Evaluation of a Synthetic Tsetse-repellent Developed for Control of Cattle Trypanosomosis in Kenya

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Abstract

A field trial was carried out in two endemic foci of animal trypanosomosis to assess the effectiveness of a synthetic tsetse-repellent technology developed for the control of cattle trypanosomosis in Kenya. The trial was conducted over a period of 12 months that was preceded by a baseline period of 4 months. A sample size of 24 herds made up of 12 treatment and 12 control herds was used. The sample size was estimated assuming an • of 5 %, • of 20 %, intra-herd correlation coefficient of 0.4 and that the repellent technology, if effective, would reduce the incidence of trypanosomosis in treated herds by 50 % from the baseline level. The controls were selected purposefully to match the treatments in size and location. Trypanosome infections and tsetse challenge were monitored on monthly basis. Two variables were used to gauge the effectiveness of the repellent: the herd-level trypanosomosis incidence and the rate of trypanocidal treatments administered by the recruited farmers. Trypanosomosis incidence was treated as an outcome variable in a population-averaged regression model that had treatment, study area, tsetse density in a village where a herd was located, season, drug use and herd size as independent effects. The rate of treatment was analyzed using a Weibull model. In all the analyses, the level of confidence was fixed at 95%. This paper presents the results of this work and discusses how the treatment interacted with the other variables offered to the models.

Introduction

Tsetse-transmitted trypanosomosis remains one of the major disease constraints to improved livestock production in sub-Saharan Africa. It directly reduces productivity in cattle and contributes to mortality, as well as discourages use of more productive, improved breeds in infested areas. Particularly affected are pastoral and agro-pastoral communities, comprising a population of approximately 260 million, among the poorest in Africa.

Recent research at the International Centre for Insect Physiology and Ecology (ICIPE) led to the development of a novel technology using repellents to protect cattle from the tsetse fly and reduce the risk of trypanosomosis (Saini and Hassanali, 2002). Two repellents were developed, one a synthetic analogue of a mild natural repellent of savannah tsetse species called guaicol found in aged bovid urine, and another, a blend of odor constituents isolated from waterbuck. The repellents act as olfactory antagonists of a kairomone which tsetse use to locate hosts (International Livestock Research Institute [ILRI]/ICIPE, 2001). ICIPE also developed a prototype repellent dispenser that had two reservoirs, each with a capacity of 4.5 mg of the repellent. This study was conducted in two trypanosomosis endemic foci in Kenya to evaluate the effectiveness of the technology in reducing trypanosomosis incidence in cattle.

Materials and methods

The study was conducted in Nkuruman, Kajiado and Nkineji, Narok in Kenya. A sample size of 24 herds was estimated assuming a priori repellent effect of a 50 % reduction in herd-level disease incidence from the baseline level, the level of confidence (1 - α) of 95% and a power of (1 - β) of 80 %. The sample size was further adjusted to take into account the expected within-herd correlation of observations. A correlation coefficient of 0.4 and an average herd size of 50 were used. A sampling frame was constructed with information on the distribution of households, herd sizes, grazing patterns, tsetse density and trypanosomosis prevalence. Farmers
that had more than 200 cattle were later removed from the sampling frame to limit the trial to those herds that had manageable numbers of animals for repellent application and trypanosomosis surveillance. Treatment herds were randomly selected using computer generated random numbers, whereas control herds were selected purposively to match treatment herds in size and location.

All the animals were ear tagged at the beginning of the study and screened for trypanosomosis on a monthly basis using buffy coat technique. No attempt was made to blind the treatments from farmers, technicians or researchers because of the extra costs that could have been incurred in making extra dispensers. It was also considered not possible to create a placebo liquid that would be indistinguishable in odour from the repellent. The number of treatments administered by the recruited cattle owners was recorded over time.

Although it was expected that the prototype repellent dispenser would hold the repellent for at least month after being filled, it was realized early in the trial that the dispenser design was sensitive to abrasions and tension, especially at the point of diffusion. Depending on the status of the repellent/dispenser at inspection time and according to the presence and nature of damage, a scheme was developed to characterize the levels of protection for each treated animal. Combining the information about the status of each animal’s dispenser when monitored each month, with some simple assumptions about the rate at which damage to the dispensers occurred and relative protection offered by the different dispenser states, a measure of herd-level repellence efficacy was derived for each herd for each month.

