EPIDEMIOLOGIC STUDY ON RIFT VALLEY FEVER IN THE SOUTH-WEST Of KINGDOM OF SAUDI ARABIA

BY

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ABSTRACT

Data pertinent to Rift Valley Fever outbreak in the Kingdom of Saudi Arabia were obtained and analyzed. The outbreak occurred in the regions of Jazan, Tohamat Asir and Tohamat Makkah during the period from September 2000 to April 2001. Out of the total animal cases, 65.6% were in Jazan, 26.9% in Tohamat Asir and 7.5% in Tohamat Makkah. In Jazan region 65.8% of the cases occurred in the districts of Baish and Alarda while in Tohamat Asir 39.5% of the cases occurred in the district of Mahayil. Nevertheless, 64.7% of the cases in all regions occurred in September and October 2000.

Infection rates in animals were 23% in Jazan, 8.7% in Tohamat Asir and 2% in Tohamat Makkah. In types of animals, infection rates were 9.7% in sheep, 7.9% in goats, 1.2% in cattle and 1.3% in camels.

The possible sources of infection as well as transmission of the virus from Africa to the Arabian Peninsula were discussed.

ملخص

جمعت المعلومات الخاصة بإندلاعة حمى الوادي المتصدع في المملكة العربية السعودية ودرست دراسة وبائية. حدثت الإندلاعة في كل من مناطق جازان وتهامة عسير وتهامة مكة في الفترة ما بين سبتمبر 2000م وأبريل 2001م. من كل حالات المرض في الحيوانات كانت النسبة المئوية في جازان 65.6%، وفي تهامة عسير 26.9%، وفي تهامة مكة 7.5%. في منطقة جازان كانت 65.8% من الحالات في محافظتي بيش والعارضة. أما في تهامة عسير فقد كانت 39.5% من الحالات في محافظة محايل. كما أن 64.7% من الحالات في كل المناطق حدثت في شهري سبتمبر وأكتوبر 2000م.

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كانت نسبة الإصابة في الحيوانات في منطقة جازان 23%، وفي تهامة عسير 8.7%، وفي تهامة مكة 2%. أما في نوع الحيوان فقد كانت نسبة الإصابة في الضأن 9.7%، وفي الماعز 7.9%، وفي الأبقار 1.2% وفي الإبل 1.3%.

تطرقت هذه الدراسة لمناقشة المصدر المحتمل للإصابة وكيفية انتقال الفيروس من أفريقيا إلى شبه الجزيرة العربية.

INTRODUCTION

Rift Valley Fever (RVF) is an acute or peracute viral zoonotic disease of sheep, goats, cattle, camels and humans.It is caused by a mosquito-borne Bunyavirus of the genus Phlebotomus(1). The disease is transmitted among animals mainly by mosquitoes (*Aedes sp.* and *Culex sp.*) which act as biological vectors (2,3,4). Humans contract the disease through direct contact with aborted fetuses, fetal membranes, blood and body fluids of infected animals and also through exposure to infected mosquitoes (1).

The disease has been known in Africa since the thirties of the last century. Several outbreaks occurred in Kenya, South Africa, Sudan and Egypt during the seventies. In the last twenty years several outbreaks occurred in Senegal (1987), Mauritania (1987 and 1998), Egypt (1987 and 1993/1994), and in Kenya, Tanzania and Somalia (1997/1998) (5).

Rift Valley Fever outbreak in the Kingdom of Saudi Arabia and Yemen Republic in 200/2001 is the first to occur outside Africa and Madagascar (6,7). It started in late August 2000 when the first human suspect cases in the Kingdom of Saudi Arabia were reported to the Ministry of Health. At the same time cases of abortion and death in animals were reported to the Ministry of Agriculture and Water. The first human and animal cases occurred in Alarda district in Jazan Region in the South West of Saudi Arabia. Also, and at the same time, cases of abortion and animals death were reported in the Yemen Republic. In mid September 2000, the Centers for Disease Control (CDC) of the United States confirmed the human cases as Rift Valley Fever. Samples taken from animals suspects were also confirmed by the Veterinary Laboratory in Jazan city as Rift Valley Fever.

Immediately after the diagnosis of the disease the Ministry of Agriculture and Water implemented stringent measures to control the

outbreak. These control measures included restriction of movement of animals, insecticide spraying, vaccination and surveillance. The control measures proved successful since there has been no positive case since 22/4/2001.

