

AN *IN VIVO* COMPARISON OF THE EFFICACY OF THE HEARTWATER BLOOD AND GROUND-UP TICK SUSPENSION VACCINES IN CALVES

J. D. BEZUIDENHOUT and A. M. SPICKETT, Department of entomology, Veterinary Research Institute, Onderstepoort 0110

ABSTRACT

BEZUIDENHOUT, J. D. & SPICKETT, A. M., 1985. An *in vivo* comparison of the efficacy of the heartwater blood and ground-up tick suspension vaccines in calves. *Onderstepoort Journal of Veterinary Research*, 52, 269-271 (1985)

Two groups of calves were respectively immunized with heartwater blood (BV) and ground-up tick suspension (GUTS) vaccine. A third group was left unimmunized as controls. No difference in the immune status conferred could be demonstrated between the 2 vaccines at 6 months and 12 months challenge after vaccination. An index, based on the rectal temperature before and during the reaction, was calculated as an aid in evaluating the data. In practice, the evaluation of heartwater vaccination by challenge is more effective at 12 months than at 6 months after vaccination. No effective difference was demonstrated between the 2 vaccines in their immunizing efficacy.

INTRODUCTION

Neitz & Alexander (1941, 1954) established the basis for the vaccination of animals against heartwater, using *Cowdria ruminantium*-infected blood administered intravenously. More recently, Bezuidenhout (1981) reported on the production procedure for a heartwater vaccine. He used nymphae of the vector, *Amblyomma hebraeum*, as a source of the causative organism in a ground-up tick suspension, diluted to an effective concentration, to elicit a heartwater temperature response when administered intravenously to sheep. The immunogenicity of the heartwater blood vaccine (BV) was also compared with that of the proposed ground-up tick suspension vaccine (GUTS) in sheep. Similar reactions were noted, but no differences were evident in the pathogenicity of the 2 vaccines.

This paper reports on field trials conducted on calves under intensive ranching conditions to test the efficacy of the GUTS vaccine compared with that of the BV vaccine routinely issued by the Veterinary Research Institute, Onderstepoort. In addition, a numerical assessment of results is described as a means of evaluating heartwater temperature reactions in the absence of clinical cases.

MATERIALS AND METHODS

Vaccination

Fifty-six 3- to 4-week-old Afrikaner cross calves were randomly assigned to 3 groups. Heartwater blood vaccine was administered i.v. to one group of 20 calves. Another group of 19 calves received ground-up tick suspension vaccine, prepared according to Bezuidenhout (1981), at an effective concentration of 1/10 nymph per 5 ml dose and administered i.v. The third group of 17 calves was left untreated as a control. Both the vaccines used contained the Ball 3 strain of *Cowdria ruminantium*. Rectal temperatures were monitored daily to determine reactions. Regular weekly dipping, routinely practised, was maintained throughout the experiment to minimize the possibility of heartwater infection being imparted by tick infestation.

Challenge

After 6 months, randomly selected individuals from each of the 3 groups were challenged with heartwater blood vaccine to assess the reaction status attained. The BV group contained 8, and the GUTS and control groups 11 calves respectively. Challenge was repeated 12 months after the initial vaccination with the remaining calves in each group.

Rectal temperatures were monitored and observations were made daily for 25 days post-challenge, to determine temperature reactions indicating an immune response and to discern clinical signs or symptoms typical of the disease.

Treatment of the data

Rectal temperatures (°C) were used to develop a numerical basis to express post-challenge reactions. Temperatures from Days 1-10 post-challenge were designated incubation-time temperatures (It), this period being the mean elapsed time before a reaction occurred. Temperatures from Days 11-20 were taken as reaction-time temperatures (Rt). A reaction index (RI) was computed by the formula:

$$RI = Rt/It$$

for each individual animal, and the reaction indices attained at 6 months and 12 months respectively after vaccination for the 3 groups were compared, using the least significant squares method of Bonferroni.

