

The persistence of Rift Valley fever in the Jazan region of Saudi Arabia

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Summary

A survey was conducted in the Jazan region of Saudi Arabia to investigate the presence of Rift Valley fever (RVF) in sheep and goats, by clinical identification of suspected herds and detection of immunoglobulin M (IgM) antibodies to RVF virus. The level of herd immunity was identified by detecting immunoglobulin G (IgG) antibodies. Rift Valley fever was diagnosed in six out of eight districts included in the survey. Twenty-two animals from 17 herds tested positive for the presence of IgM antibodies against RVF in these districts. The infection rate ranged from 0.12% in the Sabya district to 1.04% in the Jizan district. The level of herd immunity ranged from 22.2% in Jizan to 39.3% in the Alarda district. It can be concluded that the presence of IgM antibodies in clinically suspected herds suggests persistent RVF infection in the Jazan region. Thus, RVF control programmes should be continued to prevent the recurrence of outbreaks in the region and the possible further spread of infection to other regions of Saudi Arabia.

Keywords

Epidemiological surveillance – Jazan – Middle East – Persistence – Rift Valley fever – Saudi Arabia – Serological survey.

Introduction

Rift Valley fever (RVF) is a zoonotic disease of domestic ruminants, caused by a mosquito-borne virus of the family *Bunyaviridae*, genus *Phlebovirus* (17). In the years 2000 to 2001, an outbreak of RVF occurred in south-west Saudi Arabia and north-west Yemen (2, 3, 4, 5). This was the first occurrence of RVF outside the African continent and Madagascar (9, 12, 15). The virus isolated from this outbreak was almost identical to the virus implicated in the 1997 to 1998 outbreak in East Africa (15). Two species of mosquitoes, namely, *Aedes vexans arabiensis* and *Culex (culex) tritaeniorhynchus*, were implicated in the Saudi Arabian outbreak (9). Since environmental conditions in south-west Saudi Arabia are suitable for breeding dense populations of mosquitoes, there is some concern that RVF

may persist in these regions and spread to other parts of the country.

In south-west Saudi Arabia, the Jazan region was the hardest hit by the outbreak. Out of the total number of animal cases, 65.6% occurred in the Jazan region, 26.9% in Tahamat Asir and 7.5% in Tahamat Makkah. Moreover, the infection rate was 23% in Jazan, 8.7% in Tahamat Asir and 2% in Tahamat Makkah (5). Control measures, including the mass vaccination of livestock (primarily sheep and goats) with the live attenuated RVF Smithburn strain vaccine, were implemented in the south-west immediately after the outbreak began. This vaccination programme has continued in the south-west, with young animals being vaccinated at the age of six months. In addition, monitoring and surveillance programmes have been conducted to investigate herd immunity and disease

status in different seasons. In a previous serological survey, conducted in 2003, not a single case of RVF was diagnosed in Jazan (7).

This paper describes a recent epidemiological and serological study conducted during the 2004 rainy season in the Jazan region. The season runs from July to October and the study took place from 21 August to 31 October. The purpose of the study was to:

a) investigate the presence of RVF through the clinical identification of suspected herds and the detection of immunoglobulin M (IgM) antibodies against the RVF virus

b) determine the level of herd immunity through the detection of immunoglobulin G (IgG) antibodies against the virus.

Materials and methods

Study area

The Jazan region is geographically located in the south-west of Saudi Arabia. There are several valleys in this area, which extends from the Sarawat Mountains to the Red Sea. The climate is hot, with considerable rainfall (300 mm per year to 700 mm per year) in areas close to the mountains. This amount of rainfall facilitates significant agricultural and animal production. Fields are irrigated mainly through flooding and rainwater may also stay in the fields for several weeks. The hot and humid climate provides the ideal breeding conditions for the mosquitoes *A. vexans arabiensis* and *C. (culex) tritaeniorhynchus*, the vectors that transmit the RVF virus in Saudi Arabia (9).

Study design

This was a prospective cross-sectional study that targeted sheep and goat herds in which death, abortion and/or diarrhoea were observed (suspected herds). Blood samples were obtained from sick animals as well as from a random sampling of 10% to 15% of healthy animals in the same herd. In the case of small herds (i.e. no more than 20 animals), blood samples were obtained from all the individuals in the herd. Animals vaccinated with the live attenuated RVF Smithburn strain vaccine within the month running up to the day samples were taken were not included in the survey.

