The 2006–2007 Rift Valley fever outbreak in Kenya: sources of early warning messages and response measures implemented by the Department of Veterinary Services

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Summary
The authors characterised sources of early warning messages about occurrences of Rift Valley fever (RVF) and examined the response measures that were used by the Department of Veterinary Services (DVS) to manage the 2006–2007 RVF outbreaks in Kenya. The study was conducted between November 2009 and March 2010 and it included national, provincial and district veterinary officers who were involved in the management of the outbreak. Structured questionnaires were used to collect the data. Although the majority of the respondents reported having limited capacity to implement response measures, they perceived that the measures implemented were effective. Vaccination, movement control and market closures were the main response measures implemented, particularly in districts that had cases in both livestock and humans. Vaccination, however, was implemented too late and the coverage achieved was too low to be effective. The authors suggest ways to improve the capacity of the DVS to respond to similar outbreaks in the future.

Keywords

Introduction
Rift Valley fever (RVF) is a mosquito-borne viral zoonosis that mainly affects sheep, goats, cattle and camels. Humans become infected following either a bite from an infected mosquito (5) or intensive contact with acutely infected animals, or by handling infected tissues (4). The disease occurs as explosive outbreaks characterised by high perinatal mortality. Adult animals exhibit moderate mortality accompanied by high rates of abortion (4). During outbreaks, the disease also impacts on the livelihoods of livestock keepers through closure of livestock markets and bans on livestock movement and slaughtering. The disease was first characterised and the causal virus isolated in Kenya in 1931. By 2007, 11 national RVF epizootics had occurred, with the 2006–2007 outbreaks being the most extensive (18). Spill-over of infections to humans resulted in approximately 700 reported RVF cases in the country (17). It has been estimated that RVF-induced losses during the 2006–2007 outbreaks amounted to over 2.1 billion Kenyan shillings (USD 32 million) and extended to various stakeholders in the marketing chain (19).

In the Greater Horn of Africa, RVF outbreaks are closely linked to the El Niño/Southern Oscillation phenomenon (2). These outbreaks often occur in irregular cycles...
that can range between five and 35 years (12). In the 2006–2007 outbreaks, the Government of Kenya, through the Ministry of Health and Department of Veterinary Services (DVS), with assistance from non-governmental organisations (NGOs), implemented surveillance and emergency response interventions that included vaccination of livestock using a live attenuated vaccine, quarantine and slaughter bans, vector control, and distribution of bed nets and insect repellents to protect humans from coming into contact with RVF vectors (6).

An epidemiological assessment conducted after the 2006–2007 outbreaks indicated that there had been a delayed response to the outbreaks and that some of the contingency measures implemented, for example, vaccination, did not achieve desired levels of effectiveness (14). The present study assessed how the DVS accessed early warning messages and analysed the perceptions of DVS staff regarding their capacity to implement response measures. The study also examined the effectiveness of the measures implemented during the outbreak. The authors identify institutional interventions that could be implemented to improve responses to future RVF outbreaks.

Materials and methods

Selection of the respondents

The study was conducted between November 2009 and March 2010 and involved a total of 59 senior veterinary officers in the DVS. These included:

– six officers based at the DVS headquarters who coordinated the implementation of emergency response measures at the national level

– all seven Provincial Directors of Veterinary Services (PDVSs), (except Nairobi province, the location of the DVS headquarters)

– 46 district-level officers (District Veterinary Officers [DVOs]).

Districts were purposefully selected from each province on the basis of exposure. The districts chosen were those that reported RVF cases in either livestock or humans in the 2006–2007 outbreaks or those that had had cases in the past. Table I shows the distribution of the districts used in the survey by province.

Development of the questionnaire

The questionnaire used in the study was developed and pre-tested with five veterinary officers based at the DVS headquarters who were experienced in the control of transboundary animal diseases. The questionnaire consisted of four sections. Section I focused on background information on the respondent, including his or her responsibilities. Section II concentrated on information about the 2006–2007 RVF outbreak, including the timing of early warning notification relative to the commencement of the outbreak, and the response measures undertaken. Perceptions of response capacity and effectiveness of RVF control measures were assessed using Likert questions that used a five-point scale. The
points used were: ‘strongly disagree’, ‘disagree’, ‘neutral’, ‘agree’, and ‘strongly agree’. Capacity questions assessed:

- level of preparedness for RVF prevention and control
- ability to implement mass vaccination campaigns
- ability to implement quarantine measures
- ability of stock owners to accurately identify cases of RVF

Effectiveness questions analysed perceptions on the levels of success attained with:

- information provided to the public on how to manage the disease
- emergency vaccination
- quarantine measures
- market closures.

