Rev. sci. tech. Off. int. Epiz., 2008, **27** (3), 741-749

The transfer of East Coast fever immunisation to veterinary paraprofessionals in Zambia

T. Marcotty [(1)*], G. Chaka [(2)], J. Brandt [(1)], D. Berkvens [(1)], E. Thys [(1)], M. Mulumba [(3)], L. Mataa [(2)] & P. Van den Bossche [(1, 4)]

(1) Department of Animal Health, Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerp, Belgium
(2) Department of Veterinary and Livestock Development, Ministry of Agriculture and Cooperatives, P.O. Box 510155, Chipata, Zambia
(3) Centre for Ticks and Tick Borne Diseases, P/Bag A-130, Lilongwe, Malawi
(4) Department of Veterinary Tropical Diseases, Faculty of Veterinary Sciences, Private Bag X04, Onderstepoort, South Africa
*Corresponding author: E-mail: tmarcotty@itg.be

Submitted for publication: 13 October 2006
Accepted for publication: 25 July 2008

Summary

In eastern Zambia, immunisation by 'infection and treatment' is the main method used to control East Coast fever, an acute and lethal cattle disease. This service, which requires a stringent cold chain, used to be free of charge. When a minimal user fee was introduced, attendance dropped drastically. Consequently, this complex immunisation programme was transferred to veterinary paraprofessionals working on their own account, with the aim of boosting a more sustainable distribution of vaccine. Paraprofessionals were provided with a motorbike and the required specific equipment, but fuel and drugs were at their expenses. The paraprofessionals recovered their costs, with a profit margin, by charging the cattle owners for immunisation.

The reasons for the successful transfer of immunisation to paraprofessionals (despite the maintenance of a fee) are attributed mainly to the absence of information asymmetry between the paraprofessional and the livestock owner, the appreciable level of effort of the paraprofessionals and the verifiable outcome of the service provided.

Keywords

Cattle – Cold chain – Distribution – East Coast fever – Immunisation – Infection and treatment – Paraprofessional – Tick-borne disease – Zambia.

Introduction

Many sub-Saharan African countries have been facing severe economic difficulties that have necessitated structural adjustments of their administration. In this context, the Government of Zambia embarked on a vast agricultural sector investment programme in 1996. The aim was to enhance agricultural performance by privatising and decentralising the provision of services, including animal health care (AHC). Much of the discussion on the provision of AHC to African smallholders revolves around the specific roles, responsibilities and required qualifications of the different service providers. Paraprofessionals, defined as trained persons having sub-university level qualifications and operating on their own account, have been used effectively in several AHC schemes (11). Their role is usually restricted to routine services that do not require academic training and referring complicated cases to a veterinarian.

Animal health care on the intensively farmed plateau of eastern Zambia mainly concerns the control of two

endemic cattle diseases, i.e. the wasting tsetse-transmitted trypanosomosis and the acute and often lethal tick-borne disease East Coast fever (ECF). In both cases, management of the disease includes controlling the vectors and treatment using chemotherapy. Whereas trypanosomosis is a chronic disease that can be treated in the course of the infection, ECF is usually acute and requires early treatment for it to be effective. An effective way of controlling ECF is by preventive immunisation of calves using the 'infection and treatment' method (I&T) (10). This consists of the inoculation of live cryopreserved *Theileria parva* sporozoites (stabilate) and the simultaneous injection of a long-acting formulation of oxytetracycline (8). *Theileria parva* infects leucocytes where it multiplies in synchrony with the division of the host cell. The parasite, which is never exposed to the extracellular environment during its pathogenic stage (schizogony), can only be affected by cell-mediated immunity. For this reason, more than 30 years after its development, immunisation by the I&T method remains the only efficient immunisation technique against *T. parva* available in the field. Since the method makes use of heat-sensitive live protozoan organisms, it relies heavily on a cold chain (below –80°C, using ultra-freezers or liquid nitrogen). The role of the oxytetracycline is to attenuate the multiplication of the parasite. In a small number of cases (<2%), immunisation causes a severe ECF reaction requiring additional chemotherapy (7).

