely affected due to death and recovery. Subsequently, follow-up has not been done and long-term effects will be missed. Fundus photography and fluorescein angiography would have been useful but were not done due to logistical difficulties.

### **5.13 Ethical considerations**

The study was done as part of the emergency response of Ministry of health, GoK, to the epidemic. Those needing treatment were referred to the district hospital where arrangements had been made for their care.

## 6.0 RESULTS

One hundred and forty-five patients were tested for RVF in Baringo district. Results were available for one hundred and sixteen of them. Seventy-two tested positive for RVF by either RT-PCR or IgM serology or both. Of the positive cases, twenty were discovered to have been double registered and the anomaly was corrected. Eleven of these positive cases had died by the time data of collection. One had emigrated from the area while six could not be traced in the area they were said to be and there was no report of their death or migration. Four cases tested positive in Machakos group, one had died and three were interviewed and examined.

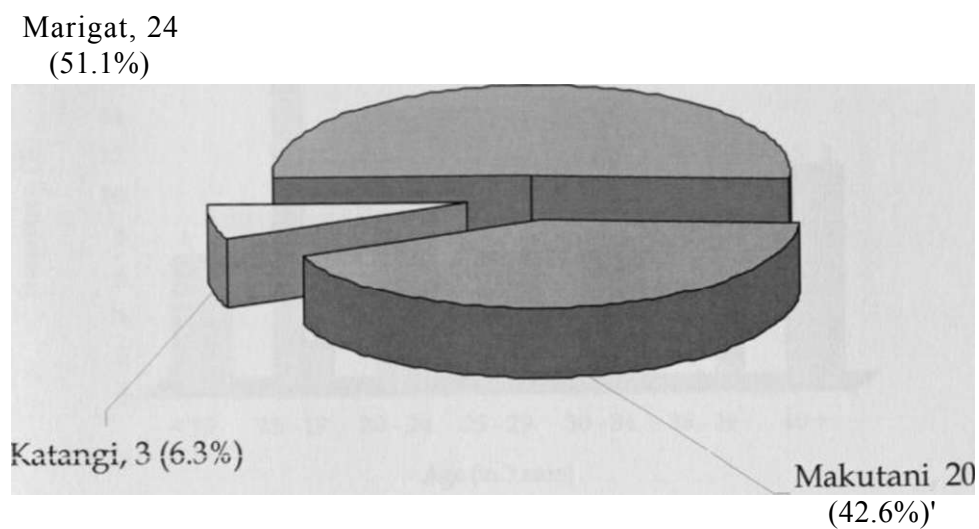
All patients who tested positive for RVF in Baringo and Machakos district of Kenya were included in the study. Forty-six subjects (43 from Baringo and 3 from Machakos) agreed to be interviewed and examined while one from Baringo declined to have fundoscopy done.

Forty-five (95.7%) of them had mosquito bites at least two weeks before the onset of the illness. During this period, twenty-four (51.1%) people reported to have slept under an insecticide treated net. Goats were the sick animals most subjects came in contact with during this period.

Visual acuity was not tested in two subjects who were comatose (4.5%) and two were too young for the available testing methods. One was monocular and another declined further examination.

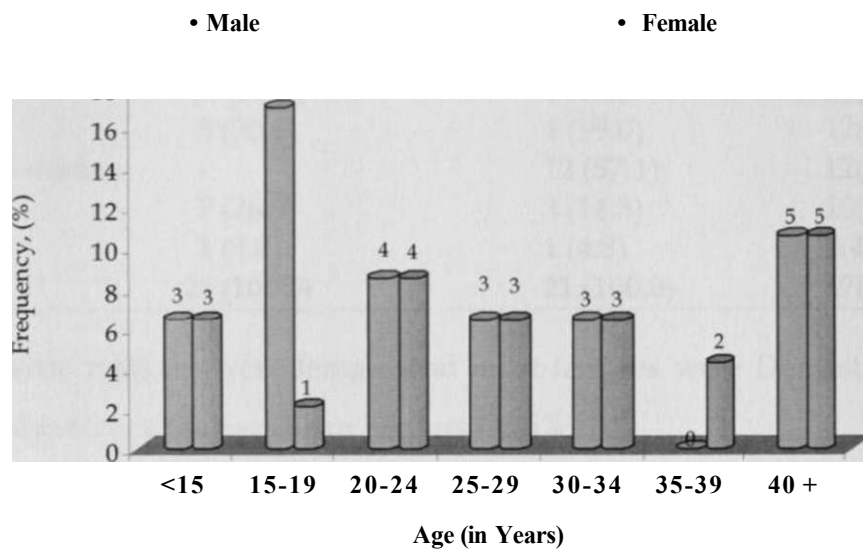
Fundoscopy was not possible for eight eyes. This was due to very young age (2), dense cataracts (3), monocular subject (1) and lack of consent (2)

**Figure 1: Distribution of cases by divisions (n = 47)**



Most of the cases were from Marigat and Makutani divisions of Baringo district (93.6%).

**Figure 2: Age and sex distribution (n=47)**



The mean age of the patients was 28.36 (STD=15.58) with minimum age being 2 years and the maximum of 76 years. Median age of the patient was 25.0 years. The mode was 20 years. M:F ratio was 1.2:1.



**Table 1: Occupation and Sex distribution (n = 47)**

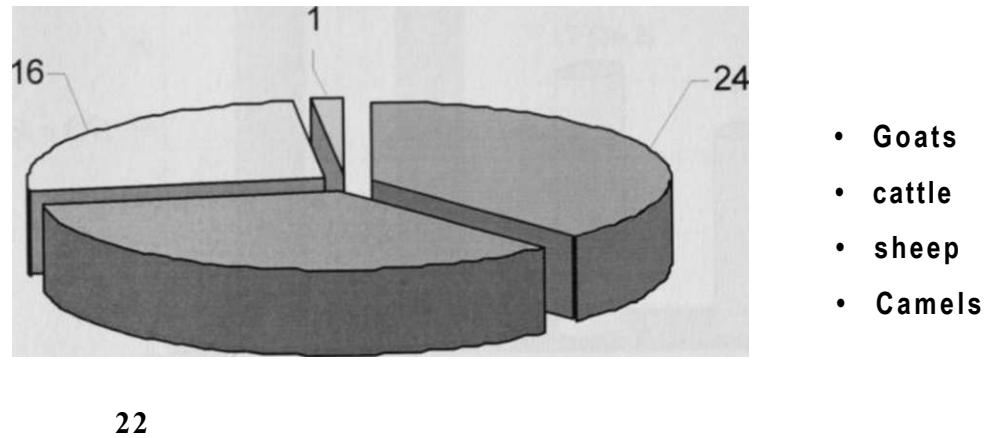
<b>Occupation</b>	<b>Sex</b>		<b>Total n (%)</b>
	<b>Male, n (%)</b>	<b>Female, n (%)</b>	
Herder	10 (38.5)	1 (4.8)	11(23.4)
Farmer	8 (30.8)	4 (19.0)	12(25.5)
Domestic worker	-	12(57.1)	12(25.5)
Student	7 (26.9)	3 (14.3)	10(21.3)
Other	1 (3.8)	1 (4.8)	2(4.3)
<b>Total</b>	<b>26 (100.0)</b>	<b>21 (100.0)</b>	<b>47(100)</b>

All Domestic workers were female and most females were Domestic workers (57.1%). Majority of the men were herders (38.5%).

