Survey of canine babesiosis in South Africa

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ABSTRACT

A questionnaire, designed to obtain qualitative information on a number of variables concerning canine babesiosis (biliary fever) in South Africa, was sent to 510 veterinary practices in late 1993. Of the 157 practices that responded, all were presented with cases of babesiosis and most were situated in Gauteng, the Western Cape and KwaZulu-Natal. Apart from the Western Cape, a winter-rainfall region, the prevalence of babesiosis cases in dogs was highest in summer. Most of the respondent practices treated between 1000 and 5000 sick dogs that included 100 to 500 babesiosis cases each year. Respondents identified cerebral babesiosis, enterorrhagia, 'red' or haemoconcentrated babesiosis, acute renal failure and pulmonary babesiosis or 'shock lung', amongst others, as the most prevalent forms of complicated ('atypical') babesiosis. Diminazene, imidocarb and trypan blue were the most popular antibabesials. Trypan blue was most often used in shocked patients, whereas diminazene and imidocarb were preferred when there was a high parasitaemia in the absence of shock. At least 19 antibabesial treatment regimens were used in practices. These comprised the use of single doses of antibabesial drugs; split doses with repeat injections, and combined drug variations, some of which are undesirable due to possible sterilisation of *Babesia* infection or potential toxicity. Side-effects were most commonly associated with imidocarb use. Ninety-six percent of respondents used supportive treatment (*e.g.* corticosteroids, vitamins and 'liver support') in all cases of babesiosis. The use of blood transfusion as supportive treatment varied according to practice and severity of the case. Most practices never cross-matched blood to be transfused, and transfusion reactions were rare. Diminazene was most frequently incriminated in cases where drug 'resistance' or relapses occurred. Cerebral and 'red' cases resulted in high mortality. Treatment of babesiosis costs the dog-owning public in South Africa more than R20 million each year. Information on the distribution and possible complicating role of *Ehrlichia canis* was obtained. Development of a vaccine was the first research priority identified.

Key words: antibabesial therapy, *Babesia canis,* babesiosis, biliary fever, complications, costs, dog, *Ehrlichia canis,* importance, prevalence, priorities, research, supportive treatment, survey.

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INTRODUCTION

Babesiosis (biliary fever), a tick-borne haematozoan infection caused by *Babesia canis,* is one of the most prevalent diseases of dogs in southern Africa[20]. Over the past 100 years, a number of reports on aspects of the epidemiology[6], pathophysiology[8,19,21,27,40,41], clinical signs[2,12,14,20,23,32,34,35,40], pathology[4,14,40], treatment[1,3,7,13,15,17,18,22,26,30,33,38,40,43,44], immunology[5] and prevention[28,36,40] of canine babesiosis, as well as concurrent ehrlichiosis[9,10,25], have been published.

At the Onderstepoort Veterinary Academic Hospital (OVAH), approximately 12 % of sick dogs presented each year at the outpatients clinic are diagnosed with babesiosis, and about 31 % of these are admitted for more intensive treatment[37]. Despite intensive treatment, many affected dogs die[26] or are euthanased because of a poor prognosis. According to the records of the Department of Pathology, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, approximately 12 % of the 760 canine necropsies performed in 1990 were babesiosis cases. Most of these were from the OVAH, while a few were 'outside cases', *i.e.* carcasses for necropsy brought directly to the Pathology Department.

Although the pathogenicity of *Babesia canis* strains[5] is likely to vary, the discovery that French, North African and South African stocks of *Babesia canis* can be distinguished serologically, and that each is transmitted by a different tick (*Dermacentor reticulatus, Rhipicephalus sanguineus* and *Haemaphysalis leachi* respectively)[42], probably contributes to our understanding of the fact that southern African canine babesiosis is often severe compared to milder disease elsewhere[14,35,40]. Concern about the inadequacies of present knowledge, however, particularly with respect to the pathogenesis and treatment of complicated ('atypical')[23] cases, led to the establishment of the Canine *Babesia* Interest Group in 1991. Since little is known of the national distribution or seasonal variation of canine babesiosis, or the prevalence of complicated cases, it was decided to conduct a countrywide survey amongst practitioners. Additional variables to be surveyed included practice preferences regarding antibabesial and supportive treatment, the costs of treatment, the role of *Ehrlichia canis,* and perceived research priorities.

MATERIALS, METHODS AND RESULTS

A questionnaire was designed to obtain subjective information on the above variables. In the formative stage, it was scrutinised by a number of veterinarians in Gauteng. Once the format was finalised, the questionnaire was distributed in late 1993 to 510 veterinary practices in South Africa. These practices, which included 2 managed by state veterinarians, constituted the mailing list of a pharmaceutical supplies company. Unfortunately, the author does not know the provincial distribution of these practices. Of the 510, 157 self-administered questionnaires were returned, a response rate of 31 %. Qualitative data from each questionnaire were analysed using the Epi Info 5 computer program (Centers for Disease Control, Atlanta, USA, and World Health Organization, Geneva, Switzerland). Of the 157 veterinary practices that responded, 53 were in Gauteng, 36 in KwaZulu-Natal, 33 in Western Cape, 19 in Eastern Cape, 10 in Free State, 3 in North West and 3 in Mpumalanga. No questionnaires were returned from either Northern Cape or Northern Province. The districts, cities and towns represented by the respondents are given in Table 1.