Immunisation by the I&T technique is considered to protect the animals against homologous challenges for their life time, particularly in endemic areas where their immunity is regularly boosted. Unfortunately, both the animals recovering from a natural infection and those that are immunised (7) become carriers of the parasite and remain infective to ticks for extended periods of time. Therefore, in endemic areas, immunisation merely protects individual animals against ECF, it does not lessen the number of infected animals and the incidence of *T. parva* contacts in cattle. Consequently, as the aim of ECF immunisation is to protect animals from clinical disease rather than eradicate or eliminate the infectious agent (in other immunisation campaigns, such as those for rinderpest or foot and mouth disease, eradication or elimination is the aim) a distribution network must be put in place that ensures the continuous availability of immunisation against ECF.

In the Eastern Province of Zambia, calf immunisation against ECF started in 1986 and is still in use today. A local strain (Katete) of *T. parva* is used, thus avoiding introduction of foreign parasites. Immunisation campaigns, which were initially fully subsidised, were carried out twice a year by State veterinary officers assisted by State veterinary assistants.

In 1996, initial attempts were made to render the exercise economically sustainable. Cattle keepers were required to make a minimal financial contribution towards the cost of immunisation. This resulted in a severe reduction in the attendance. At the same time, some technical improvements that made possible the transportation of the ECF vaccine on ice (6) and its inoculation by veterinary assistants allowed the delivery of the service on request rather than in campaigns.

To further improve the sustainability of this ECF control method under the conditions prevailing in eastern Zambia, an attempt was made to transfer, as much as possible, the responsibility for the delivery of the immunisation to paraprofessionals. The level of success of the operation and the reasons for this success are described in the present paper.

Study area

The study was conducted in the Eastern Province of Zambia. The topology of the province consists of a plateau, where the vast majority of people and livestock live, and the wide, hot and dry valley of the Luangwa River that separates the province from the rest of the country. The great majority of cattle found in the province belong to the Angoni breed, a small zebu. They are kept in small herds of 10 to 50 heads and forage on communal land. In 1995, the income of traditional cattle keepers was estimated to be less than US$2/person/day (1). All veterinary services used to be provided by the State through a network of veterinarians and veterinary assistants (3 years technical training after secondary school). Since the early nineties, efforts had been made to transfer the provision of veterinary services from the public sector to the private sector and cooperatives, but by the year 2000 there was not a single private veterinary surgeon operating in the province.

Distribution and density of cattle in the study area

In 2002, a census of communal cattle was carried out in the Province by the Department of Animal Production and Health (DAPH) of the Zambian Government. Livestock were counted in each village by veterinary assistants and data were summarised per veterinary camp, i.e. the operational area (about 500 km²) of a veterinary assistant. The 232,000 head of cattle that were recorded were mainly found on the plateau in the southern part of the Province and around Lundazi in the north. Low cattle densities were encountered in the tsetse-infested Luangwa valley, in the hills and the forest reserve in the south-eastern part of the province and in the areas adjacent to game management areas between Chipata and Lundazi (Fig. 1).