MATERIALS AND METHODS

Study Area: The study area included the regions of Jazan, Tohamat Asir and Tohamat Makkah. These regions are geographically located in the South-West of Saudi Arabia. Jazan region is adjacent to the Yem-en Republic to the East and South, the Red Sea to the West and Asir region to the north. Makkah region is located to the North-West of Asir. The three regions lie between the Sarawat Mountains to the East and the Red Sea to the West. There are several valleys crossing the regions from the Sarawat Mountains to the Red Sea. Jazan and Toha-mat Asir regions have a hot climate with a considerable level of rain-fall (300-700 mm rain) in areas close to the mountains. This level of rainfall facilitates agricultural and animal production activities in these areas. However, in the coastal plains the level of rainfall is low if any. (Table 1).

Table (1): Monthly and Yearly Rainfall Average in Some Districts of Jazan Region (in mm)

DISTRICT	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
JIZAN	0	0	0	0	0	0	0	0	0	0	0	9	11
ABU-ARISH	16	6	14	10	11	1	36	68	24	19	11	14	211
ALDARB	16	5	3	4	58	1	12	10	8	8	4	8	82
HAROB	24	35	19	29	68	44	68	108	98	96	50	30	654
FAYFA	41	31	33	70	68	46	84	93	47	27	35	39	596
ALKHOBA	8	7	8	30	67	66	88	103	72	54	33	21	309
ITWID	13	19	13	1	8	4	15	14	21	15	10	5	99
SABYA	7	3	6	3	6	0	28	7	13	17	7	7	100
SAMTA	12	3	2	2	11	2	13	10	7	14	10	5	82
ALARDA	24	12	8	25	36	34	73	87	62	45	40	23	421

Source: Geography of Agriculture in Jazan. Authors: Dr. Majdi Abdelhamid Alsorsi and Dr. Ali Mohamed Shayban.

Source of Information: Information pertinent to RVF in Saudi Arabia were obtained from records filed in the headquarters office control of RVF in Jazan city as well as visits to the affected areas. Data used to estimate infection rates and distribution of infection region, district, month and animal are based on cases diagnosed in the veterinary laboratory in Jazan city. The laboratory was established and initially equipped through technical assistance of experts from the National Institute for Virology of the Republic of South Africa in late

September 2000. In this study a case is defined as a sample of serum, which tested positive to IgM antibodies to RVF virus in the ELISA diagnostic test. The samples were collected by field veterinarians from suspected animals, animals in contact and randomly from animals in the affected regions.

Since data did not include information about factors which affected the occurrence and distribution of the disease, quantitative statistical analysis was not possible.

RESULTS

Geographic Distribution and Date of Onset: Results are summarized in (Table 2). The first case of RVF in animals occurred in the village of Alhomayra in Alarda district, Jazan region. On 26/9/2000, 97 positive cases were diagnosed in the veterinary laboratory. On 27/9/2000 several cases were diagnosed in Sabya district. Cases of disease were then diagnosed in Baish district and Aldarb district on 28/9/2000. Then, on 3/10/2000 cases of the disease were diagnosed in Jazan district and Abu-Arish district. On 4/10/2000 cases were diagnosed in Algunfoda district, Makkah region, all the cases that occurred in the first month of the outbreak were confined to Jazan region. (Table 2).

In the second month of the outbreak, cases started to appear in Asir region. On 19/10/2000 several cases were diagnosed in Gana/Albahr district and Rigal Alma district in Asir. Cases were also diagnosed in Mahayil district and Albirk center on 20/10/2000. On 26/10/2000 cases were diagnosed in Amagarda district and Algahma center. On 3/11/2000 cases were diagnosed in Alhereda center. In the region of Makkah, only Algunfoda district was affected.

The outbreak occurred in the regions of JAZAN, Tohamat Asir, and Tohamat Makkah during September through December 2000. During January and February 2001 only a single case was diagnosed in Alsawalha village in Tohamat Asir. Few cases were diagnosed again from each of Jazan, Tohamat Asir and Tohamat Makkah during March 2001. The last cases occurred in the outbreak were diagnosed from Almoassum village in Ahad Almasarha district in April 2001.

Distribution of Cases by Region and District: In Jazan region 358 cases were diagnosed. Baish district reported 138 cases which represent

38.5% of the cases in Jazan. Alarda district reported 98 cases which represent 27.3%. The number of cases in both districts represents 65.8% of cases in Jazan region. Table (2).It is important to mention that Baish and Alarda district are located close in the area of Wadi Baish and Wadi Jazan. Also, Alarda district is located to Alsad Lake and Mushrif Lake.