Field veterinarians in each district of the Jazan region performed daily clinical investigations among herds in which abortion, death and/or diarrhoea were observed and collected blood samples. Each blood sample was obtained with a separate needle and a vacuum tube. After serum separation in these same tubes, the blood samples were

sent to the Jazan Veterinary Diagnostic Laboratory in Jizan City for diagnosis.

Immediately after diagnosis, herds that tested positive for IgM antibodies against the RVF virus were visited by the consultant epidemiologist and field veterinarian to investigate the vaccination status of the herd. If the herd had been vaccinated, the vaccination date was verified from government veterinary records. Information was also gathered on the introduction of new animals into the herd.

Laboratory diagnosis

The enzyme-linked immunosorbent assay (ELISA) kits used to detect IgM and IgG antibodies against the RVF virus were prepared by the National Institute for Communicable Diseases, Johannesburg, South Africa. The IgM-capture and IgG-sandwich ELISA techniques used to detect IgM and IgG antibodies in this study have been fully described in an earlier study (14).

Results

A total of 6,143 serum samples were tested by IgM-capture ELISA. Rift Valley fever was diagnosed in six out of the eight districts included in the survey. Twenty-two animals from 17 herds tested positive for IgM antibodies. The rate of infection ranged from 0.12% in the Sabya district to 1.04% in the Jizan district. The overall infection rate was 0.36% in the Jazan region (Table I).

In addition, a total of 3,794 serum samples were tested by sandwich ELISA for IgG antibodies. The level of herd immunity ranged from 22.2% in the Jizan district to 39.3% in Alarda. The overall level of herd immunity in the Jazan region was 29% (Table I).

Among the 17 herds that tested positive for IgM antibodies against the RVF virus, 14 herds were raised by local farmers, two herds had been smuggled from a neighbouring country (and confiscated by border authorities) and the last was a sentinel herd. Subsequent epidemiological investigations into the 14 herds raised by local farmers revealed that none had been vaccinated with the live attenuated RVF Smithburn strain vaccine within the seven months prior to sampling. Furthermore, all farmers confirmed that no new animals had ever been introduced into their herd.

The two smuggled herds came from a neighbouring country which has no vaccination programme. The sentinel herd was one of seven placed in Jazan as part of the control programme. All sentinel animals had ear tags and had not been vaccinated against RVF.

Table I
The rates of Rift Valley fever infection (demonstrated by immunoglobulin M) and herd immunity (by immunoglobulin G) in sheep and goats of all ages, raised in the eight districts of the Jazan region, Saudi Arabia, in 2004

District	Immunoglobulin M		Immunoglobulin G	
	Number of samples tested	Number testing positive (%) ^(a)	Number of samples tested	Number testing positive (%) ^(b)
Abu-Arish	701	7 (0.99%)	748	220 (29.4%)
Jizan	480	5 (1.04%)	225	50 (22.2%)
Alarda	555	4 (0.72%)	512	201 (39.3%)
Ahad-Almasarha	1,327	2 (0.15%)	632	224 (35.4%)
Baish	418	1 (0.24%)	157	44 (28%)
Sabya	813	1 (0.12%)	705	219 (31.1%)
Ayban	252	0	202	74 (36.6%)
Alhorra	218	0	162	63 (38.9%)
Altwal ^(c)	1,379	2 (0.15%)	451	4 (0.89%)
Total	6,143	22 (0.36%)	3,794	1,099 (29%)

a) rate of infection

b) level of herd immunity

c) a border city, where the quarantine facilities for smuggled animals are located

Five IgM-positive herds showed clinical signs of RVF and were visited for 'follow-up' investigations. The first herd consisted of approximately 120 animals (sheep and goats). The farmer reported 17 cases of abortion in the two to three weeks before the diagnosis of three IgM-positive female goats (aged from two to five years). These three goats tested negative for brucellosis. Moreover, a further 13 cases of abortion were observed by the veterinarian over several subsequent visits to the herd.

The second IgM-positive herd consisted of 170 sheep and goats. The farmer reported 30 deaths among lambs and kids that were less than one month old and 20 cases of abortion in the two to three weeks preceding the visit. Three cases of abortion in goats were observed during the day of the follow-up visit. In this herd, one female goat (two to three years old) tested positive for IgM antibodies. The three animals that aborted, as well as the IgM-positive case, tested negative for brucellosis.

The third herd was a sentinel herd of 28 sheep and goats, which had been vaccinated against brucellosis but not against RVF. The farmer confirmed that no new animals had ever been introduced into his herd. He reported one case of abortion and another of neonatal death. In this herd, one female goat (more than one year old) tested positive for the presence of IgM antibodies against the RVF virus.