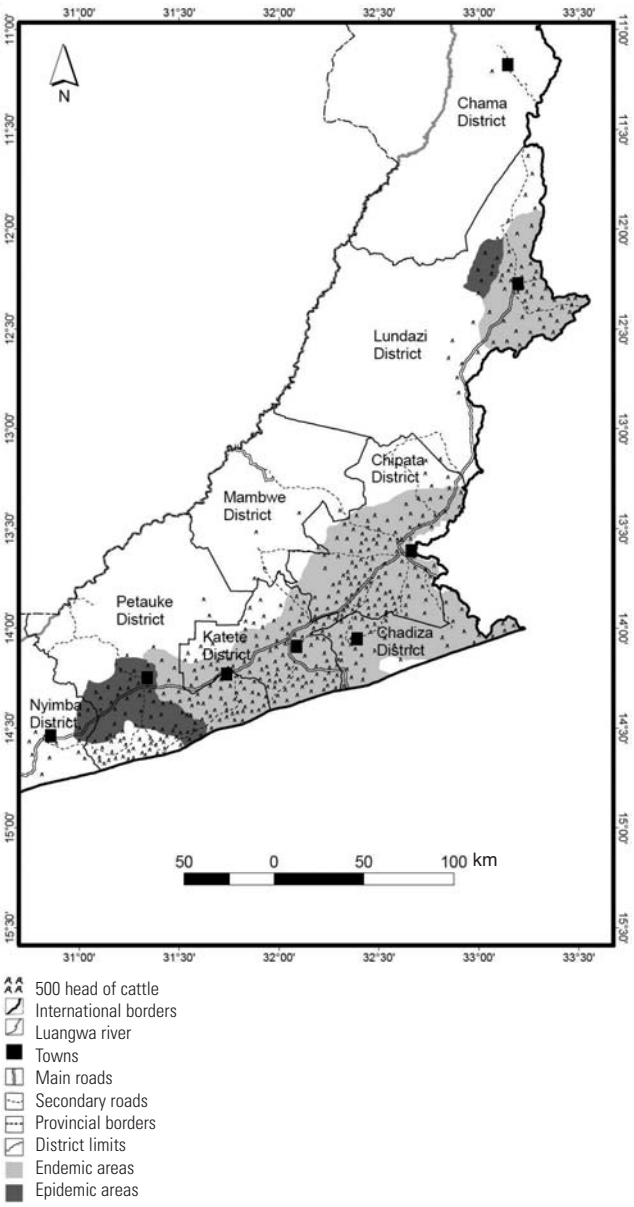

Fig. 1
Traditionally raised cattle population in the Eastern Province of Zambia in 2002 and East Coast fever endemic/epidemic areas between 2000 and 2002
Lusaka, Zambia's capital is 300 km west of the map's western border
This map was drawn using the Arcview software (Environmental Systems Research Institute, California)

Epidemiology of East Coast fever in the study area

East Coast fever cases were recorded by passive surveillance. Suspected cases (acute febrile illness, swollen parotid lymph nodes and rapid death) were reported by the cattle owners to their veterinary assistants and confirmed at the district veterinary laboratories by parasitological examination of biopsies extracted from swollen lymph nodes. East Coast fever-free veterinary camps were defined as veterinary camps where ECF was not recorded between 2000 and 2002. In ECF epidemic areas, cattle of all age classes developed signs of ECF infections whereas in endemic areas, ECF was mainly recorded in animals less than three years old (2). In accordance with these definitions, ECF was endemic in the south-eastern part of the province, between Petauke in the west, the Luangwa valley to the north and the international borders with Malawi to the east and Mozambique to the south (Fig. 1). Epidemics were recorded east of Petauke, mainly along the road connecting the Eastern Province to the capital, Lusaka, and east of Lundazi (Fig. 1). Despite the high cattle population, ECF was not reported in the low-altitude regions in the southern part of Petauke District. It was also not recorded in the sparsely populated areas bordering the Luangwa valley and the game management areas (Fig. 1).

East Coast fever immunisation distribution network

Stabilate of cryopreserved tick-derived *T. parva* sporozoites (Katete type) was used as infective material for the I&T immunisation. Concurrently, the animals were injected with a formulation of long-acting oxytetracycline (20 mg/kg bodyweight) (6). From 1986 to 1996, immunisation was implemented by veterinary officers in well-organised, large-scale campaigns. During those immunisation campaigns the stabilate was transported in liquid nitrogen containers, which implied the use of four-wheel-drive vehicles. The deferred immunisation method, whereby stabilate is kept on ice for up to six hours between thawing and inoculation into animals (6), was introduced in 1996. This improved stabilate storage method allowed trained veterinary assistants to distribute the vaccine to the villages, using a motorbike. At this stage, veterinary assistants were operating under the full control of their district veterinary officer. All expenses were met by the State and the fee charged to the cattle owners was returned to the State.

Early in 2000, eight ECF immunisation centres staffed by paraprofessionals were established throughout the Province (paraprofessionals working out of these centres are denoted by letters surrounded by squares in Fig. 2a). Some were located at the provincial veterinary office (I in Chipata) or at district veterinary offices (C in Lundazi, E in Katete, D in Chadiza and H in Petauke) whereas others were located at veterinary camps (S in Kamulaza and G in Sinda) or at a private location (a second centre B in Chipata) (Fig. 2a). Immunisation centres were situated along main roads for easy access and distributed in such a way that the distance separating them from cattle keepers did not exceed 25 km. Immunisation centres were