**Table 2: Mode of Exposure to RVF (n = 47)**

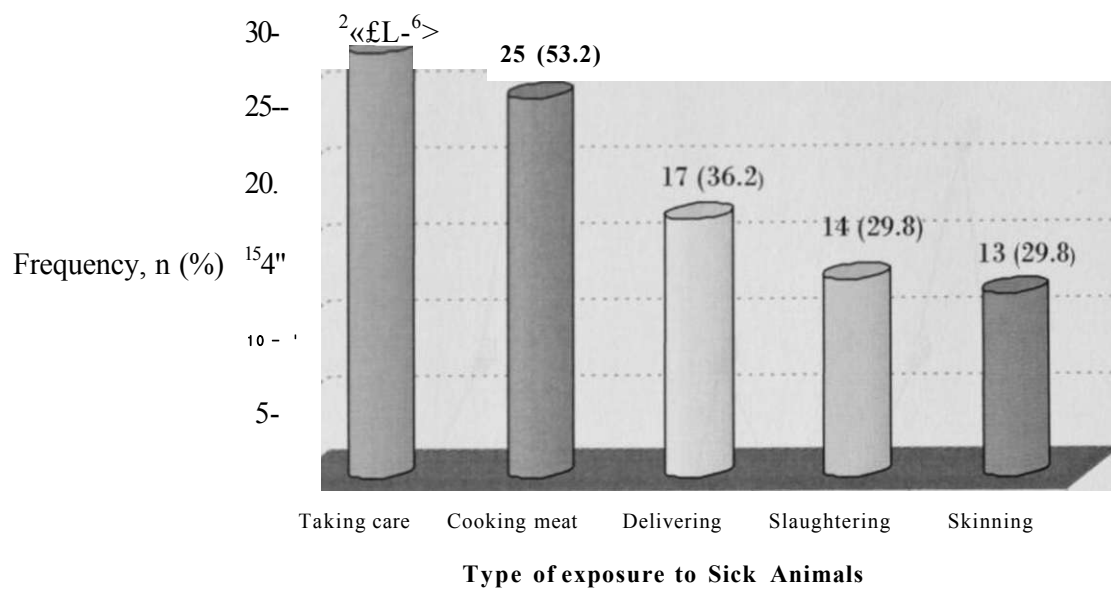
<b>Exposure</b>	<b>Frequency</b>	<b>Percentage</b>
Had mosquito bites in the period	45	95.7
Handled animal	38	80.9
Had animals that aborted/died	38	80.9
Preparation of Raw meat	26	55.3
Drinking of unboiled milk	19	43.2
Slaughtered animal	17	36.2

Figure 3: Type of animals exposed to (n=38),multiple response.



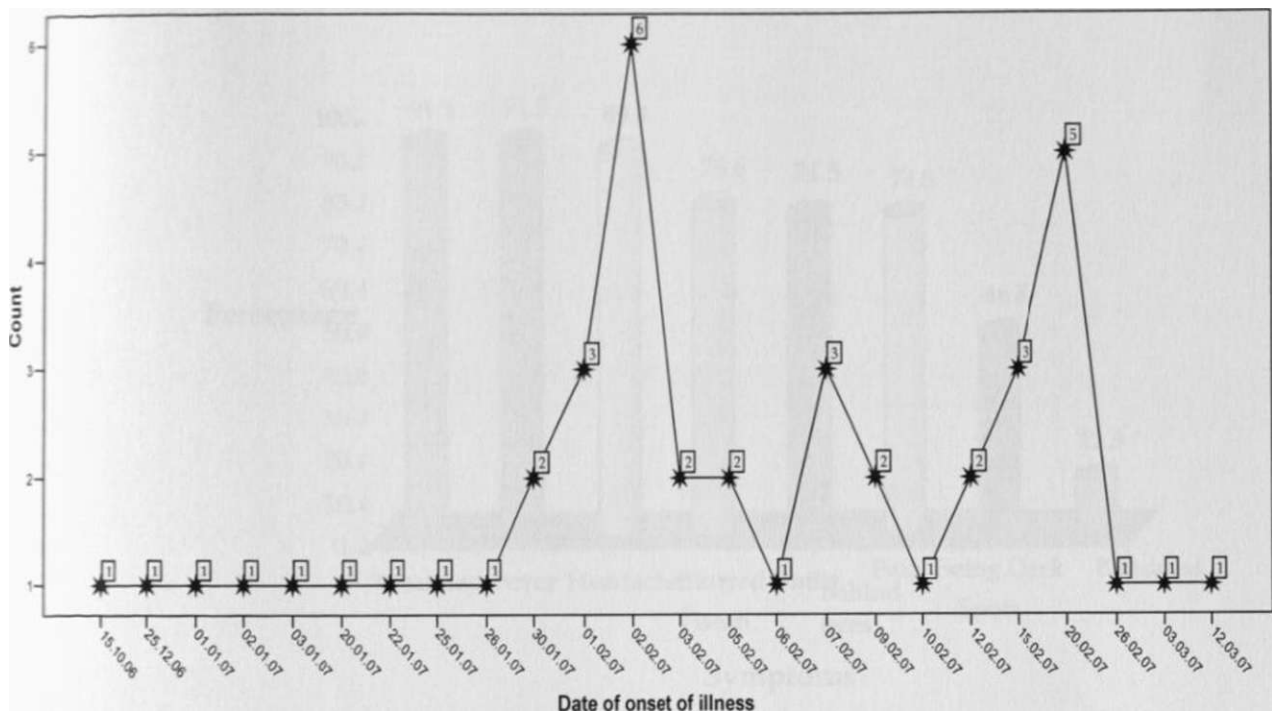
Goats are reared for milk and meat. Goat pens are constructed adjacent to the house. Kids of are kept in the houses for warmth and security.

**Figure 4: Type of Contact with Sick animals (n = 47)**



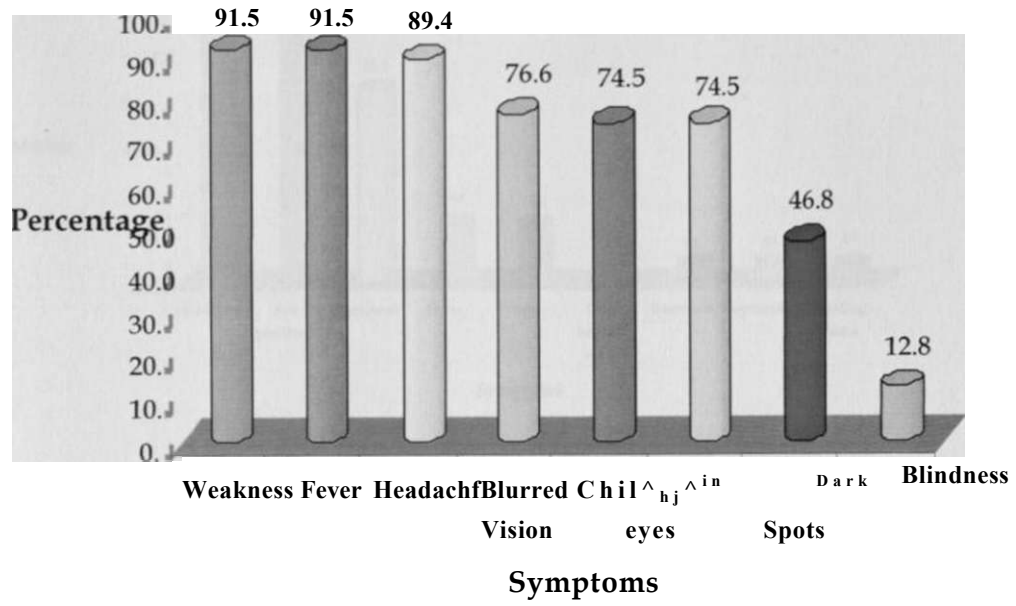
Taking care of sick animals and preparing meat for eating were the commonest mode of exposure to body fluids/ tissues of sick animals.