The event of interest in the analysis of trypanosomosis incidence was the first occurrence of the disease per animal over the study period. A herd-level monthly trypanosomosis incidence was therefore generated as an aggregate of new infections identified in a herd offset by the number of animals at risk within that herd. Herd-level trypanosomosis incidence was modeled using a Poisson model. The independent effects were: study area, tsetse density, season, drug use and herd size. The effect of treatment was investigated in two ways. The first analysis ignored the frailties of the repellent dispenser, and the second used the weighted relative efficacy of the repellent based on dispenser defects. The weighted relative repellent efficacy was coded as: greater or equal to 70%, < 70 % and control. A naive model did not fit the data because of overdispersion. This was accounted for using generalized estimating equations (GEE). The rate of treatment was analyzed using a conditional risk-set model that allowed for multiple treatments while controlling for the effects of area, tsetse challenge, season, sex of the animal, and body condition. All statistical analyses were conducted in STATA version 8.2.

**Results**

**Parasitology** A total of 961 cases and 13 389 animal-months were recorded over the longitudinal phase of the study translating to an overall trypanosomosis incidence of 7.2 % per animal-month. On average, the incidence of the disease in the two groups of animals was fairly comparable over the baseline period. Over the longitudinal phase of the study (after the repellent was introduced), the incidence in the treatment group declined to 6.0 %, whereas in the control group it was maintained at 8.3 %. The trypanosome parasites identified in the study sites were *Trypanosoma congolense* and *T. vivax*. In Kajiado, most of the infections (84.6 %) were caused by *T. congolense*, but in Narok, there was no apparent difference in the number of cases caused by *T. congolense* (53.7 %) and *T. vivax* (45.5 %). Few mixed infections were observed probably because of the low sensitivity of the test used for diagnosis.

**Entomology** In Kajiado the predominant tsetse species was *Glossina pallidipes*. *G. longipennis* could also be caught in dense thickets. *G. swynnertoni* was the predominant species in Narok, although mixed infestations of *G. pallidipes* and *G. swynnertoni* was observed in a few villages.

**Modeling trypanosomosis incidence** The three variables that were found significant in the two Poisson models fitted to the data were: area, tsetse density and herd size. The model used auto-regressive correlation pattern lagged by one month to adjust for repeated measures in time. Treatment was not significant irrespective of the form of the variable used although it reduced the incidence rate ratio by about 20 – 30 %. It was, however, forced into the model as it was the variable of interest. First-order interaction terms between treatment and other covariates were also not significant. Trypanosomosis incidence was positively associated with tsetse density. The incidence was also higher in Narok than in Kajiado. Similarly, the incidence was higher in small than in large cattle herds. The high trypanosomosis incidence observed in Narok could be explained by the fact that tsetse was more spatially spread in the area. This could have led to a higher rates of tsetse:cattle contact compared to the expected levels in Kajiado. There was also a higher density of game in Narok. These animals act as
reservoirs of the trypanosome parasites. With regard to the size of the herd, the probability of an animal being bitten by tsetse reduces as the size of the herd in which that animal comes from increases.

**Rate of use of trypanocides** A total of 2,887 treatments were recorded by the cattle owners with 2,251 being administered in Narok and 636 in Kajiado. Overall, 92.6% (n = 2,642) of the recorded treatments involved trypanocides. Most of the treatments (n = 2,840) were administered as single doses with a small proportion of trypanocides being mixed with antibiotics (n = 15) before being administered. There were few recorded instances (n = 31) when different types of trypanocides were also mixed before being administered. The overall daily rate of treatment with a trypanocidal drug was 0.017. The rates of treatment in the treatment and control groups were 0.016 (95% CI: 0.015, 0.017) and 0.018 (95% CI: 0.017, 0.019) per day, respectively. Controlling for the effects of area, tsetse challenge, season, area, sex and body condition of an animal using a conditional risk set model, the rates of treatment did not vary significantly by the treatment group. The model fit was better when the baseline hazard was assumed to follow a Weibull than an exponential distribution.

**Conclusion**

The analyses suggest that using the repellent technology may contribute to a 20-25% reduction in the incidence of trypanosomosis at the herd level. This effect, however, was not statistically significant and failed to achieve the threshold of a 50% reduction set a priori to indicate sufficient effectiveness. The rate of use of trypanocides by the cattle owners did not also decline following the treatment of their animals with the repellent.

**References**

ILRI/ICIPE. (2001) Getting tsetse repellent technology out of the laboratory and to the farmer: enhancing the transfer, delivery and adoption of a new control technology for improved livestock health and productivity. *Full Design Document*. Nairobi


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