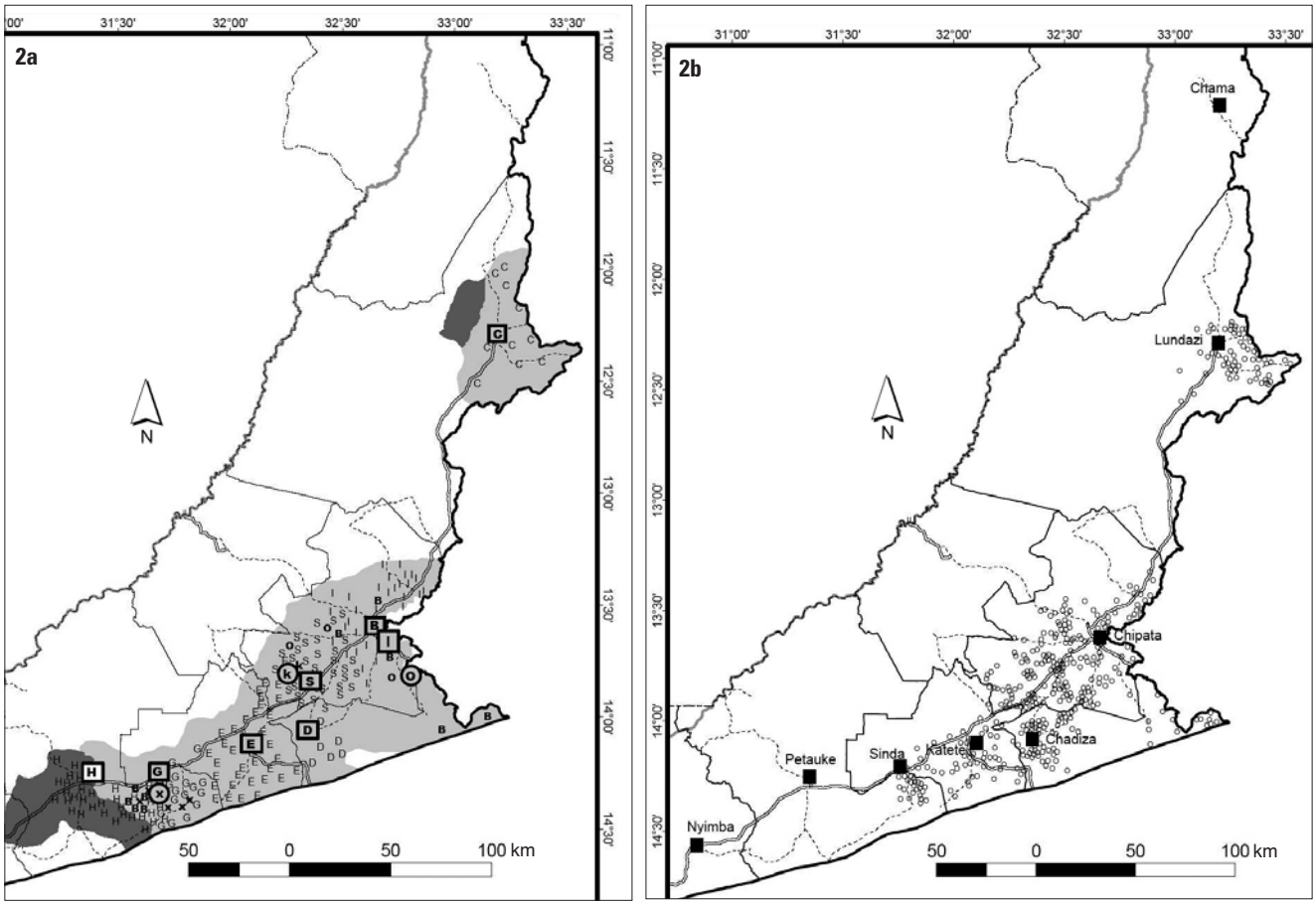

Fig. 2

Average annual number of immunisations carried out by paraprofessionals between 2000 and 2002 (2a) and the geographical areas covered by the free-of-charge East Coast fever immunisation programme in 1995 (2b)

In both maps, symbols (small letters in Fig. 2a and circles in Fig. 2b) represent 50 immunisations. In Fig. 2a, the squares are immunisation centres whereas circles are the homes of paraprofessionals without equipment. The letters in bold small capitals indicate immunisations performed by paraprofessionals who are not needed for ECF vaccination coverage, but who play an important role in creating competition. The areas in grey represent regions where ECF is endemic (light) and epidemic (dark)

These maps were drawn using the Arcview software (Environmental Systems Research Institute, California)

equipped with a motorbike, a liquid nitrogen container (–196°C) for the preservation of the *T. parva* stabilate and a deep-freezer (–20°C) for the storage of stabilate diluent and for the production of ice (for the storage of the stabilate during the transport from the immunisation centre to the farmer).