RESULTS AND DISCUSSION

The heartwater RI employed here is based on the difference between the baseline temperature of the incubation period and the higher temperatures displayed during a febrile reaction to heartwater infection. As such, the RI provides a numerical assessment of the temperature reaction indicating the reaction status of the animal, allows statistical evaluation of the results, and, in addition, makes possible a numerical classification of the reaction

TABLE 1 Reactions classed according to severity with corresponding numerical reaction index values

Severity of reaction*	Class	Reaction index values	
High fever and other clinical signs	I	1,028	
High fever	II	1,028	1,022
Mild fever	III	1,022	1,010
No reaction	IV	1,010	

* The class descriptions are according to Du Plessis & Bezuidenhout (1979). The reaction index does not reflect clinical symptoms *per se*.

TABLE 2 Mean heartwater reaction indices of the 3 treatment groups on challenge 6 months after initial vaccination

Group	No. of animals	Mean reaction index
GUTS	11	0,998**
BV	8	1,000
Controls	12	1,008**

** Significant difference (P = 0,01)

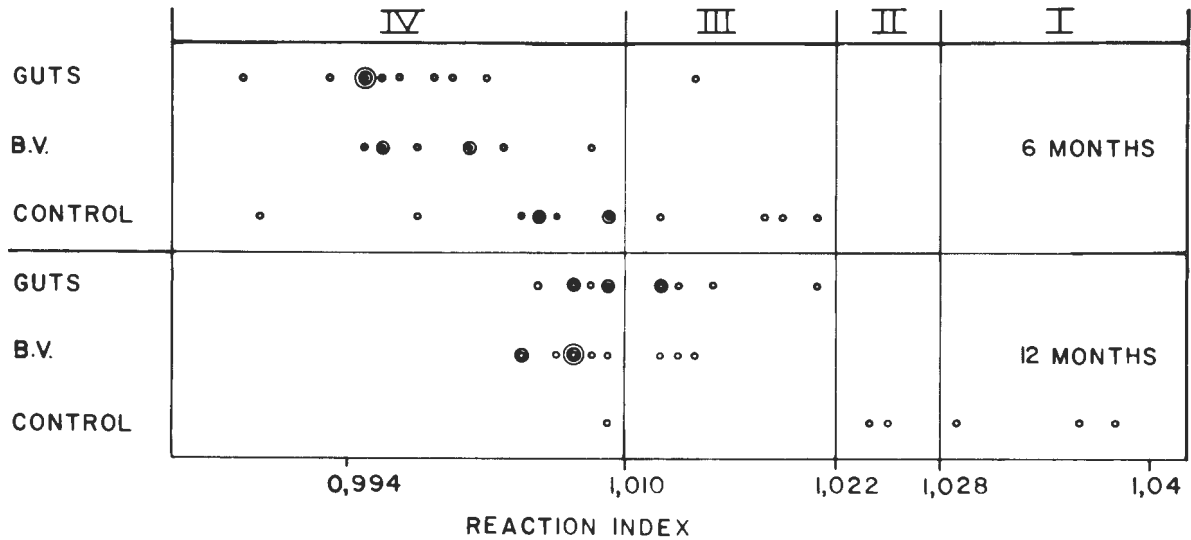


FIG. 1 Classification of individual temperature reactions into class of severity according to the reaction index at both 6 and 12 months challenge after vaccination