For the response questions, a combination of positive and negative capacity questions was used to avoid bias. However, for the effectiveness questions, all the statements that respondents were asked to agree/disagree with were framed negatively (e.g. ‘Market closures for RVF prevention and control implemented were not effective’). As this type of question requires the respondent to think a little more it is a useful strategy for preventing agreement bias. Section III of the questionnaire investigated the measures that were implemented in response to the RVF scare in 2008, while Section IV probed whether the officers used an RVF Decision Support Tool (RVF DST) that had been developed by RVF major stakeholders in East Africa after the 2006–2007 outbreaks and made available in 2008 (8).

**Administration of the questionnaire and data analysis**

Questionnaires were sent to each respondent by ordinary post. Follow-up telephone calls were made shortly after to verify whether each respondent had received the questionnaire and understood the instructions that had been provided. They were asked to fill out the questionnaires and post them to their provincial headquarters from where they would be collected by the research team following verification of the accuracy of the information given.

Data were entered into a database constructed using Microsoft® Access 2007 (Microsoft Corporation, Redmond WA, 2007) and exported to STATA 10 (20) for analysis. Descriptive statistics summarising characteristics of the respondents, sources of information and types of responses were generated in STATA. Likert items were each assigned a score between 1 and 5 depending on the option chosen by the respondents and the dimension of the statement made. For example, an option that strongly affirmed (strongly agree) a statement presented in a positive dimension was assigned the highest possible score of 5, while that which strongly opposed (strongly disagree) the statement got the lowest possible score of 1. The scales were then collapsed into three levels, i.e. disagree (combining strongly disagree and disagree responses and assigning a score of 1), neutral (assigned a score of 2), and agree (combining strongly agree and agree responses and assigning a score of 3), in order to attain an appreciable number of records at each level. Descriptive analyses showing proportions of different scenarios under each of the three levels were also generated.

Scores from the eight Likert questions (four on capacity and four on effectiveness) were used as outcomes in univariate proportional odds models which assessed factors that influenced perceptions of capacities to implement RVF control measures and of the effectiveness of the measures implemented. Various methods of analysing Likert-type items have been described by Clason and Dormody (7). In this study, data were treated as ordered categorical data. The approach presumed that there was an underlying latent or continuous scale whose value characterised respondents’ attitudes and opinions. This scale matches with proportional odds model assumptions in which the outcome is thought to have an ordinal scale that represents an underlying continuous latent variable. The model was deemed appropriate for the Likert scale data because the scale used had a logical ordered sequence from disagree (score 1) to agree (score 3). Independent factors considered in all the models included:

- responsibilities of a respondent (administrative duties only versus field work, or both field work and administrative roles)
- posting of the officer (district, provincial or national office)
- access to internet (yes/no)
- length of time the office where the officer operated from had been in existence (< 2 years compared to > 2 years)
- length of time the respondent had been in the current office (< 2 years as opposed to > 2 years).

Districts were also classified on the basis of whether or not they were affected by the 2006–2007 outbreaks (yes/no) and if they received early warning of RVF outbreaks (yes/no). The level of significance used for this analysis was 90%. The proportional odds assumption for each model was tested by comparing log likelihood estimates of the ordered logit and multinomial logit models were run with the same variables using a likelihood ratio test (11). Models that did not satisfy the assumption were re-analysed as logistic regression models after collapsing the outcomes into binary variables (agree versus neutral and disagree).
Results

All the respondents contacted agreed to participate in the survey. There was a good response to the questions in all sections except for Section III (see below). This was probably because an outbreak of RVF did not occur in 2008 despite the early warning signals that were given at the time.