The fourth and fifth herds were smuggled herds kept in quarantine. Smuggled animals are mostly goats aged about one to three years and they are regularly confiscated at

border villages by security guards and sent to quarantine. The country of origin has no vaccination programme against RVF. These two herds consisted of about 150 animals each, mostly goats. Signs of bloody diarrhoea (3% to 10%) and some deaths (1% to 5%) were observed. Two IgM-positive female goats (one in each herd) showed bloody diarrhoea.

Discussion

Outbreaks of RVF have occurred, with high rates of abortion, high rates of death among young animals, and high rates of infection among humans, in various regions of Africa, Madagascar and the Arabian Peninsula (1, 12, 13, 17). Most of these epizootics occurred during seasons of above-average and sustained levels of rainfall. However, the occurrence of enzootic and unapparent RVF infection during seasons of average and below-average rainfall is not uncommon (10, 17, 19).

This was the first time that cases of RVF had been diagnosed in the Jazan region since the end of the 2000 to 2001 outbreak. The results of this study confirmed the occurrence of RVF infection in the rainy season of 2004, in most districts of the Jazan region. The control programme in south-west Saudi Arabia over the last three years has only required the vaccination of young animals, at the age of six months, and a previous study indicated that IgM antibodies against the RVF virus disappeared from the serum of vaccinated sheep and goats in the fourth week (22nd to 28th day) following inoculation (6). Therefore, as the blood samples were obtained from herds that had not been vaccinated within the month before sampling took place, these cases were considered to be natural recent infections, caused by recent activity of the RVF virus. (Subsequent investigations confirmed that none of the affected herds had been vaccinated for at least seven months prior to testing.)

Moreover, since all farmers confirmed that there were no new animal introductions into their herds, and smuggled animals are regularly confiscated at border villages immediately after entry, there is a strong indication that the infection was not introduced from a neighbouring country.

The IgM-capture and IgG-sandwich ELISAs are useful tests for serological surveillance. Since the sensitivity of the capture ELISA for detecting IgM antibodies against RVF virus has been reported to be 100% by Paweska *et al.* (14), the results of this study could be considered highly accurate. However, another study, by Madani *et al.*, reported that the capture ELISA detected IgM antibodies in only 51% of samples that were confirmed positive by other techniques (12). Considering this report, it is possible that the real rate of RVF infection in the Jazan region is double

the apparent rate. Furthermore, the Paweska study reported that ELISA testing was 100% sensitive from five to 42 days following infection but only 12.5% sensitive three weeks later (14). Therefore, the real rate of RVF infection in Jazan could be very much higher.

The occurrence of clinical signs (such as abortion, neonatal death, death in lambs and kids less than one month old and bloody diarrhoea) in five out of 17 herds (29.4%) confirms that the significant rate of positive IgM antibodies is cause for concern, and may suggest clinical RVF involvement. This possibility is, the authors suggest, greatly strengthened by the following facts:

- that four IgM-positive cases, in two herds with increased rates of abortion, tested negative for brucellosis
- that another (sentinel) herd, vaccinated against brucellosis but not RVF, experienced abortions and neonatal deaths
- that IgM antibodies against the RVF virus were detected in two animals with bloody diarrhoea.

Certainly, it would have been appropriate to investigate the presence of RVF virus in mosquitoes in the vicinity of the farms included in the survey. Failure to do so is considered one of the main drawbacks of this study. However, in a previous study, conducted during the 2000 epidemic of RVF in Saudi Arabia (25 September to 10 October), minimum mosquito infection rates per 1,000 at sites with infected mosquitoes were:

- 0.3 to 13.8 for *C. (culex) tritaeniorhynchus*
- 1.94 to 9.03 for *A. vexans arabiensis* (9).

Since the RVF infection rate in animals in the Jazan region during the 2000 to 2001 epidemic was 23%, and 64.7% of the cases occurred in September and October 2000 (5), the infection rate in mosquitoes in the present study would have been very much lower, considering that the infection rate in animals in this study was only 0.36%.