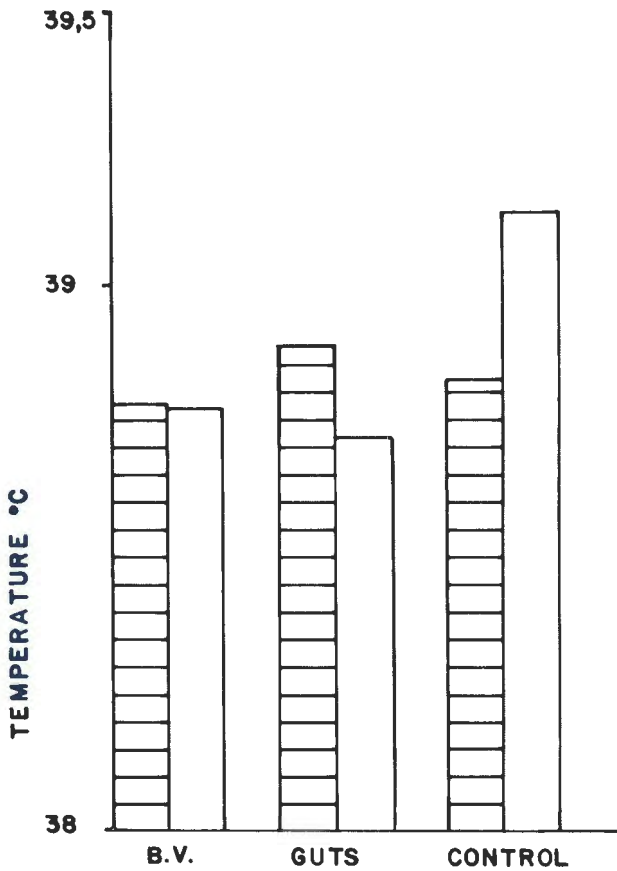


FIG. 2 Mean incubation-time temperature (It) (▨) and mean reaction-time (Rt) (□) temperature of the 3 groups at 6 months challenge

according to severity. Du Plessis & Bezuidenhout (1979) identified 4 reaction classes according to severity, which, when correlated with the RI, give values as shown in Table 1.

A classification of the severity of temperature reactions attained in these experiments is given in Fig. 1.

Six months challenge

At 6 months challenge, only Class IV and Class III reactions occurred. Only one animal in the GUTS group

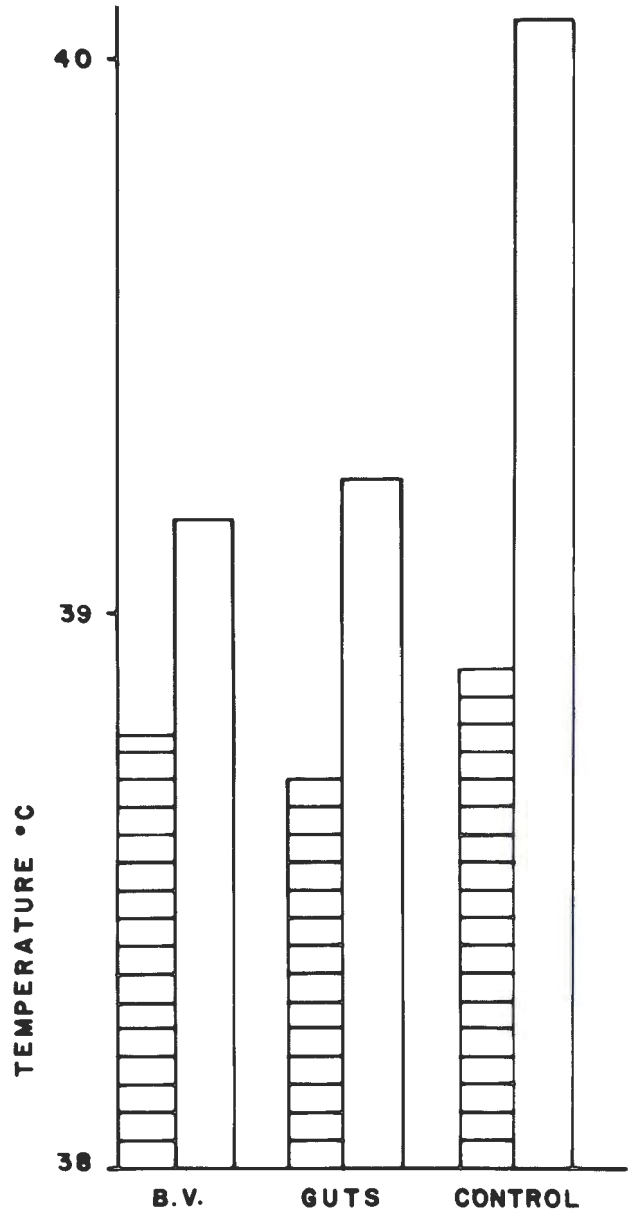


FIG. 3 Mean incubation-time (It) temperature (▨) and mean reaction-time (Rt) temperature (□) of the 3 groups at 12 months challenge.