Figure 5: Number of cases by date of onset of illness, (n = 47)



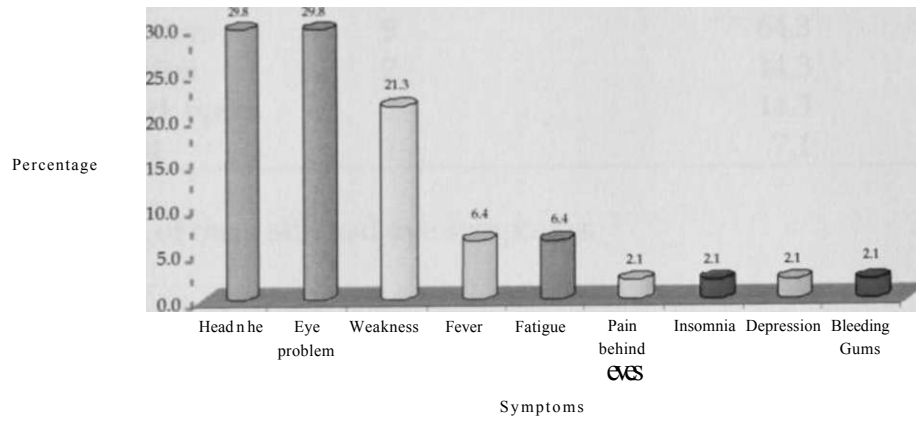
Onset of illness was on 16.10.2006 with the peak number of reported cases on 01.02.2007. Another peak was observed on 20.02.2007 due to a breach of MOH regulations in one area.

**Figure 6: Initial General Symptoms**



Generalised body weakness, fever headache and blurred vision commonest symptoms.

Figure 7: Symptoms at examination time (n=31)



Sixteen subjects did not have complaints. Pain behind the eye was not considered an eye problem.

**Table 3: Ocular symptoms at time of data collection (n = 47)**

<b>Symptoms</b>	<b>Count</b>	<b>Percentage</b>
None	33	70.2
Blurred vision	9	64.3
Loss of vision	2	14.3
Seeing Dark Spots	2	14.3
Short Sight	1	7.1

Minority (29.8%) of them still had eye symptoms.

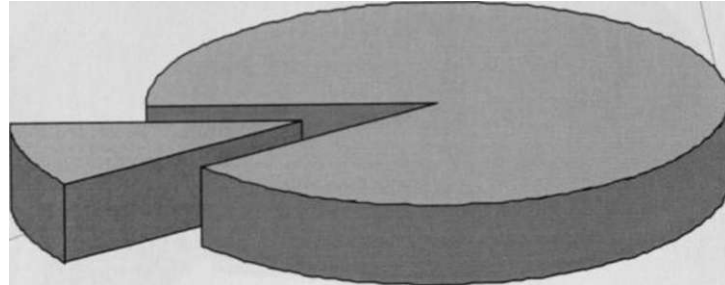
**Table 4: Corrected Visual Acuity (n =83 eyes)**

<b>VA</b>	<b>Frequency</b>	<b>Percentage</b>
6/6	61	73.5
6/9	10	12.1
6/12	1	1.2
6/18	7	8.4
6/36	1	1.2
6/60	1	1.2
3/60	1	1.2
HM	1	1.2

Most (95.2%) of those examined had normal visual acuity by WHO classification.

**Figure 9: State of the pupils (n=91)**

**Clear, 80 (89.9%)**

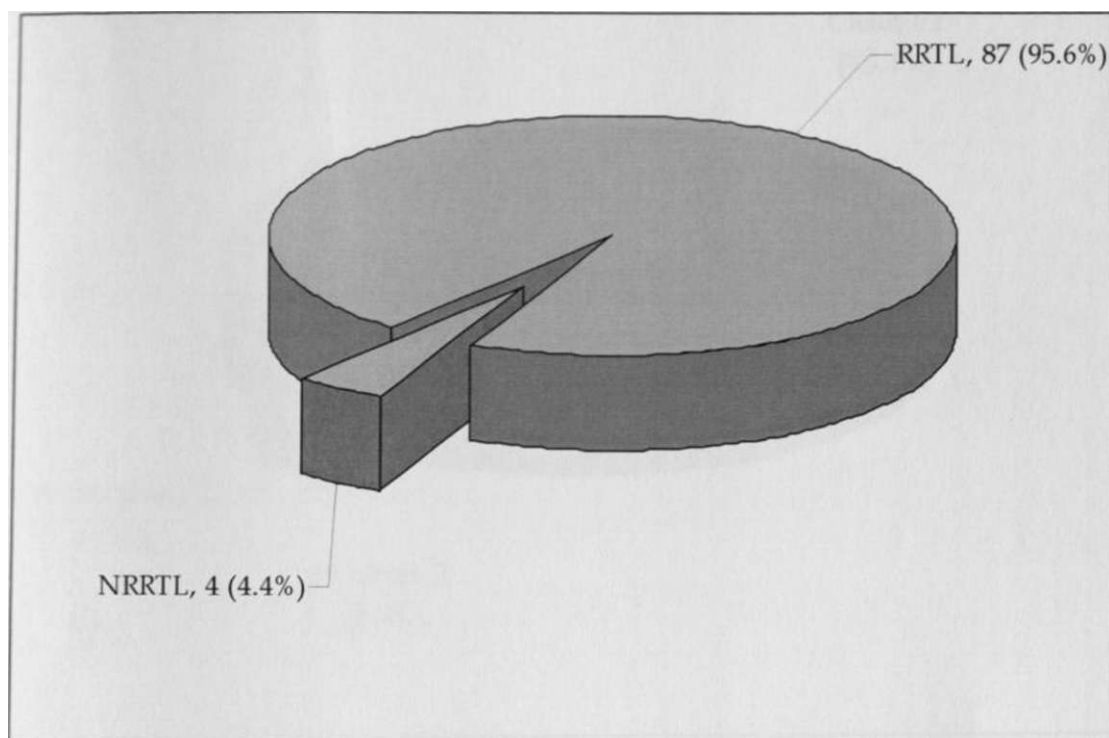


**Cataract, 9  
(10.1%)**

Nine (10.1%) of the eyes had cataracts.

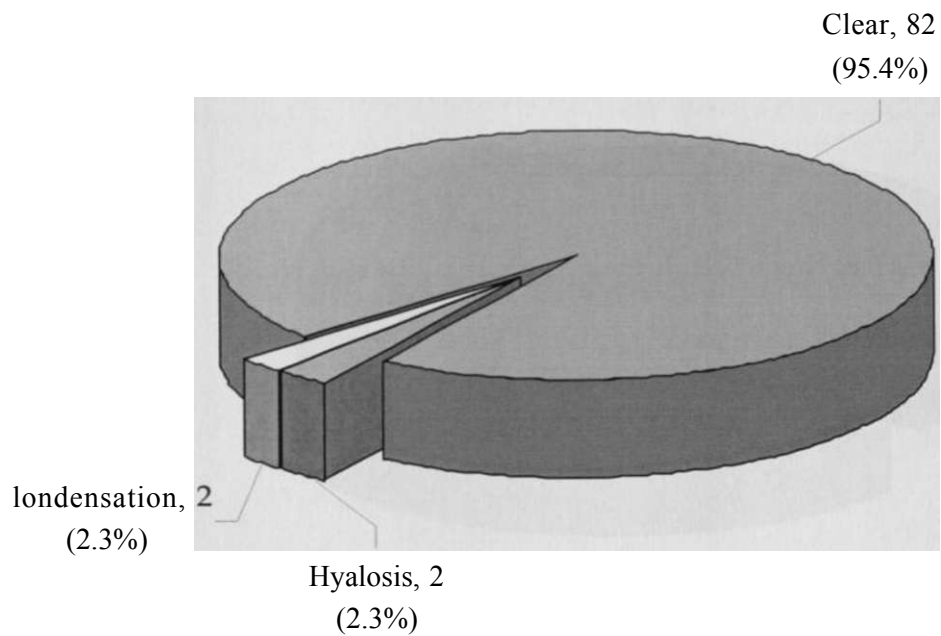


**Figure 9: State of the pupils (n=91)**



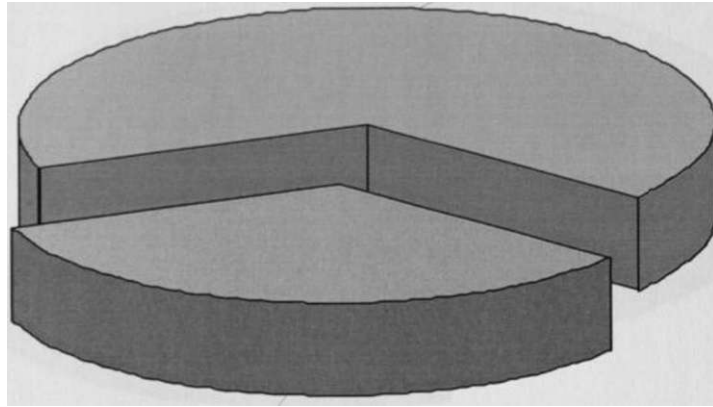
Two eyes of one comatose subject were dilated and not reacting to light.