Characterisation of the respondents and their administrative units

Respondents did not respond to all questions in the questionnaire. Therefore, in the following descriptive analysis, the denominator indicates the number of respondents to the particular question, whereas the numerator indicates the number of those who provided relevant answers. Given the design used for the survey, 78.0% (46/59) of all respondents were DVOs. A large majority (76.3%, 45/59) of all respondents performed administrative duties only, while others performed both administrative and field activities (23.7%, 14/59). Most of them (86.4%, 51/59) had unlimited access to the internet where they could access information on livestock diseases. Overall, slightly over half of the respondents (54.4%, 31/57) had been operating from the stations where they were interviewed for more than two years. In addition, a large majority (72.7%, 40/55) of the respondents indicated that the stations where they operated from had been in existence for more than two years. A large majority (92.9%, 52/56) of these stations maintained a rumour register to log suspect cases, with all respondents at the district level maintaining and updating the registers.

Responses to early warnings of the 2006–2007 Rift Valley fever outbreaks

Only 41.7% (20/48) of respondents received early warning messages before the 2006–2007 RVF outbreaks. Out of the 20 respondents who received the warning messages, 16 were DVOs (which was 43.2% of all the DVOs who responded to this question [16/37]). Out of the 16 DVOs who received the warning messages 7 (43.8%) later experienced the outbreak in their district administrative units. Overall, however, 52.2% (24/46) of all DVOs later experienced the outbreak in their district administrative units. Sixty-five percent (13/20) of the respondents who received warnings obtained them from the DVS headquarters in Nairobi, while 20% (4/20) received them from the Food and Agriculture Organization (FAO) Global Animal Disease Information System (EMPRES-i). These warnings were, however, issued late, the timeline given by the respondents indicated that the warnings were received in September 2006 and the first suspect cases occurred in November 2006 (Table II).

Thirty-three percent (11/33) of respondents who experienced the outbreaks in their administrative units received initial reports of disease occurrences from stock owners, 18.2% (6/33) from their public veterinary colleagues, 3% (1/33) from private veterinary associates, and only 9.1% (3/33) from community animal health workers (CAHWs). Other respondents obtained similar alerts from various other sources, such as the Ministry of Health (following the occurrence of human cases), household interviews and the media. Most respondents (88.6%, 31/35) collected samples for laboratory testing, had further consultations with colleagues to determine the types of responses to implement (75.6%, 25/33) and implemented preventative measures (60.6%, 20/33) even before diagnostic tests were carried out.

Twenty-eight out of the 46 districts (60.9%) implemented vaccination campaigns against RVF in livestock. The estimated coverage ranged from 3% to 18% in cattle, 3% to 56% in sheep, 1% to 25% in goats and 2% to 4% in camels. Other measures implemented at the same time are outlined in Table III. The results indicate that movement control (65.2%, 30/46) and market closure (45.7%, 21/46) were implemented in most districts. In addition, a larger proportion of districts that had RVF cases in both livestock and humans implemented RVF control measures

Table II

<table>
<thead>
<tr>
<th>Province</th>
<th>Provision of the early warning message</th>
<th>Occurrence of the first suspect case</th>
<th>Confirmation of the cases (laboratory tests)</th>
<th>Receipt of vaccines</th>
<th>Commencement of vaccination campaigns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western</td>
<td>August 2006</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Nyanza</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

than those that had cases only in livestock and those that were not infected (Table III).

**Capacity for and effectiveness of response and control measures**

**Distribution of Likert scores**

Table IV gives the response distribution of perceptions to the eight Likert items, consisting of four statements each on capacity and effectiveness. In general, most of the respondents indicated that they were not sufficiently prepared for RVF prevention and control. They also revealed that movement control measures were not implemented satisfactorily. Slightly more than half of them also did not think that farmers could accurately identify RVF cases. Responses to the question on vaccination were more or less evenly balanced between agree and disagree options.

Respondents perceived that market closures and movement control measures were effective in preventing further outbreaks of the disease. Slightly more than half of the respondents thought that vaccination was effective in preventing the disease. Responses to the question on communication for RVF prevention and control were also balanced between agree and disagree options (Table IV).

**Univariable analyses**

Table V presents the results of univariable analysis using each of the four capacity Likert items as outcome variables. Similar analyses were done using Likert items on effectiveness of interventions, but results were not tabulated because statistically significant associations were not found.