The immunisation centres were staffed by paraprofessionals that were selected among the veterinary assistants on the basis of their work attitude, their knowledge of ECF and ECF immunisation and their ability to carry out commercial activities. They had all been trained and in active service in Government for several years and therefore had a good knowledge of ECF and ECF control in the field. The paraprofessionals were mandated to immunise against ECF and to distribute veterinary drugs as private entrepreneurs for a period of three years. With the exception of one (B in Fig. 2a), they did not resign from their position in the Government and remained on the Government payroll during the entire study. Their monthly salary ranged between 350,000 and 450,000 Zambian Kwacha (ZMK) (the equivalent of between EUR 75 and EUR 96 in 2002). When the exercise started in January 2000, the stabilate was purchased from the provincial veterinary office in doses of 20 at a subsidised price of ZMK 10,000 (between EUR 3.6 and EUR 4 in accordance with the exchange rate at that time). As a step towards full cost recovery (about EUR 40 for 20 doses) (3), the subsidised price rose in October 2001 to ZMK 25,000 (EUR 9.9 in October 2001; EUR 5.3 in December 2002). The provincial veterinary office also supplied the centres with liquid nitrogen. Paraprofessionals carried the costs of electricity, fuel and drugs, including long-acting oxytetracycline. Maintenance

of the equipment (i.e. motorbikes and freezers) and the supply of liquid nitrogen were entirely subsidised. The paraprofessionals were encouraged to develop their clientele by advertising their services and their prices and by competing among themselves. Paraprofessionals submitted reports listing the identity and the address of the owners and the number of animals immunised by the immunisation centre. Those data, validated by district veterinary officers, were used to estimate the coverage of the immunisation.

At a later stage, three additional paraprofessionals (denoted by circled letters in Fig. 2a), of which two were on the Government payroll (O and X in Figure 2a), voluntarily joined the trial. They were based at Feni (O), Kwenje (K) and Chimpundu (X) (Fig. 2a). After making arrangements with the established paraprofessionals, they made use of the infrastructure of existing immunisation centres in those areas. These paraprofessionals plus paraprofessional B were supported in an attempt to promote private initiative and competition. The animals they immunised appear in bold letters in Fig. 2a.

In ECF endemic areas, paraprofessionals were allowed to immunise calves only between 2 and 12 months old. This was to avoid unnecessary expenditure, since all adult animals living in endemic areas were assumed to be immune. In epidemic areas, all age classes were subject to immunisation, provided that outbreaks had been recorded in the vicinity. This condition was imposed to avoid introducing the pathogen into uninfected areas. To ensure quality, the activities carried out by the paraprofessionals were monitored by State veterinary officers. East Coast fever occurrence and mortality in immunised animals, as recorded by passive surveillance and monitoring by State veterinary officers, ranged within the values reported by Marcotty *et al*. (7). Paraprofessionals were allowed to adjust the price of an immunisation but were advised to start with the same charge as that imposed by Governmental Veterinary Services in 2000 (ZMK 10,000 = EUR 3.8 per animal). In addition, the paraprofessionals formed an association that, among other objectives, aimed at regulating competition in the field.

The evaluation of the exercise was based on the number of animals immunised. This indicator reflects the availability of the service to the community, the efforts of the paraprofessionals to distribute it and, in the longer term, the satisfaction of the clients in previous services. The annual number of animals immunised in the province is presented in Figure 3. In 1995, the last year during which immunisation was free of charge, a total of 19,158 calves were immunised. Despite the fact that the immunisation area has increased since then, this number can be considered the annual 'immunisation potential' for the province. From a socio-economic perspective, it corresponds to the annual number of at-risk calves that

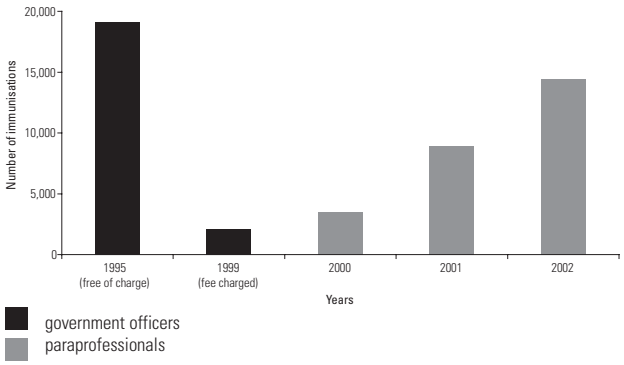

Fig. 3
Annual number of immunisations against East Coast fever carried out by government officers and paraprofessionals in the Eastern Province of Zambia between 1995 and 2002

cattle owners allowed to be immunised. Four years later, when the immunisation fee was ZMK 5,000 (EUR 1.9), the annual number of immunisations dropped to 2,121. After transfer to the paraprofessionals, the number of animals immunised increased gradually to reach 14,399 in 2002. The price of an immunisation at that time was, on average, ZMK 15,000 (EUR 3.2) per animal.