**Figure 14: State of the optic disc (n=86)**



**Figure 11: State of macula (n=86 eyes)**

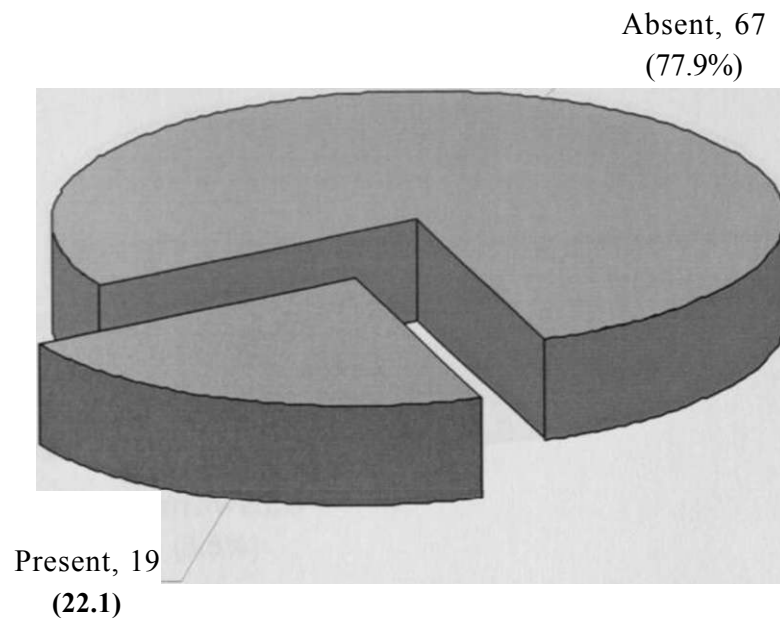
Normal, 57  
(66.3%)



Oedema, 29  
(33.7%)

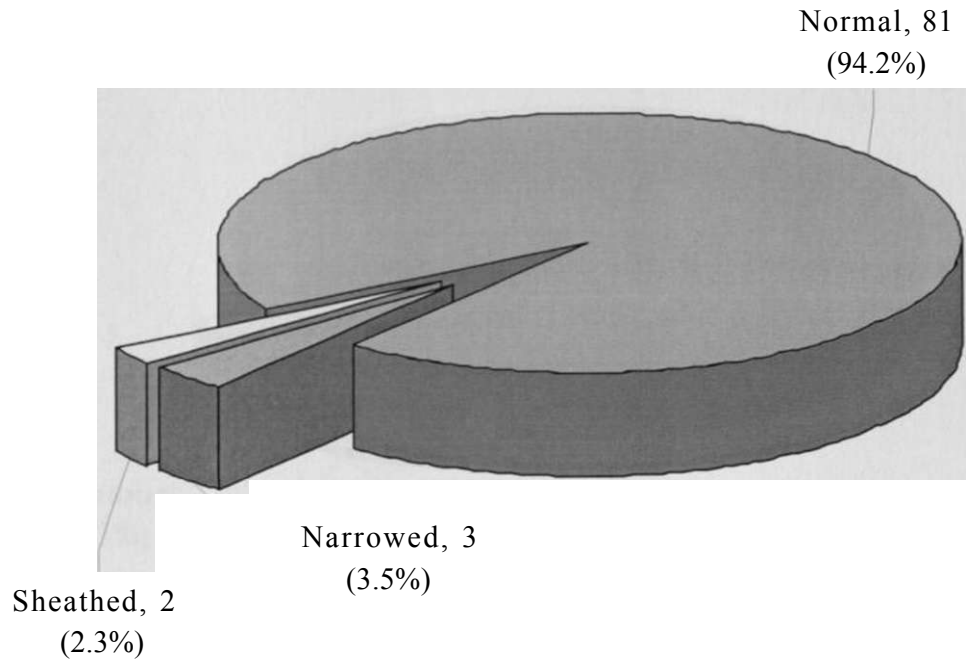
Two had cystoid macula oedema. There may have been more oedema missed due to lack of fundus FLA and contact-lens funduscopy.

Figure 12: Presence of retinitis (n=86)



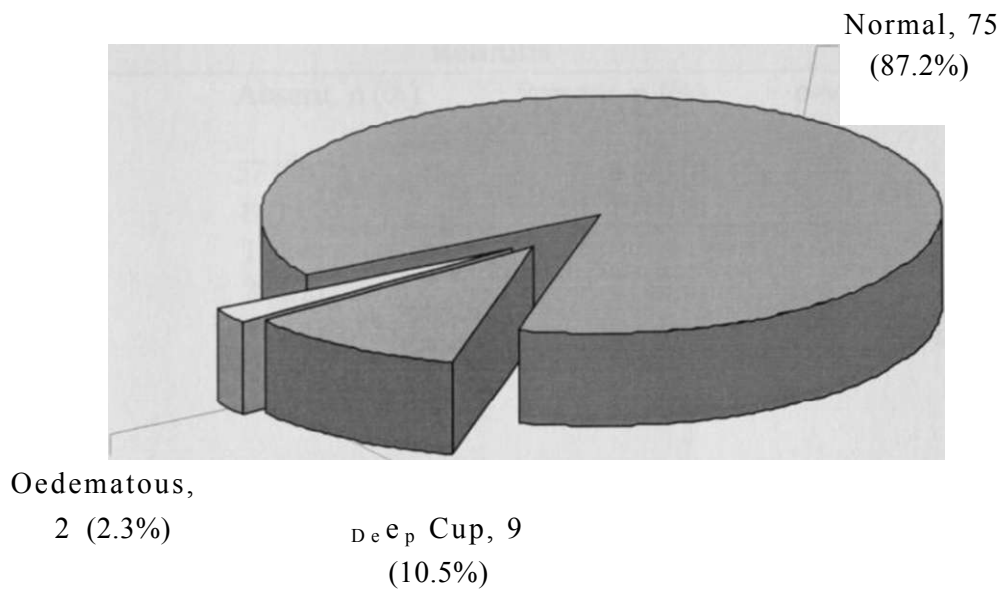
The retinitis was mainly macula and paramacular.

Figure 13: State of the retinal vessels (n=86)



The narrowed vessels were also empty. All eyes with abnormal vessels had retinitis and macula oedema.

**Figure 14: State of the optic disc (n=86)**



The cup to disc ratio of cupped discs were  $>7$ . Ten (10) of the discs that were cupped or oedematous was accompanied by macula oedema in the same eye.

**Table 5: Association between VA and Retinitis ( n=86)**

VA	Retinitis		p-value
	Absent, n (%)	Present, n (%)	
6/6	57 (80.3)	4 (40.0)	0.001
6/9	8(11.3)	1 (10.0)	
6/12	1 (1.4)	-	
6/18	3 (4.2)	4 (40.0)	
6/36	1 (1.4)		
6/60	1 (1.4)	-	
3/60	.	1 (10.0)	

There was a statistically significant presence of lower vision in those with retinitis. (p=0.001)

**Table 6: Association between VA and Macular oedema (n=86)**

VA	Status of Macular		p-value
	Normal, n (%)	Oedematous, n (%)	
6/6	46(82.1)	15 (60.0)	<b>0.049</b>
6/9	7 (12.5)	2 (8.0)	
6/12	-	1 (4.0)	
6/18	3(5.4)	4 (16.0)	
6/36	-	1 (4.0)	
6/60	-	1 (4.0)	
3/60		1 (4.0)	

Presence of macula oedema was associated with poorer vision. (p=0.049)

## 7.0 DISCUSSION

### 7.1 Age and sex distribution

The mean age of the patients was 28.36 years (STD=15.58), median was 25 years, with minimum age being 2 years and the maximum of 76 years. This compares favourably with observation during a previous outbreak in Garissa where the median age was 30 years and range of 3-86 years<sup>3</sup>. Hazmi et al found the mean age as 53.2 years; while Elwan et al found a range of 34-64 years, mean of 50.3 years and none were in the pediatric age group<sup>8-10</sup>. The younger age in Kenya studies could be explained by the mode of transmission. Young children in this study population herded livestock and drank unboiled milk while adults were exposed to body tissues of animals and insect bites.