Respondents who felt that they were not sufficiently prepared for RVF prevention and control had access to the internet, operated from stations that were more than two years old or had experienced the 2006–2007 outbreaks in their areas. Unlike DVOs, PDVSs and respondents who operated from the national offices felt that vaccinations were implemented well. In addition, respondents who neither received early warning messages nor kept rumour registers felt that quarantine measures were implemented well. None of the independent variables were significantly associated with respondents’ perceptions regarding stock owners’ ability to identify RVF cases.

**Responses to warnings of predicted Rift Valley fever outbreak in 2008**

Forty-two percent (22/52) of the respondents received a warning of a heightened RVF risk in 2008. The majority (59%, 13/22) of them obtained the warnings from the DVS headquarters in April 2008. FAO EMPRES-i issued similar warnings in September 2008, according to 23.8% (5/21) of the respondents. At the same time, 3 out of 54 respondents (5.6%) confirmed receipt of reports of suspected RVF cases in their administrative areas. Two of the respondents collected samples for laboratory examination, both of which proved to be negative on reverse transcription-polymerase chain reaction at Kabete Veterinary Laboratories, Nairobi. Livestock movement bans were implemented by 13.6% (8/59) of respondents in response to these warnings even before laboratory results were received.

**Rift Valley fever decision support tool**

Only 10.2% (6/59) of the respondents received the RVF DST (8). Two of these were from the national office, while four came from Lamu, Taveta and Mombasa (Coast province) and Thika (Central province) districts.

**Discussion**

With the global climate change, the frequency and severity of RVF outbreaks are expected to increase in the Horn of Africa (16). This implies that countries in this area need to improve the existing response systems as one way of...
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Table IV
Percent distribution of perceptions on response capacity and response effectiveness among three category levels
The number of districts that responded is given in brackets

<table>
<thead>
<tr>
<th>Likert statement</th>
<th>Number of districts that agreed or disagreed with the statement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agree</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>Respondents were not prepared for prevention and control of RVF (n = 47)</td>
<td>41 (87.2%)</td>
</tr>
<tr>
<td>Vaccination against RVF was properly implemented (n = 43)</td>
<td>18 (41.9%)</td>
</tr>
<tr>
<td>Movement control to prevent RVF was properly implemented (n = 45)</td>
<td>6 (13.3%)</td>
</tr>
<tr>
<td>Farmers were able to accurately identify cases of RVF (n = 44)</td>
<td>7 (15.9%)</td>
</tr>
<tr>
<td><strong>Effectiveness</strong></td>
<td></td>
</tr>
<tr>
<td>Communication for RVF prevention and control implemented was not effective (n = 45)</td>
<td>19 (42.2%)</td>
</tr>
<tr>
<td>Vaccination was not effective in controlling further spread of RVF (n = 43)</td>
<td>7 (16.3%)</td>
</tr>
<tr>
<td>Movement control to prevent RVF was not effective in preventing further spread of RVF (n = 46)</td>
<td>4 (8.7%)</td>
</tr>
<tr>
<td>Market closures for RVF prevention and control implemented were not effective (n = 44)</td>
<td>4 (9.1%)</td>
</tr>
</tbody>
</table>