The annual number of immunised animals in 2002 almost reached the level of 1995 in the southern part of the plateau and in the areas between Chipata and Katete. Furthermore, immunisation was extended to animals in marginal areas east of Petauke and north-west of Chipata. Immunisation numbers remained dramatically low in Chadiza and Lundazi districts and in the north-east of Chipata (Fig. 2a and 2b). It appears that the proportion of immunised animals in the vicinity of the Chadiza and Lundazi immunisation centres was particularly low compared to other centres (Fig. 4). Immunisation coverage by individual paraprofessionals did not overlap much in remote areas such as Lundazi in the north and Petauke in the west, or in the less densely populated region in the south of the province. In contrast, four paraprofessionals were competing around Chipata (B, I, O and S) and Sinda (B, G, H and X) where attendance was high (Fig. 2a).

Discussion

The sustainable provision of AHC in developing countries is fraught with difficulties. However, notwithstanding the problems associated with the provision of AHC in general and an immunisation process that is highly dependent on a cold chain in particular, transferring responsibility for immunisation against ECF in eastern Zambia to paraprofessionals can be considered a success. Indeed, a large number of animals were immunised, despite the fact that an increasing proportion of the cost was borne by the livestock owners. A range of factors have contributed to this successful transfer.

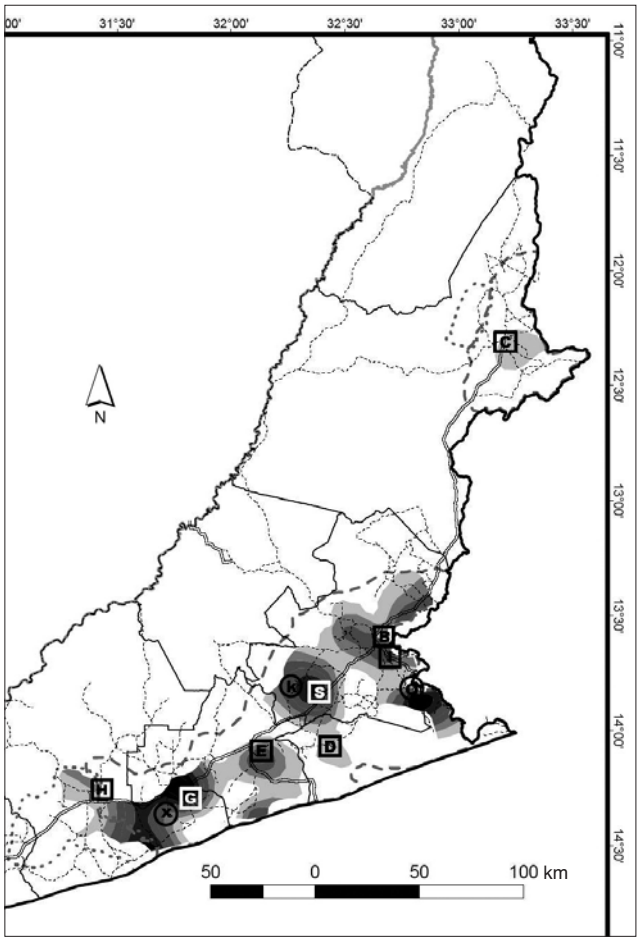

Fig. 4

Average proportion of cattle immunised against East Coast fever in a year in the Eastern Province of Zambia (average number of immunisations/number of cattle)

Five categories were defined using the following limits: 0%, 7%, 14%, 28%, 35% and 49%. The darker areas indicate a higher proportion of immunisations. ECF endemic and epidemic areas are surrounded by dashed lines (----) and dotted lines (....), respectively

This map was drawn using the Arcview software (Environmental Systems Research Institute, California)