Twenty-six (55.3%) cases were male with a male to female ratio of 1.2:1. This corresponds with the findings of 1997 Garissa outbreak in Kenya where males comprised 58% of cases (1.4:1)<sup>3</sup>. Hazmi et al found 78% males (male-to-female 3.5:1) which could have been related to the higher likelihood of male patients being involved in farming fieldwork and care of animals, and hence being more exposed to infected mosquitoes or animals in their population than women are. Elwan found 36.4% males but his sample size was small (22) and all females subjects(16) did not consent to RVF blood test due to culture barriers to venepuncture<sup>7-8-10</sup>.

The balanced distribution by sex in this study is consistent with the mode of exposure to the causation, which is evenly spread between the sexes. Females prepared meat of dead/dying livestock. They as also assisted in aborting the livestock. Men herd animals, take care of sick ones and slaughtering them when needed.



## **7.2 Geographical distribution**

The cases were evenly distributed within the Baringo divisions; Marigat division accounting for 24 (51.0%) and Makutani 20 (42.6%). Both divisions lie in a low rainfall zone, which experienced inordinately high rainfall and flooding prior to the epidemic. Both factors lay the breeding ground for vector borne diseases particularly RVF<sup>3</sup>. Machakos cases, 3 (6.4%) were family members who slaughtered and feasted on a sick animal. They came from the same village in Katangi division. The cases were discovered due to the high alert and active case search for RVF during the epidemic. All the three divisions fit the characteristics of RVF prone areas. The fewer cases in Katangi Division may have been due to public health measures already put in place which were violated by the subjects. There could have been an on going animal epidemic that evaded humans due to the high alert late in the national epidemic.

## **7.3 Occupation**

Most of the males were mainly herders (38.5%) and farmers (30.8%). Majority of the females were domestic workers (57.1%). This shows a clear demarcation of roles of females and males in the studied community. The community is a livestock keeping society, and people of all gender and age got in contact with animals in one way or the other during the outbreak.

## **7.4 Exposure to RVF**

Rift valley fever is a zoonotic as well as epizoonotic disease. The study subjects were exposed to mosquito bites (95.7%) during and before the outbreak and may have contributed to the epidemic. The affected community interacts closely with domestic animals and their products as a way of livelihood.

This was through handling sick animals (84.4%), owning sick and aborting ruminants (80.9%), preparing raw meat for eating (57.8%) and drinking unboiled milk (40.4%). Goats were the animals most commonly involved in the epidemic.

Exposure to mosquito bites and low use of insecticide treated nets (ITN) predisposed them to viral transmission from ruminants. The exposure to body fluids of animals also exposed them to non vector transmission from sick animals.

## **7.5 Symptoms**

### **7.5.1 General symptoms**

The common complaint at onset of illness were generalized body weakness (91.5%) headache (88.6 %), hotness of the body (90.9%) and chills (77.3%) which are consistent with the description of RVF as an influenza-like illness. Noteworthy is the absence of hemorrhage as an important complaint in RVF. This could be explained by the fact that hemorrhagic RVF is a severe illness with very high mortality. The deaths could have already occurred prior to the study.

### **7.5.2 Ocular symptoms**

Blurring of vision was the commonest eye (81.8%) complaint. Seventy-five per cent had pain behind the eye, 50% reported seeing dark spots and 13.6% said they were not able to see. Blurred vision found indicates that RVF may significantly affect the eye at early stages; meaning that eye physicians could have a primary role to play in RVF epidemics. Dark spots could be due to presence of vitreous strands, an indication of probable intraocular inflammation. It also may strengthens assertion of earlier studies that transient uveitis is a common entity of RVF<sup>2</sup>.

## **7.6 Ocular signs**

### **7.6.1 Prevalence of ocular signs**

Nineteen of the forty-four (43.1%) subjects had either macula oedema, retinitis, vascular sheathing and optic disc swelling with no other explanation for their occurrence. Three had both eyes affected by both oedema and retinitis. All the patients from Machakos had macula oedema. The interval between the onset of

illness and the interview was shorter in the Machakos group. In all the cases studied, no anterior segment finding was present and consistent as to be purely attributable to RVF.

Previous studies have estimated the prevalence to stand at between one and 15%<sup>8-10</sup>. No population-based study similar to this study has been published as previous ones were hospital-based. The studies estimate of 43.1% is the highest and future studies need to be carried out to add to this knowledge.

#### 7.6.2 Visual acuity

Forty one (97.6%) of the subjects had normal vision according to WHO classification. One (2.4%) had visual impairment together with bilateral macula oedema. Two cases had unilateral cystoid macula oedema that affected vision adversely but the other eye in both cases had normal vision. Involvement of an eye in a retinal event resulted in a statistically significant vision less than 6/6 vision. These findings compare poorly with other studies in which initial acuity was worse than 6/60 (severe visual impairment) in 80% of the cases<sup>8</sup>. Vision remained the same in 89% of these cases<sup>8</sup>. The disparity could be explained by the design of the studies, one being a hospital based and the other a population based. This may have resulted in study of severely ill subjects in the hospital based studies and a mixed picture in this study, the other possibility is that the virus strain in the earlier epidemics were more virulent.

The cause of reduced vision in RVF is multifactorial. Retinitis, the commonest ocular manifestation of RVF can affect the macula with resulting reduction of VA. Anterior and posterior uveitis found in RVF affects vision adversely. Retinal Complications of RVF such as macula oedema, retinal detachment, cystoid macula oedema, vascular occlusion, optic atrophy, necrosis and scarring lead to reduced VA<sup>8-18</sup>. Macular and paramacular retinitis, macula oedema, vascular

occlusion and optic disc swelling were the most likely causes of reduction of vision in this study.

### **7.6.3 Uveitis**

Uveitis has been an inconsistent finding in several studies. No direct signs of anterior uveitis were found in any of the study subjects. However, the presence of retinitis, vasculitis, macula oedema, cystoid macula oedema and optic disc oedema could be indicative of resolving posterior uveitis. If that is taken to be the case then posterior uveitis would be a common feature affecting 43.1%. Hazmi et al, Siam et al found that anterior uveitis of RVF is transient and fully recover within 2-3 weeks without sequelae<sup>7-8</sup>. This quick resolution of anterior uveitis could explain why the study did not find evidence of it. The interval between onset of illness and examination was at least one month for this study.

### **7.6.4 Retinitis**

Retinitis is the most frequent eye manifestation of RVF<sup>7-8,10,21,22</sup>. Creamy macula and paramacular lesions with ill-defined margins were found in nineteen (22.1%) of all the eyes. The retinitis was bilateral in five patients and involved the macular in thirteen eyes. Elwan et al, and Hazmi et al, found macular and paramacular retinitis in all the patients that had ocular complications<sup>8,10</sup>. Their findings do not compare well with this study and could be due to the following differences of the study setups:-

- Hazmi patients were either severely ill, admitted patients or had presented to the eye clinic with ocular complaints<sup>8</sup>.
- Elwan patients were referred hence possibly the most ill<sup>11</sup>.
- This study was community based while the other studies were hospital based.

All studies however agree that retinitis is an important finding in RVF 2, 7, 8, n. Histopathological examination of these lesions has not been done. It is postulated to represent edema secondary to exudation or local swelling of axons. It might be a response of the retina to choroiditis due to the virus or immune response to the virus. The lesions of RVF retinitis are very similar to those found in acute posterior multifocal placoid pigmentary epitheliopathy<sup>22</sup>. Approximately 25% to 40% of APMPE patients report a previous prodromal viral illness. In the pathogenesis of APMPE, there is a choroidal vasculitis with a secondary reaction in the overlying retinal pigment epithelium<sup>22,27</sup>.