RVF: Rift Valley fever

Table V
Univariate association between perceptions on capacity issues and independent variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
<th>Not prepared for prevention and control of RVF (n = 47)</th>
<th>Vaccination against RVF was properly implemented (n = 43)</th>
<th>Quarantine measures were properly implemented (n = 45)</th>
<th>Farmers were able to identify cases of RVF (n = 44)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Coefficient (95% CI) P</td>
<td>Coefficient (95% CI) P</td>
<td>Coefficient (95% CI) P</td>
<td>Coefficient (95% CI) P</td>
</tr>
<tr>
<td>Duty</td>
<td>Administrative only</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>0.59 (−1.29 to 2.48) 0.59</td>
<td>1.16* (−0.04 to 2.35) 0.11</td>
<td>−0.88 (−2.29 to 0.52) 0.28</td>
<td>1.03 (−0.06 to 2.12) 0.12</td>
</tr>
<tr>
<td>Posting</td>
<td>District</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>−1.34 (−2.79 to 0.10) 0.10</td>
<td>0.65 (−0.56 to 1.87) 0.39</td>
<td>−0.29 (−1.58 to 0.98) 0.70</td>
<td>–</td>
</tr>
<tr>
<td>Internet access</td>
<td>Yes</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>−2.64 (−4.54 to −1.14) 0.01</td>
<td>0.61* (−0.97 to 2.21) 0.52</td>
<td>−1.10 (−2.97 to 0.75) 0.28</td>
<td>−0.31* (−1.76 to 1.12) 0.72</td>
</tr>
<tr>
<td>Office existence</td>
<td>&gt; 2 years</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>≤ 2 years</td>
<td>−1.65 (−3.16 to −0.13) 0.08</td>
<td>0.25 (−0.93 to 1.44) 0.72</td>
<td>0.32 (−1.10 to 1.70) 0.66</td>
<td>−0.14 (−1.33 to 1.03) 0.84</td>
</tr>
<tr>
<td>Current station</td>
<td>&gt; 2 years</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>≤ 2 years</td>
<td>−1.34 (−2.96 to 0.17) 0.13</td>
<td>−0.75 (−7.6 to 0.26) 0.22</td>
<td>−0.20 (−1.29 to 0.88) 0.76</td>
<td>0.02 (−0.95 to 1.00) 0.97</td>
</tr>
<tr>
<td>RVF outbreaks in 2006/2007</td>
<td>Yes</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>−1.49 (−3.01 to 0.03) 0.10</td>
<td>−0.90 (−1.94 to 0.12) 0.14</td>
<td>−0.27 (−1.34 to 0.79) 0.67</td>
<td>–</td>
</tr>
<tr>
<td>Receipt of RVF outbreak warning</td>
<td>Yes</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>1.34 (−0.63 to 3.31) 0.23</td>
<td>−0.07 (−1.09 to 0.95) 0.91</td>
<td>1.22 (0.06 to 2.38) 0.07</td>
<td>−1.00 (−2.05 to 0.047) 0.11</td>
</tr>
<tr>
<td>Maintains rumour register</td>
<td>Yes</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2.12 (0.41 to 3.83) 0.04</td>
<td>1.10 (−0.43 to 2.63) 0.24</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

* Agree versus neutral and disagree combined
† Model did not converge
‡ Variable not considered
CI: confidence interval
RVF: Rift Valley fever

building their capacities to manage RVF epizootics when they occur. The authors characterised the early warning and response system employed by the DVS in Kenya during the 2006–2007 RVF outbreaks. This study focused more on the measures implemented by provinces and districts than at national level, since these units serve as front-line administrative centres responsible for disease control and other veterinary interventions.
In Kenya, most of the endemic and epidemic sites of RVF are in a few arid and semi-arid lands (ASALs) where the DVS is expected to play a greater role in service delivery. This is because 88% of the private veterinary practices are located in the high agricultural potential areas (23) as there are fewer incentives for private veterinary providers in ASALs (10). A large proportion of the veterinarians interviewed in this study had been in their stations for less than two years even though most of the stations had been in existence for more than two years. This signifies a relatively high staff turnover, which is likely to have an impact on the quality of services provided in RVF endemic and epidemic sites. Vian et al. (21) have observed that the ability of a health service to offer quality services depends largely on there being a stable human capacity. High staff turnover rates compromise the establishment of institutional memory and effective networks with clientele and other stakeholders such as NGOs. In addition to interventions that have been developed by the DVS to enhance staff retention, there is a need to devise ‘one-health’ programmes at multiple administrative units. Such programmes would, for instance, allow community nurses and medical practitioners to work regularly with the DVS personnel to carry out surveillance and implement emergency responses.

These results support previous observations that early warning messages that preceded the 2006–2007 RVF outbreaks were given at very short notice. Not all districts, including those that were later affected by the outbreak, received them (Table II). The global climate surveillance and response organisations first became aware of a possible increase in the risk of RVF in mid-September 2006 when unusually heavy rains were forecast for later in the year (3). They alerted FAO and the World Health Organization (WHO), which immediately forwarded the warning to their representatives in at-risk countries; a consolidated warning was subsequently issued in November 2006 (13). In light of this, the respondents’ reports of receiving early warnings in September could not be verified. The existing RVF forecasting models (which mainly rely on climate and mathematical models) ought to be improved so that reliable predictions are obtained early enough for governments to implement preventative measures, including community sensitisation. Options for improving the existing models include promoting research that seeks to increase the frequency/precision of climate predictions (i.e. seasonal predictions rather than medium-term forecasts). Early warning systems which additionally include non-climatic factors, such as disease surveillance and changes in animal migration patterns or land use, should also be utilised for effective RVF control. There are reports that failure to include non-climatic factors can lead to incorrect predictions or attribution of disease occurrence to climatic changes only (24).