In Asir region 147 cases were diagnosed. Mahayil district reported 58 cases which represent 39.5% of cases in Asir. Rigal Alma district reported 30 cases (20.5%), Gana/Albahr reported 17 cases (11.6%), and Algahma reported16 cases (10.9%) (Table 2). It is worth mentioning that Mahayil district is located in the area of Wadi Hily and Wadi Tayah. In Makkah region, the 41 cases diagnosed were from Algunfoda district. (Table 2).

Table (2): Distribution of RVF Cases by Region and District Showing The Date of Onset of First and Last Case

REGION	DISTRICT	DATE OF FIRST CASE	DATE OF LAST CASE	NUMBER OF CASES (%)
JAZAN	ALARDA	26/9/2000	26/11/2000	98 (27.3)
	SABYA	27/9/2000	26/11/2000	31 (8.7)
	BAISH	28/9/2000	12/4/2001	138 (38.5)
	ALDARB	28/9/2000	28/9/2000	7 (1.9)
	JIZAN	3/10/2000	24/11/2000	13 (3.6)
	ABU-ARISH	3/10/2000	26/11/2000	29 (8.1)
	AHAD ALMASARHA	9/10/2000	22/4/2001	37 (10.3)
	AYBAN	18/11/2000	18/11/2000	3 (0.8)
	ALSHIGEG	9/12/2000	9/12/2000	2 (0.6)
TOTAL				**358 (100)**
REGION	**DISTRICT**	**DATE OF FIRST CASE**	**DATE OF LAST CASE**	**NUMBER OF CASES (%)**
ASIR	GANA/ALBAHR	19/10/2000	27/11/2000	17 (11.6)
	RIGAL ALMA	19/10/2000	16/12/2000	30 (20.5)
	MAHAYL	20/10/2000	16/12/2000	58 (39.5)
	ALBIRK	20/10/2000	14/12/2000	8 (5.4)
	ALGAHMA	26/10/2000	16/12/2000	16 (10.9)
	ALMAGARDA	26/10/2000	28/3/2001	9 (6.1)
	ALHEREDA	3/11/2000	5/11/2000	9 (6.1)
TOTAL				**147 (100)**
REGION	**DISTRICT**	**DATE OF FIRST CASE**	**DATE OF LAST CASE**	**NUMBER OF CASES (%)**
MAKKAH	ALGUNFODA	4/10/2000	28/3/2001	41 (100)

Infection Rates in Regions and in Animals: Infection rate (disease prevalence) varies from one region to another. From data collected from September 2000 to April 2001, the disease prevalence was 23% in Jazan, 8.7% in Tohamat Asir, and 2% in Tohamat Makkah. The

Overall prevalence in the regions affected was 12.3%. Out of the total cases, 65.6% of the cases occurred in Jazan, 26.9% in Tohamat Asir and 7.5% in Tohamat Makkah.

Infection rates in animals varied from one type of animal to another. Infection rate was 9.7% in sheep, 7.9% in goats, 1.2% in cattle, and 1.3% in camels. These rates differed according to the region. In Jazan the rates were 12.6% in sheep and 11.9% in goats. While in Tohamat Asir the rates were 13.6% in sheep and 7.6% in goats. In Tohamat Makkah the rates were 6.1 in sheep and 6.6% in goats. (Table 3).

Table (3): Distribution of RVF Cases by Region and Type of Animal

REGION	No. of SAMPLES	SHEEP		GOATS		CATTLE		CAMELS	
		+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve
JAZAN	1018	40	282	49	364	3	216	1	63
+ve%		12.4%		11.9%		1.4%		1.6%	
ASIR	1569	44	279	92	1126	0	18	0	10
+ve%		13.6%		7.6%		0%		0%	
MAKKAH	1306	36	550	46	649	0	19	0	6
+ve%		6.1%		6.6%		0%		0%	
TOTAL	**3893**	**120**	**1111**	**187**	**2139**	**3**	**253**	**1**	**79**
+ve%		9.7%		7.9%		1.2%		1.3	

DISCUSSION

The outbreak of RVF in the Kingdom of Saudi Arabia and the Republic of Yemen needs to be thoroughly investigated because it is the first time to occur outside Africa and Madagascar (6,7). This study clarifies the epidemiologic aspects of the outbreak in Saudi Arabia.