Mumps infection and hepatitis B virus vaccine have been associated with APMPE. Could RVF be another viral illness associated with APMPE? This would be the first time such an association has been made. There has been a case of APMPE after streptococcal infection<sup>22-27</sup>.

#### **7.6.5 Macula oedema**

Macula oedema was the commonest ocular finding in this study affecting twenty nine (33.7%) eyes. There was significant reduction in visual acuity in cases that had macular oedema (p=0.049). It was associated with retinitis in seven of the eyes, and with optic disc oedema in two eyes of one person. The cause of macula oedema in this and previous studies is difficult to discern. Vasculitis and uveitis may be contributory factors but human histopathological studies need to be undertaken to ascertain it. Cystoid macula oedema is a known complication of uveitis, and was found in two eyes of two people in this study.

#### **7.6.6 Optic disc oedema**

Two eyes (2.3%) of one person had optic disc edema. The same patient had macula oedema and decreased vision in both eyes not improving with refraction.

Previous studies had shown optic disc oedema in 15% of the cases without an explanation to its causation<sup>8-10 n</sup>.

#### **7.6.7 Vasculitis**

There was vasculitis evidenced by finding of narrow and empty vessels and perivascular sheathing in 5.8% cases. This finding compares well with 7% in one previous study<sup>8</sup>. Vasculitis can result in retinal ischemia, oedema, and haemorrhage. Retinal oedema and ischemia were seen in this study but haemorrhage was not. The vasculitis may be due to direct invasion of the blood vessel by the virus or immune reaction occurring at the vessel wall<sup>22-27</sup>.

#### **7.6.8 Others**

There was no retinal haemorrhage or vitreous reaction in this study. This may be because the study begun late into the epidemic with resolution of haemorrhage or early death. It could also be that this epidemic was not a haemorrhagic one. Previous studies had found retinal haemorrhage in 40% of those affected<sup>8</sup>. Retinal haemorrhage in RVF, like other haemorrhagic viral infections is poorly understood. It may be due viral infection of endothelial cells or immune protein modulation of coagulation, or both. Endothelitis and coagulation defects result in bleeding<sup>8-27</sup>.

## 8.0 CONCLUSION

1. This RVF epidemic was associated with ocular morbidity in 43.1% of the cases.
2. Retinitis and macular oedema were the most common findings.
3. Mosquito bites and direct contact with body fluids of infected animals may have had a role in viral transmission during this epidemic.
4. Eye workers have a role in the response to RVF epidemic.

## 9.0 RECOMMENDATIONS

Eye care workers need to be involved in the early response to RVF epidemic to address the ocular morbidity.

There is need for long-term follow-up of these cases to learn more on the long-term effects of RVF.



## 10.0 REFERENCES

1. Gerdes G.H., Rift Valley fever. *Rev. Sci. tech. Off. int. Epiz.*, 2004, 23 (2), 613-623
2. WHO Hemorrhagic Fever Task Force. Rift Valley fever outbreaks in East Africa. Presented at the International Conference on Emerging Infectious Diseases, Atlanta, March 8-12,1998.
3. Abdel-Wahab K.S.E., El Baz L.M., El Tayeb E.M., Omar H., Ossman M.A. & Yasin W. (1978). Rift Valley fever virus infections in Egypt: pathological and virological findings in man. *Trans, roy. Soc. trop. Med. Hyg.*, 72 (4)
4. Abd El-Rahim I.H.A., Abd El-Hakim U. & Hussein M. (1999). An epizootic of Rift Valley fever in Egypt in 1997. *Rev. Sci. tech. Off. Int. Epiz*, 18 (3), 741-748.
5. KsiazekTG, Jouan A, Meegan JM, Le Guenno B, Wilson ML, Peters CJ, Digoutte JP, Guillaud M, Merzoug NO, Touray EM. Rift Valley fever among domestic animals in the recent West African outbreak. *Res Virol* 1989; 140(1):67-77
6. CDC. Rift Valley Fever Outbreak — Kenya, November 2006-January 2007. *MMWR* 2007; 56(04);73-76
7. CDC. Rift Valley fever—East Africa, 1997-1998. *MMWR* 1998; 47:261-4.
8. Al-Hazmi A, Al-Rajhi AA, et al. Ocular Complications of Rift Valley Fever Outbreak in Saudi Arabia. *Ophthalmology* 2005; 112:313-318

9. Kenya: five more die from unidentified disease., East African Standard (Nairobi) 2006 Dec 20.
10. Elwan MS, Sharaf MH, Gameel K, et al. Rift Valley fever retinopathy: observations in a new outbreak. *Ann Saudi Med* 1997;17:377- 80.
11. Siam AL, Meegan JM, Gharbawi KF. Rift Valley fever ocular manifestations: Observations during the 1977 epidemic in Egypt. *Br J Ophthalmol* 1980; 64:366.
12. Diguotte JP, Peters CJ. General aspects of the 1987 Rift Valley fever epidemic in Mauritania. *Res Virol* 1989; 140:27.
13. Agriculture and Resource Management Council of Australia and New Zealand. Disease strategy. Rift valley fever. AUSVETPLAN Edition 2.0,1996
14. Sanders EJ, Borus P, Ademba G, Kuria G, Tukei PM, LeDuc JW. Sentinel surveillance for yellow fever inKenya, 1993 to 1995. *Emerg Infect Dis* 1996;2:236-8
15. Turell MJ, Linthicum KJ Beaman JR. Transmission of rift valley fever virus by adult mosquitoes after ingestion of virus as larvae. *Am. J. Trop. Med. Hyg.*, 43(6), 1990, pp. 677-680.
16. Krogstad DJ. Malaria as a reemerging disease. *Epidemiol Rev* 1996;18:77-89.
17. Baba Soumare, Stefano Tempia, et al,. Screening for Rift Valley fever infection in northern Somalia: A GIS based survey method to overcome the lack of sampling frame. *Veterinary Microbiology* 2007; 121, (3-4):249-256