The DVS headquarters and EMPRES-i were the two most common sources of early warning information, with the former being the main source. This is not surprising because, at the time, Kenya had a unitary government with a centralised management structure. Some PDVSs and DVOs were also aware of EMPRES-i, which uses official information furnished by the World Organisation for Animal Health (OIE) (of which Kenya is a Member State), as well as other sources such as technical projects, consultancy missions or personal contacts. Most officers interviewed had access to the internet, yet a majority of them still relied on the DVS headquarters for early warning messages. While there is a need to strengthen the role that the DVS headquarters plays in information dissemination, each PDVS and DVO should be encouraged, by a deliberate state institutional approach, to access and act on web-based information systems such as EMPRES-i directly instead of relying on the DVS headquarters. Nearly all districts currently have the required infrastructure for setting up internet facilities.

A large number of districts maintained rumour registers but it did not appear that the registers were used for tracing RVF cases. The responses indicated that suspect cases were not observed until November 2006, yet a study that was implemented by Jost et al. (14) indicated that stock owners from north-eastern Kenya observed the first suspect case in October 2006. This indicates that either stock owners did not report suspected cases to the veterinary department, or, veterinary officers ignored reports that they received. In fact, most of the officers testified that they did not believe that stock owners could reliably identify RVF cases. However, Jost et al. (14) found that Somali pastoralists in north-eastern Kenya could accurately describe the disease and identify risk factors associated with RVF, probably because they depended on livestock for their livelihoods. Personnel involved in conventional disease surveillance must recognise that the level of knowledge on RVF is expected to vary between communities depending on exposure and livelihood practices. Participatory surveillance that recognises stock owners’ knowledge as being reliable (given that they have sufficient experience of the disease and good livelihood practices) is, therefore, expected to be more sensitive and potentially more useful in integrated disease surveillance systems. Additionally, considering that CAHWs are part of the same communities that accurately identify cases and accompanying RVF epizootic indicators (14), there are opportunities to strengthen capacity for early outbreak detection by placing greater emphasis on systematic RVF awareness-raising programmes and retention of institutional memory. In addition, most of the herders currently own mobile phones, which also can be harnessed for disease surveillance purposes.

Vaccination, movement control and market closures were the main response measures implemented against the
2006–2007 outbreaks, particularly in those districts that had cases in both livestock and humans. These control measures are the most effective in preventing further RVF spread (12). Similar interventions were used following the 2008 RVF early warning. It is not clear why respondents felt that the measures used (especially to control the 2006–2007 outbreaks) were effective yet regarded their capacity to implement the measures as inadequate (Table IV). It has been suggested that countries targeted for the 2006 early warning did not benefit from these warnings because they were given at such short notice that contingency plans could not be implemented promptly enough (13). Similarly, some of the measures, such as vaccination, were implemented late (14) when the outbreak had started waning, possibly creating a mistaken perception that these interventions were effective.

The vaccination coverage estimated by this study was too low for the establishment of effective herd immunity. Adequate RVF vaccination coverage for the establishment of effective herd immunity is not currently known but, epidemiologically, herd immunity is assumed to be achieved if actual vaccination coverage exceeds the critical vaccination coverage ($pc$) where $pc = (1−(1/R_0))$ and $R_0$ is the basic reproduction number (1). Although the magnitude of $R_0$ does not necessarily oscillate in proportion to the intensity of epizootic transmission, an $R_0$ of, for instance, 2 generates $pc$ of 50%. Reported actual vaccination coverage for all livestock species was largely less than the critical vaccination coverage over a wide range of $R_0$. It is, however, understandable that it is a big challenge to implement vaccination campaigns in the course of an RVF outbreak, because flooding impairs transport (14). Some of the measures that can be implemented to improve vaccination coverage and hence effectiveness include ordering vaccines much earlier so that vaccination can be done before flooding occurs, sub-contracting vaccination to private providers and involving CAHWs in vaccination campaigns. In Morocco, for example, sub-contracting vaccination programmes to the private sector reduced vaccination costs by 34% and increased the proportion of animals vaccinated from 52% to 66% (10). In certain South American countries, the public and private sectors synergistically participated in the eradication and control of foot and mouth disease on the continent in the mid-1980s (9).