Many of the problems encountered in the provision of AHC are the result of the particular relationship between the livestock owner and the AHC provider. This 'agent–principal' relationship has been the subject of many discussions in public health care (4). It occurs when an individual, the principal, delegates authority to another individual, the agent, to take action(s) on his or her behalf. In the case of ECF immunisation in eastern Zambia, the livestock owner (principal) delegates the authority to immunise his/her animals to the paraprofessional (agent). Under ideal circumstances the relationship between livestock owner and AHC provider should be based on mutual understanding and trust. In practice, however, the relationship is often subject to incomplete information or information asymmetries and the ensuing uncertainty (i.e. the livestock owner has serious problems determining the appropriateness and quality of the intervention by the AHC provider), which reduces the acceptability of, and demand for, services such as immunisation and the willingness to spend money for that purpose. This is certainly so for the risk-averse subsistence-oriented livestock owners living on the eastern plateau. Information asymmetry can apply to the service provided, the service provider or both. The successful transfer of ECF immunisation in the Eastern Province suggests that the relationship between service providers and livestock owners did not suffer much from information asymmetry. This is probably the result of years of experimenting and free immunisations in the province and the vivid souvenir of the devastation that ECF caused in the area in the 1970s and the 1980s. As a result, livestock owners do appreciate the private benefits accrued from immunisation in the absence of other efficient control methods under the conditions prevailing in the province (3). The immunisation process itself constitutes a considerable level of effort (i.e. restraining animals, preparation and injection of stabilate and long-acting tetracycline) on behalf of the provider that can be appreciated by the livestock owner. Such observable efforts do increase the acceptability of services and the willingness to pay for them (5, 9). Furthermore, acceptability of AHC is likely to increase substantially when evaluation of the level of care is based entirely on verifiable outcomes. This is certainly the case for immunisation against ECF where animals that have not been vaccinated may die from the killer disease; the mortality in vaccinated animals is much lower (7). It is very likely that a large proportion of livestock owners, paying for the immunisation, had experienced mortality in their own herds due to ECF before their animals were protected by immunisation.

Another factor that has probably contributed substantially to the success of the transfer is the fact that most of the paraprofessionals are part of the livestock owner's community and are well-known by the livestock owners. Such a close relationship usually results in repeated interactions. Repeated interactions between a livestock owner and an AHC provider serve as an incentive for the provision of appropriate services, even when observable efforts are absent. The livestock owner will, with an increasing number of interactions, be able to judge the outcome of the intervention from the health status and production of his livestock. Finally, the incentive to provide appropriate AHC services can also be independent of the frequency of interaction between the livestock owner and the AHC provider. This is, for example, the case when a professional organisation supervises the performance of the provider and the penalty of poor performance is revocation of the right to practice. The association of the paraprofessionals in the Eastern Province might not have provided such a guarantee, but the supervision by a State

veterinary officer was probably sufficient and removed the responsibility for monitoring the quality of services provided by the paraprofessional from the livestock owner. Furthermore, the availability of several paraprofessionals competing in an area allowed the livestock owners to select the AHC provider of their choice. Their choice was most likely based on price, trust, prestige or reputation.

Obviously, the sustainability of immunisation by paraprofessionals is also dependent on the continuous affordability of the service (the price of an immunisation). The provision of any type of AHC in rural areas is difficult and usually subjected to substantial transaction costs. Transaction costs are costs associated with providing the AHC or immunisation service and that neither benefit the paraprofessional nor the livestock owner. In the case of immunisation against ECF in eastern Zambia, the most important transaction costs are those resulting from storage of the stabilate and its transport to the site of immunisation. Subsidising parts of the immunisation process has certainly reduced the transaction costs and, thus, the price and increased its affordability. The choice of items that were subsidised was, however, not random. Only those that were specific to immunisation and difficult to obtain under rural conditions and that could not be used for other purposes were included. The subsidy probably contributed significantly to the immunisation's affordability and the success of its transfer. It is envisaged that research into cheaper methods of storing the stabilate in the field will, however, reduce the amount of subsidy required. Furthermore, exploiting economy of scale may reduce the transaction costs related to transport into the field. Nevertheless, the inability to pay for immunisation may explain the low proportion of immunised animals in remote districts such as Chadiza and Lundazi.

The proportion of immunised animals was higher in the vicinity of most immunisation centres. This may be explained by several factors, including a closer 'agent–principal' relationship as described above. It could also be due to the higher socio-economic development prevailing in the locations that were selected to accommodate the centres. The communities living in such areas might benefit from higher incomes than those living in remote areas. Finally, paraprofessionals might be reluctant to engage in remote areas where their operations are more expensive and where they could expect more competition.