The 2004 diagnosis of serological and probable clinical cases of RVF in the Jazan region resulted from epidemiological and serological surveillance conducted as

part of the RVF control programme in Saudi Arabia. The occurrence of these cases was expected, partly because of the ability of the RVF virus to persist in mosquito eggs (10), but also because of the presence of dense populations of mosquitoes in the region. The results of this study demonstrate that the status of RVF in Jazan is more or less similar to the status of the disease in Africa, considering:

- the genetic constitution of the virus (15)
- the presence of mosquitoes as vectors (8, 9, 11)
- the epizootic (1, 13) as well as enzootic (10, 16, 19) occurrence of the disease in different seasons.

Although most of the livestock in Jazan had been vaccinated, the level of herd immunity observed in this study was relatively low. It has been reported that the live attenuated RVF Smithburn strain vaccine confers immunity for three years (18). In fact, most of the animals in Jazan had been vaccinated in the sixth months following the start of the 2000 to 2001 outbreak, i.e. more than three years before this serological survey. In addition, a considerable number of unvaccinated animals may have been included in the survey, as field veterinarians reported that many farmers refused vaccination. This may explain why the observed level of herd immunity is low, despite the continuing practice of vaccinating livestock when they are six months old. The low level of herd immunity observed in this study is consistent with the significant decline in the level of RVF-neutralising antibodies in the Dagana district in the Senegal river basin, from 71.7% in 1988 to 23.9% in 1989 (16).

The authors conclude that the diagnosis of IgM antibodies in clinically suspected herds suggests the persistence of RVF infection in the Jazan region. Therefore, the authors recommend that control programmes be continued, to prevent the recurrence of outbreaks in the region and the possible further spread of infection to other regions of Saudi Arabia.



Persistence de la fièvre de la Vallée du Rift dans la région de Jazan en Arabie saoudite

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Résumé

Une enquête a été conduite dans la région de Jazan, au sud de l'Arabie saoudite, afin d'élucider la situation des populations ovine et caprine au regard de la fièvre de la Vallée du Rift dans cette région. Les troupeaux identifiés comme suspects à l'examen clinique ont été soumis à une épreuve de détection des anticorps (immunoglobulines M) dirigés contre le virus de la fièvre de la Vallée du Rift. La maladie a été diagnostiquée dans six des huit districts couverts par l'enquête. Au total, 22 animaux provenant de 17 troupeaux possédaient des anticorps. Le taux d'infection variait de 0,12 % dans le district de Sabya à 1,04 % dans le district de Jizan. L'immunité de troupeau variait de 22,2 % à Jizan à 39,3 % dans le district d'Alarda. Ces résultats montrent que la présence d'anticorps IgM dans les troupeaux cliniquement suspects peut être l'indice de la persistance de la fièvre de la Vallée du Rift dans la région de Jazan. Partant, les programmes en cours visant la prophylaxie de la fièvre de la Vallée du Rift doivent être poursuivis afin d'empêcher une récurrence des foyers dans la région, voire une propagation de l'infection vers d'autres régions d'Arabie saoudite.

Mots-clés

Arabie saoudite – Enquête sérologique – Fièvre de la Vallée du Rift – Jazan – Moyen-Orient – Persistance – Surveillance épidémiologique.



Persistencia de la fiebre del Valle del Rift en la región saudí de Jazan

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Resumen

Los autores describen un estudio realizado en la región de Jazan (Arabia Saudí) para investigar la posible presencia de fiebre del Valle del Rift (FVR) en ovinos y caprinos, utilizando para ello la identificación de rebaños sospechosos por los signos clínicos y acto seguido pruebas de detección de inmunoglobulinas M (IgM) contra el virus FVR. El nivel de inmunidad de los rebaños se determinó mediante la detección de inmunoglobulinas G. Se diagnosticó la enfermedad en seis de los ocho distritos cubiertos por el estudio, donde se encontraron 22 animales de 17 rebaños que dieron resultado positivo a la presencia de IgM contra la FVR. La tasa de infección iba desde un 0,12% en el distrito de Sabya hasta un 1,04% en el de Jizan. El nivel de inmunidad de los rebaños oscilaba entre un 22,2% (en el distrito de Jizan) y un 39,3% (en el de Alarda). Cabe concluir que la presencia de IgM en rebaños con signos clínicos sospechosos apunta a la presencia persistente de FVR en la región de Jazan. Es preciso, por lo tanto, seguir aplicando programas de lucha contra la enfermedad para prevenir el resurgimiento de brotes en la región y la eventual diseminación de la enfermedad a otras zonas de Arabia Saudí.

Palabras clave

Arabia Saudí – Estudio serológico – Fiebre del Valle del Rift – Jazan – Oriente Medio – Persistencia – Vigilancia epidemiológica.



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