The live attenuated Smithburn vaccine that was used during the outbreak has safety limitations owing to its residual virulence (15). There is a need for safer vaccines of equivalent or greater efficacy than the Smithburn vaccine. A live attenuated vaccine with improved safety (Clone-13 vaccine) has been produced and is currently being field tested. However, more comparative studies on the safety and efficacy of RVF vaccines (22) are needed, as are studies on integrated RVF prevention and control.

Imposition of animal movement restrictions, market closures and slaughter bans are consistent with the objective of containing viraemic animals in order to reduce virus amplification and the creation of secondary foci. Cases in the past where these measures were not enforced led to amplification of outbreaks in Tanzania, Sudan and Madagascar (3). Enforcement of such imposition is important considering the length and scope of Kenya’s livestock value chains. For example, the 2006–2007 RVF outbreaks in Kenya struck during a period when producer prices were seasonally higher, which subsequently had severe impacts on downstream chain actors (19). Compliance with these measures can, therefore, be enhanced by improved public education of livestock value chain and relevant non-livestock value chain actors.

**Conclusion**

Over the years, there has been an improvement in RVF awareness and outbreak preparedness, and in the response to RVF epizootics. However, this study shows that there is room for further improvement. For example, there is a need for RVF forecasting models that utilise climatic and non-climatic factors and that provide for earlier warnings. Another way in which improvements could be made would be to strengthen the role that the DVS headquarters plays in information dissemination while encouraging regional and district-level DVS personnel to use web-based disease information systems and institutionalising rumour registers during heightened RVF risk periods. Finally, synergistically collaborating with other institutions, such as the medical fraternity and CAHWs, on surveillance and implementation of emergency responses would also increase RVF awareness and facilitate an effective response to epizootics.
L’épidémie de fièvre de la Vallée du Rift en 2006–2007 au Kenya: source des messages d’alerte précoce et mesures immédiates mises en œuvre par les Services vétérinaires officiels

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Résumé

Les auteurs ont cherché à déterminer la source des messages d’alerte précoce lors de foyers de fièvre de la Vallée du Rift survenus pendant l’épidémie qui a frappé le Kenya de 2006 à 2007, et étudié les mesures mises en œuvre par les Services vétérinaires officiels kenyans en réponse à ces alertes dans le cadre de la gestion de l’épidémie. L’étude s’est déroulée de novembre 2009 à mars 2010, avec la collaboration d’agents vétérinaires qui avaient participé à la gestion de l’épidémie à l’échelle nationale, provinciale et des districts. Un questionnaire structuré a été remis à ces agents afin de recueillir les informations. Tout en estimant disposer de capacités limitées pour mettre en œuvre les mesures immédiates, les agents qui ont répondu au questionnaire ont perçu, pour la majorité d’entre eux, que les mesures mises en œuvre avaient été efficaces. Il s’agissait principalement de la vaccination, du contrôle des mouvements d’animaux et des fermetures des marchés, en particulier dans les districts ayant notifié simultanément des cas chez les animaux d’élevage et chez l’homme. Malheureusement, la vaccination a été appliquée trop tard et la couverture vaccinale obtenue était insuffisante pour être protectrice. Les auteurs proposent quelques solutions pour améliorer les capacités futures des Services vétérinaires officiels à élaborer une réaction efficace en cas de foyer.

Mots-clés


El brote de fiebre del Valle del Rift ocurrido en 2006–2007 en Kenia: origen de los mensajes de alerta rápida y medidas de respuesta instituidas por el Departamento de Servicios Veterinarios

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Resumen

Los autores describen un estudio para caracterizar el origen de los mensajes de alerta rápida sobre la aparición de fiebre del Valle del Rift (FVR) y evaluar las medidas aplicadas por el Departamento de Servicios Veterinarios para responder a los brotes de esa enfermedad que afectaron Kenia en 2006–2007. El estudio, realizado entre noviembre de 2009 y marzo de 2010, se centraba en los veterinarios adscritos a administraciones nacionales, provinciales y de distrito que participaron en la gestión de los brotes. Para la obtención de datos se
References