It is not clear when and how the RVF virus transmitted from Africa to some areas of the Arabian Peninsula. However, the Centers for Disease Control (CDC) reported genetic relationship between the RVF virus isolated from the outbreak in Saudi Arabia 2000/2001 and the RVF virus isolated from the outbreak which occurred in Kenya, Tanzania and the Horn of Africa 1997/1998 (7). This may indicate that the virus was transmitted from Africa to the Arabian Peninsula during that period. Also, it is not clear how the infection crossed a natural barrier (Red Sea) which separates Africa from the Arabian Peninsula. This study presents and discusses some possible scenarios: The virus was transmitted from Africa to the Arabian

Peninsula by the movement of some infected animals as part of the massive livestock trade from the Horn of Africa to Saudi Arabia. The virus was transmitted through mosquitoes crossing the Red Sea in ships and boats or flying over assisted by wind currents. The virus was transmitted by the eggs of mosquitoes (*Aedes sp.*) which carried over by dust storms.

It is most likely that the disease was transmitted from Africa to Saudi Arabia in 1997/1998 as a result of the movement of some infected trade animals. This scenario is supported by the presence of IgG positive and at the same time IgM negative samples in the serosurvey carried out in Jazan region during the period 26/9-10/2000 which may indicate the presence of an old infection (probably 2-3 years old). Transmission of the virus during 1997/1998 is supported by the fact that environmental conditions particularly high rainfall were very much ideal for mosquito breeding during 1995, 1996 and 1997 compared to 2000/2001but no epidemics occurred during these years. The main argument is, that was no epidemic at these years because there was no virus. Also in support for the first scenario, is the fact that for an epidemic to occur an infective dose of virus is needed. This infective dose is more likely to be produced and maintained by infected animals which act as amplifier. Mosquitoes (*Aedes sp.* and *Culex sp.*) can transmit the virus horizontally from infected animals to susceptible animals and humans (2,3,4). Also, *Aedes sp.* may transmit the virus vertically through their eggs to other mosquito generations and hence maintaining low level of infection in nature. However, the role of these mosquitoes as amplifier for the virus is not documented.

Most of the cases in Jazan region occurred in Baish and Alarda districts while the most affected district in Asir region was Mahayil. These three districts are located in the areas of Wadi Baish and Wadi Jazan in Jazan region, and in Wadi Hily and Wadi Tayah in Asir region which are the biggest valleys in the two regions. Alarda district is also located close to Alsad Lake and Moshrif Lake behind Wadi Jazan dam. Environmental conditions in the areas of these valleys and lakes are ideal for the breeding of mosquitoes mainly *Aedes vexans arabiensis* and *Culex (culex) triteniorynchus* the biological vectors associated with RVF in Saudi Arabia (2). The

occurrence of outbreaks of RVF close to lakes formed as result of construction of dams was also observed in the Senegal after construction of the dam on the Senegal River (8) and in Egypt following the construction of the High Dam on the River Nile (9).

Rift Valley Fever outbreaks usually occur following seasons of high rainfall (5). This is the situation in the region of Jazan, which is characterized by high rainfall specially during July, August, September and October. Moreover, there are many valleys (seasonal riverbeds) running from the Sarawat Mountains in the East crossing the region to the Red Sea in the West. Also, an important human factor to be considered is that people tend to collect rainwater in man-made pools for the irrigation of crops (flood irrigation). Water may stay in these pools for months before it is absorbed and the soil then cultivated. These environmental factors in addition to human activities represented by this type of flood irrigation provide an ideal habitat for the breeding of mosquito vectors.

Occurrence and intensity of RVF outbreak during the period from September 2000 to April 2001 positively coincided with the level of rainfall in the region of Jazan which reached its peak during the months of August and September, and its lowest level if any during January, February and March. Likewise, the highest numbers of cases were diagnosed in September and October and the least numbers of cases were in January and February. The situation of the disease in Saudi Arabia is more or less similar to the situation of the disease in Africa on grounds of genetic constitution of the virus (7), vectors (2.3.4), intensity and distribution (8,9,10).

Infection rates of RVF in the regions, which are observed in this study, are in agreement with the results of a previous serosurvey carried out during the period from 26/9/2000 to 10/10/2000 in which infection rates were 20.4% in Jazan, 9.4% in Asir, and 3% in Makkah. Also, infection rates in animals observed in this study are in agreement with infection rates reported from the outbreak in Africa where infection rates were high in sheep and goats and low in cattle and camels. Nevertheless, severe cases and high mortality and abortion rates were observed in sheep and goats (1).

The cases diagnosed in the coastal districts and centers like Jazan, Alarda, Alshigeg, Alhereda, Algahma, Albirk, Alsawalha and

Algunfoda where rainfall is low and there is no or little agricultural activities, were most likely due to either low viral activity or as a result of movement of animals within and between the infected regions and outside to big cities like Makkah and Jeddah. All these districts and centers are crossed by the highway connecting Jazan to Makkah and Jeddah.

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