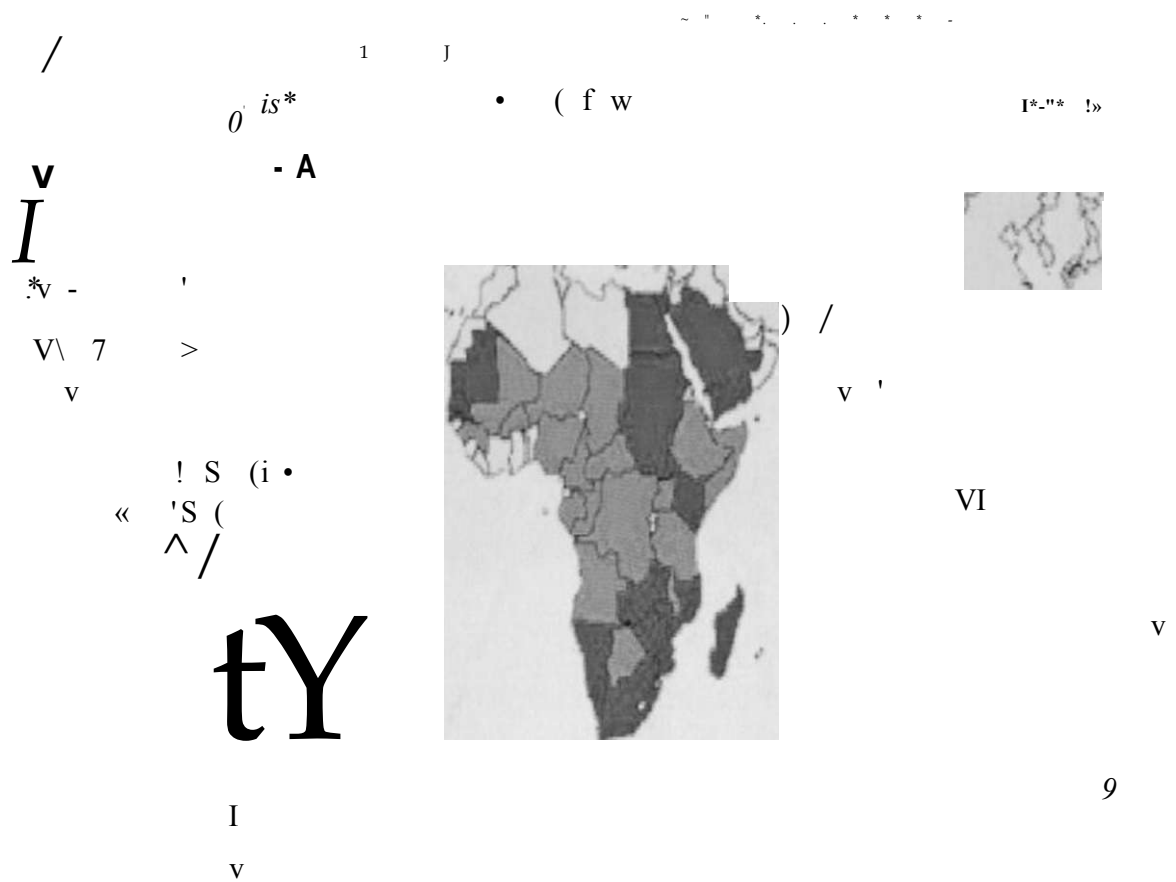
18. World Health Organization. An outbreak of Rift Valley fever, Eastern Africa, 1997-1998. *Wkly Epidemiol Rec* 1998; 73:105-9.
- 19.. Meegan JM, Bailey CL. Rift Valley fever. In: Monath T, editor. *Arboviruses: Epidemiology and Ecology*. Vol. IV. Boca Raton: CRC Press, 1988; 51-76.
20. Walsh J. Rift Valley fever rears its head. *Science* 240:1397,1988
21. Siam AL, Meegan JM. Ocular disease resulting from infection with Rift Valley fever virus. *Trans R Soc Trop Med Hyg* 74:539,1980
22. El-Bradey MH, Freeman WR. Infectious retinitis. *Duanne's ophthalmology on CD ROM* 2006.
23. Chibuga B, et al. Ocular manifestation of rift valley fever in Dodoma region. 35<sup>th</sup> OSEA Annual Scientific Conference, August 2007.(unpublished)
24. Peyrefitte CN, Pastorino B, Grau GE, Lou J, Tolou H, Couissinier-Paris P. Dengue virus infection of human microvascular endothelial cells from different vascular beds promotes both common and specific functional changes. *Journal of Medical Virology*, 78(2), Pp 229 - 242.
25. Director of rural planning, Ministry of Planning and National Development GoK. Baringo District Development Plan 2002-2008.
26. Director of rural planning, Ministry of Planning and National Development GoK. Machakos District Development Plan 2002-2008.
27. Goldstein DA, Tessler HH. Complications of uveitis and their management. *Duanne's Ophthalmology on CD ROM* 2006.

## APPENDIX

### Appendix 1: WHO grading of visual acuity.

1. 6/6 - 6/18 -Normal
2. <6/18 - 6/60 -Visual impairment
3. <6/60 - 3/60 -Severe visual impairment
- 4 <3/60- NPL -Blind

**Appendix 2: Worldwide distribution of RVF epidemics.**



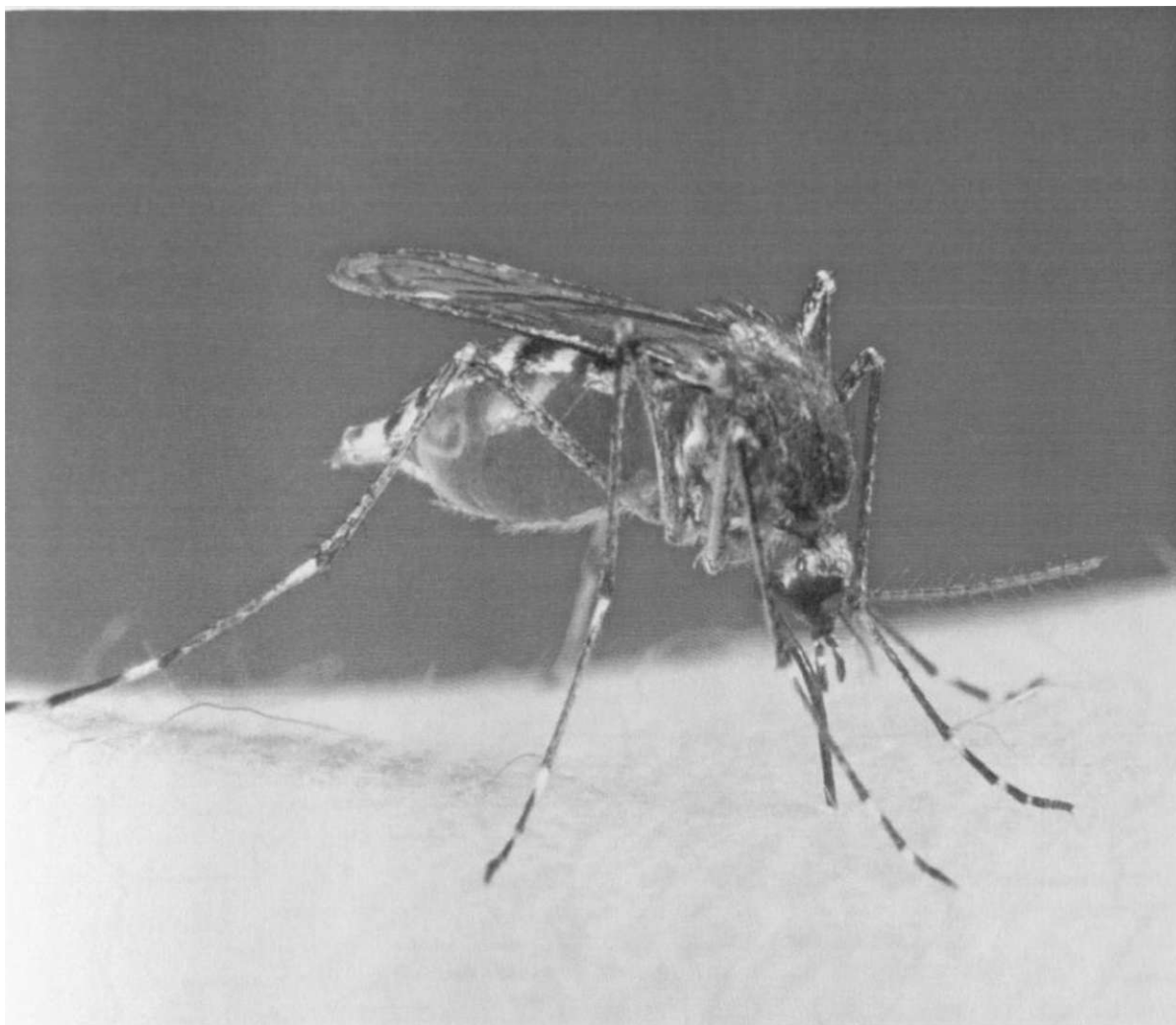
**Countries with endemic disease and substantial outbreaks of RVF:**

Gambia, Senegal, Mauritania, Namibia, South Africa, Mozambique, Zimbabwe, Zambia, **Kenya**, Sudan, Egypt, Madagascar, Saudi Arabia, Yemen