Conclusion

This trial showed how paraprofessional AHC providers can effectively implement a complicated immunisation service in rural areas of developing countries. The presence of favourable conditions certainly increased the acceptability of the service by the cattle owners. At the same time, this transfer of activity from government officers to paraprofessionals improved the living conditions of the latter, diminished substantially the overall costs of AHC provision carried by the government and assured the cattle owners of a quality service. The monitoring of ECF immunisation by the State Veterinary Services and the assurance of its quality by the various stakeholders are essential to preserve the trust and the confidence of livestock owners. Post-immunisation serology can be used for quality control. On the other hand, the cold chain, including long-term storage of the vaccine below –80°C, storage of the diluent at –20°C and the field distribution on ice, must be cautiously maintained. This is particularly important in privatised schemes in which a technical failure is prone to hamper the credibility of the paraprofessionals themselves.

Acknowledgements

This exercise was carried out in the framework of a bilateral programme of the Government of Zambia and the Belgian Development Co-operation (DGDC) and is part of a Policy Support Research funded by DGDC.

Le transfert aux paravétérinaires des opérations d'immunisation contre la theilériose due à *Theileria parva* en Zambie

T. Marcotty, G. Chaka, J. Brandt, D. Berkvens, E. Thys, M. Mulumba, L. Mataa & P. Van den Bossche

Résumé

Dans l'est de la Zambie, l'immunisation par infection et traitement est la principale méthode de lutte contre la theilériose due à *Theileria parva (East Coast fever)*, une maladie aiguë et létale affectant les bovins. Auparavant, cette intervention, qui nécessite une maîtrise rigoureuse de la chaîne du froid, était réalisée gratuitement. Un tarif minimal a ensuite été appliqué, entraînant une diminution brutale du recours à ce service. Il a alors été tenté de transférer ce programme d'immunisation relativement complexe à des paravétérinaires privés, afin d'améliorer la couverture vaccinale. Les paravétérinaires ont été équipés de motos et du matériel spécifique nécessaire ; le carburant et les médicaments demeuraient à leur charge. Les paravétérinaires recouvraient ces coûts et réalisaient une marge bénéficiaire en facturant l'acte d'immunisation aux propriétaires de bétail.

Le succès du transfert du programme d'immunisation aux paravétérinaires (malgré le maintien d'une contribution financière de la part du propriétaire) s'explique principalement par l'absence d'asymétrie d'information entre les paravétérinaires et les propriétaires d'animaux et par le caractère vérifiable des efforts fournis par les prestataires et des effets du service rendu.

Mots-clés

Bovin – Chaîne du froid – Distribution – Immunisation – Infection et traitement – Maladie transmise par les tiques – Paravétérinaire – Theilériose – Theileria parva – Zambie.

Transferencia a veterinarios paraprofesionales de las actividades de inmunización contra la fiebre de la costa Este en Zambia

T. Marcotty, G. Chaka, J. Brandt, D. Berkvens, E. Thys, M. Mulumba, L. Mataa & P. Van den Bossche

Resumen

En la región oriental de Zambia, la inmunización por 'infección y tratamiento' es el método más corriente de lucha contra la fiebre de la costa Este, enfermedad aguda y mortal que afecta al ganado bovino. Este servicio, que requiere una rigurosa cadena de frío, era gratuito, pero tras la introducción de una tarifa mínima por usuario el número de demandas cayó drásticamente. En consecuencia, este complejo programa de inmunización fue transferido a veterinarios paraprofesionales que trabajan por cuenta propia, a fin de impulsar una distribución más sostenible de la vacuna. Se les proporcionó una motocicleta y el equipo técnico necesario, pero el combustible y los medicamentos corrían a su cargo. Para recuperar gastos y obtener un margen de beneficio, los paraprofesionales cobraban el servicio de inmunización a los propietarios del ganado.

Los buenos resultados obtenidos con la transferencia de la inmunización a paraprofesionales (pese a seguir siendo un servicio de pago) se atribuyen básicamente a la ausencia de asimetría de información entre el paraprofesional y el ganadero, a la encomiable dedicación de los paraprofesionales y al hecho de que sea un servicio cuyos resultados son comprobables.

Palabras clave
Cadena de frío – Distribución – Enfermedad transmitida por garrapatas – Fiebre de la costa Este – Ganado bovino – Infección y tratamiento – Inmunización – Paraprofesional – Zambia.

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