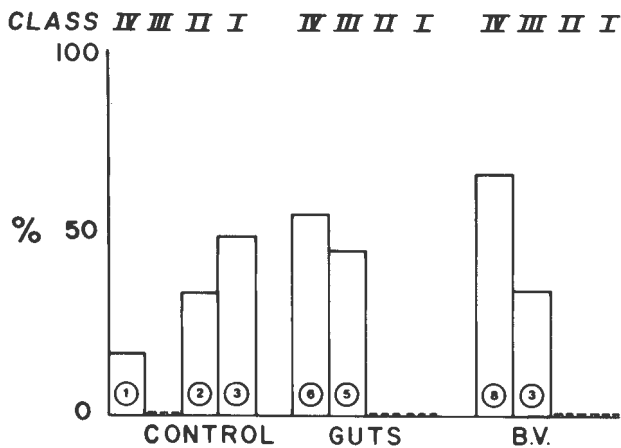


FIG. 4 Percentage and number of individuals of each experimental group in each reaction class at 12 months challenge

TABLE 3 Mean heartwater reaction indices of the 3 treatment groups on challenge 12 months after initial vaccination

Group	No. of animals	Mean reaction index
GUTS	8	1,010 a*
BV	12	1,010 b
Control	6	1,027 ab

* Means with the same symbols are significantly different (P = 0,01)

and 4 control animals showed Class III reactions. The GUTS groups as a whole differed significantly from the control group (P = 0,01) in displaying lower RI values. In contrast to the higher reactions in the control group (Fig. 2), these were elicited by little or no temperature response during the reaction period.

No differences could be demonstrated between the GUTS and BV groups at 6 months challenge, since both showed low RI values (Table 2) and negligible temperature responses (Fig. 2)

Twelve months challenge

At 12 months challenge, both the GUTS and BV groups displayed significantly lower RI values than the control group (P = 0,01) (Table 3). These showed a higher temperature response than both vaccinated groups (Fig. 3), with the majority (83 %) being classed as Type II and Type I according to severity (Fig. 4). Only one control animal did not react (Class IV, Fig. 4), having either acquired a natural immunity through tick infestation or having been naturally resistant to heartwater because of breed or hereditary characteristics (Bonsma, 1944). The other control animals all displayed reactions commensurate with heartwater susceptibility.

No differences existed between the 2 vaccinated groups, all animals of both groups displaying both Class IV and Class III reactions (Fig. 4). There was thus a parallel in immunization efficacy.

That the control group at 12 months challenge showed a significantly higher RI (P = 0,01) than the control group at 6 months challenge (Fig. 1) suggests a complete loss of natural age resistance 1 year after birth.

It is interesting also that both the GUTS and BV groups respectively showed significantly higher RI values (P = 0,05) at 12 months challenge than at 6 months challenge.

That the majority of reactions of both vaccinated groups at 12 months challenge were still of tempered severity, however, indicates heartwater immunity, although some loss seems indicated by the general shift to higher RI values (Fig. 1). This display of tempered severity reactions prompted an evaluation of the data acquired by the numerical index described.

The overall results indicate little or no effective difference in immunizing efficiency between the 2 vaccines tested. The evaluation of vaccine efficiency seems more effective by challenge 12 months after the initial vaccination, earlier challenge reactions possibly being influenced by natural age resistance.

ACKNOWLEDGEMENTS

We wish to thank Mr J. F. Putterill, who assisted at the inception of the experiments, Dr H. van Ark for assisting with the statistical analysis, Miss I. Messner for expert technical assistance with the computations involved and Dr J. du Plessis for constructive advice and criticism.

REFERENCES

BEZUIDENHOUT, J. D., 1981. The development of a new heartwater vaccine using *Amblyomma hebraeum* nymphae infected with *Cowdria ruminantium*. In: G. B. WHITEHEAD & J. D. GIBSON (eds). Tick biology and control. *Proceedings of an International Conference, 27-29 January 1981. Grahamstown, South Africa.* 41-46.

BONSMA, J. C., 1944. Hereditary heartwater-resistant characters in cattle. *Farming in South Africa*, February 1944, 71-96.

DU PLESSIS, J. L. & BEZUIDENHOUT, J. D., 1979. Investigations on the natural and acquired resistance of cattle to artificial infection with *Cowdria ruminantium*. *Journal of the South African Veterinary Association*, 50, 334-338.

NEITZ, W. O. & ALEXANDER, R. A., 1941. The immunisation of calves against heartwater. *Journal of the South African Veterinary and Medical Association*, XII, 103-111.

NEITZ, W. O. & ALEXANDER, R. A., 1945. Immunisation of cattle against heartwater and control of the tick-borne diseases, redwater, gallsickness and heartwater. *Onderstepoort Journal of Veterinary Research*, 20, 137-158.