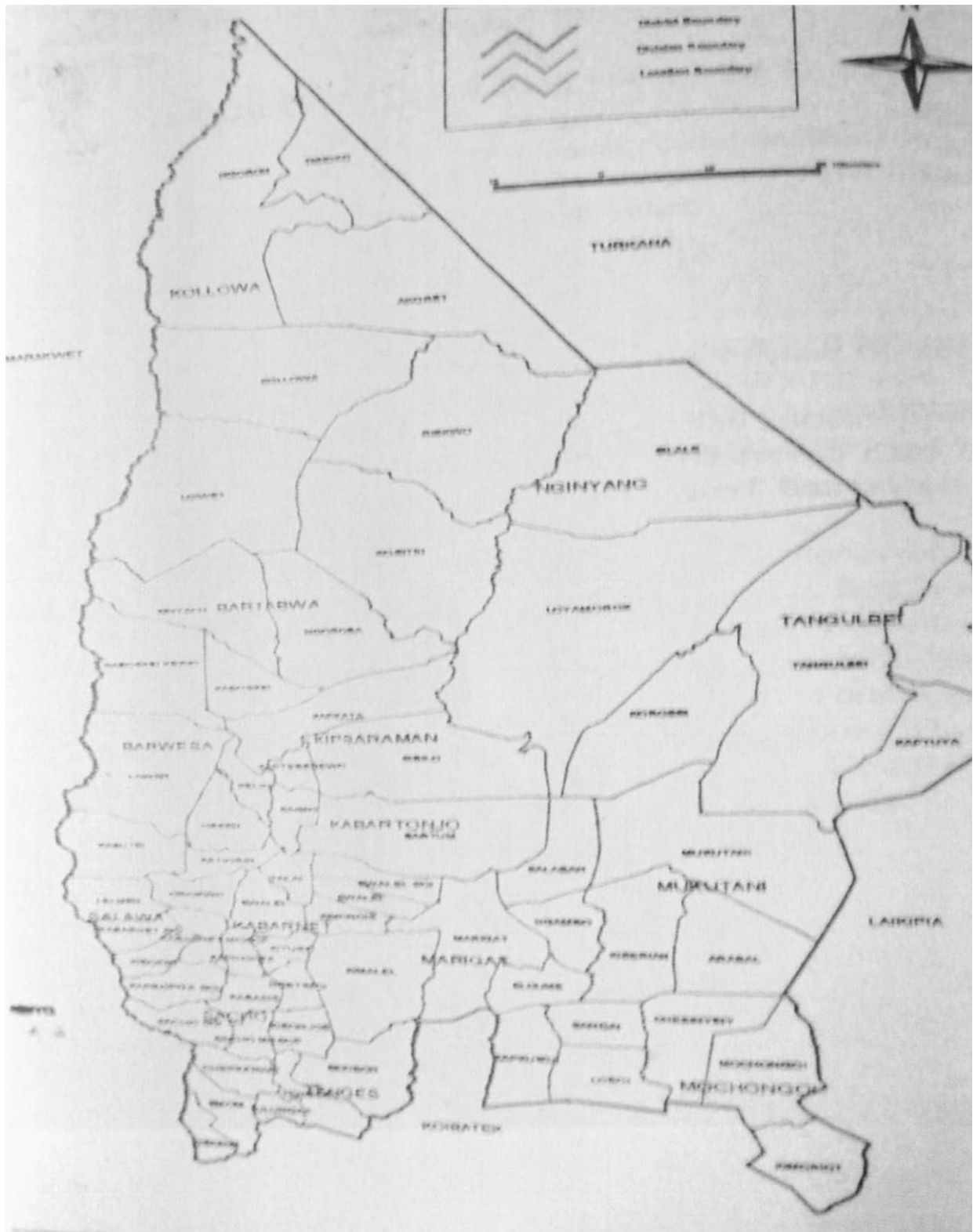
**Countries known to have some cases, periodic isolation of virus, or serologic evidence of RVF:**

Botswana, Angola, Democratic Republic of the Congo, Congo, Gabon, Cameroon, Nigeria, Central African Republic, Chad, Niger, Burkina Faso, Mali, Guinea, Tanzania, Malawi, Uganda, Ethiopia, Somalia

**Appendix 3: Aedes Mosquito**



**Appendix 4: Map of Baringo district**



**Appendix 4: Map of Machakos district**



5 12:27

MAKUENI DISTRICT

Legend:

- District Boundary
- - - Sub-district Boundary
- MAAwA District Name
- wxs 1! District Name
- Mothokos low\*



Appendix 5: Questionnaire

QUESTIONARE

Interview date \_\_\_/\_\_\_/07 Interviewer: \_\_\_\_\_ Patient No.

Province \_\_\_\_\_ District \_\_\_\_\_

Division \_\_\_\_\_ Location \_\_\_\_\_

Sublocation \_\_\_\_\_ Village \_\_\_\_\_

Village Chief \_\_\_\_\_

<i>Demographic information</i>	
1	What is your name?
2	What is your age?
3	Sex                      Male      Female
4	What do you do?    herder    Butcher    farmer    Kitchen worker • other
5	When did you first start feeling ill                      —J—/—
6	Did you seek medical care in a hospital or other health facility?                      Yes    O No
7	Did you have to stay overnight in a hospital or other health facility?                      Yes    • No
8	<i>If "Yes,"</i> how many nights did you stay overnight?
9	Were you given medicine?                      Yes    No
10	<i>If Yes,"</i> Which medicine?

*Signs and symptoms*

I am going to read you a list of problems. Please tell me if you have had any of these problems during or after your recent illness:

*[read each one, and check all that apply]*

	<i>Problem</i>	<i>Answer</i>
11	Weakness	Yes    No
12	Fever	Yes    No
13	Chills	• Yes    • No
14	Headache	Yes    No
15	Pain behind your eyes	• Yes    No
16	Blurred vision:	Yes    No
16a	<i>If yes,</i> L right eye    • left eye	
17	Blindness:	• Yes    No
17a	<i>If yes,</i> right eye    left eye	
18	Seeing dark spots:	Yes    G No
18a	<i>If yes,</i> right eye    C left eye	
19	Other visual problems (specify):	Yes    Q No
20	Are you having any eye problems now?	J Yes    • No



30	Were you sleeping under an insecticide-treated bednet during the two weeks before you became ill?	Yes <b>D</b> No
----	---	-----------------

That is the end of the questions. Thank you very much!

Now we would like to do an eye exam.

	1. Visual Acuity	OD	-PH	OS	PH
j 2.	Colour vision	0			•
1 3.	EOMM Free				•
	Not free				•
I 4.	Lids- Normal				•
	Others (Specify)	specify			
: 5.	Conjunctiva Normal	•		a	
	Not normal	•	•		
		• Injected	•		•
I		• Follicles		0	
I		• Hemorrhagic	0		0
		• Others(Specify)			
j 6.	Cornea				j
	Clear	0		•	
	Not clear			•	t
	KPs	•		•	•
	• Others(specify)	specify			
! 7.	Anterior Chamber Quiet	•		D	
	Cells				•
	Flare	D			•
	Blood	•		•	
	Others (Specify)	specify			
} 8.	Pupils		D	•	
	NRRL	0		0	
1 9.	Iris Normal	•			•
	Nodules	Q			
	Others (Specify)	specify			
J					J
1 10.	Lens Clear	•		D	
	Cataractous	Q			•
	Nuclear	•			•
	Cortical	•			•
	Others	specify			
1 11.	Vitreous				
	• Clear	•			•
	• Cells				0
	• Hemorrhage				•
	• Others(specify)				
j 12.	Fundus				
	a) Optic disc				
	• Normal			•	
	• Edematous				•
	• Cupping	•			
	• Hemorrhagic	0			•
	• Others (specify)	specify'			

<b>b)</b> Macula			
•	Normal		0
•	Edematous	•	•
•	Hemorrhage	•	•
•	Exudates	0	•
•	Others (specify)	<b>specify</b>	
<b>c)</b> Vessels			
•	Normal	•	•
•	Narrowed		D
•	Sheathing	•	•
•			
•	Others (specify)		
<b>d)</b> Retinitis			
•	Present		•
•	Absent		
•	Scar		•
•	Others (specify)		
<b>i 13.</b>	Fundus drawing		

**Appendix 6: Consent form**

I.....of P.O. Box .....and/ or district

Hereby give consent to be included in this study. I further state that the procedure has been explained to me in a language I understand well what is to be done and have agreed for the examination to be done on me.

Date

Signed.....(Participant)

I confirm that I have explained the nature of my study and examination procedure to the above-mentioned participant.

Date

Signed.....(Investigator)