At the time of the survey, the commercially available antibabesial drugs

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Table 1: **Distribution of respondent veterinary practices (sometimes more than one practice per town/city or branch practices in different towns/suburbs).**

Province	Town/city, suburb or region
Gauteng (53 respondents)	Benoni, Birnam, Boksburg, Bracken Gardens, Brakpan, Bryanston, Centurion, Craighall Park, Edenvale, Florida, Fourways, Gallo Manor, Garsfontein, Glenstantia, Hatfield, Honeydew, Johannesburg, Jukskei Park, Kilner Park, Krugersdorp, Lyndhurst, Lynnwood Glen, Lynnwood Ridge, Magalieskruin, Midrand, Muldersdrif, Noordwyk, North Riding, Onderstepoort, Ontdekkers, Parkmore, Parktown North, Petit, Pretoria, Pretoria North, Rant-en-dal, Rynfield, Sandton, Southdale, Sunninghill, Vanderbijlpark, Vereeniging, Waterkloof, Waterkloof Glen
KwaZulu-Natal (36 respondents)	Amanzimtoti, Ballito, Brighton Beach, Camperdown, Chatsworth, Dundee, Durban, Durban North, Empangeni, Gillitts, Howick, Ixopo, Kloof, Kokstad, KwaZulu, Ladysmith, La Lucia, Lower Tugela, Malvern, Mandini, Margate, Mooi River, Mtubatuba, Newcastle, Phoenix, Pietermaritzburg, Pinetown, Port Shepstone, Shelly Beach, Umfolozi, Underberg, Vryheid, Westville
Western Cape (33 respondents)	Bergvliet, Bredasdorp, Caledon, Cape Town, Constantia, Darling, Fish Hoek, Gordons Bay, Heidelberg, Hout Bay, Kenilworth, Knysna, Malmesbury, Mossel Bay, Newlands, Panorama, Piketberg, Plettenberg Bay, Rondebosch, Somerset West, Southfield, Stellenbosch, Table View, Worcester
Eastern Cape (19 respondents)	Adelaide, Amalinda, Bathurst, Bedford, Despatch, East London, Fernglen, Gonubie, Grahamstown, Humansdorp, Jeffreys Bay, Lorraine, Middelburg, Nahoon, Port Alfred, Port Elizabeth, Queenstown, Uitenhage, Walmer
Free State(10 respondents)	Bethlehem, Bloemfontein, Bothaville, Clocolan, Heilbron, Kroonstad, Ladybrand, Reitz, Tweespruit, Warden
North West (3 respondents)	Brits, Rustenburg
Mpumalanga (3 respondents)	Bethal, Carolina, Lydenburg

included diminazine aceturate (Berenil®, Hoechst Ag-Vet or Vebacide®, Centaur Laboratories), imidocarb diproprionate (Forray-65®, Hoechst Ag-Vet), trypan blue (Trypan Blue SS, Centaur or Trypan Blue, Kyron Laboratories) and phenamidine isethionate (Phenamidine®, Maybaker).

The questions and the options provided (italicised), together with the responses elicited and the number and percentage of respondents (in brackets) follow. Options were not provided for questions 4, 11, 13, 14, 23, 28, 29, 30 and 34; consequently, responses were open-ended.

1. *Approximately how many sick (for whatever reason) dogs (*i.e. *excluding healthy animals presented for vaccination/check-ups, etc.) are treated at your practice each year?*

   0–100 (2 = 1.4 %); *101–500* (4 = 2.9 %); *501–1000* (19 = 13.7 %); *1001–5000* (76 = 54.7 %); *>5001* (38 = 27.3 %) (*n* = 139).

2. *Do you see cases of canine babesiosis (biliary) at your practice?*

   No (0); *yes* (157 = 100 %) (*n* = 157).

3. *If 'Yes', approximately how many cases of canine babesiosis are seen by your practice during 1 year?*

   1–10 (2 = 1.4 %); *11–50* (17 = 12.2 %); *51–100* (22 = 15.8 %); *101–500* (73 = 52.5 %); *>501* (25 = 18 %) (*n* = 139). Accurate figures were provided by a practice in Reitz in the eastern Free State (122 cases out of 606 sick dogs, mean 20 %, with a monthly range of 2–43 % depending on the time of the year) and from the veterinary laboratory in Middelburg in the Eastern Cape (275 cases out of 1188 from 1989–1992, mean 23 %).

4. *When (what time of the year) is the prevalence of babesiosis at its peak?*

   The responses are given in Table 2.

5. *Are stained bloodsmears examined microscopically in cases of suspected canine babesiosis?*

   No (1 = 0.6 %); *sometimes* (6 = 3.8 %); *mostly* (20 = 12.8 %); *always* (130 = 82.8 %) (*n* = 157).

6. *Do you encounter complicated cases (*i.e. *cases which present with nervous signs, diarrhoea, respiratory distress, renal failure, etc., and which respond poorly to antibabesial treatment alone) of babesiosis in dogs in your practice?*

   No (3 = 1.9 %); *rarely* (105 = 66.9 %); *sometimes* (7 = 4.5 %); *often* (42 = 26.7 %) (*n* = 157).

7. *Which of the following complicated forms of canine babesiosis have you encountered in your practice?*

   Cerebral (127 = 81.9 %); *pulmonary* (77 = 49.7 %); *cardiac* (35 = 22.6 %); *enterorrhagia* (99 = 63.9 %); *'red' biliary* (94 = 60.6 %); *acute renal failure* (89 = 57.4 %); *anasarca* (31 = 20 %); *purpura* (59 = 38.1 %) (*n* = 155, multiple forms seen at many practices). An additional option, *other (specify),* delivered the following: 'immune-mediated haemolytic anaemia' (25 = 16.1 %); 'muscular' (16 = 10.3 %); 'paresis' (6 = 3.9 %); 'chronic' (7 = 4.5 %); 'necrosis of the tips of the ears and/or tail' (7 = 4.5 %); 'diarrhoea' (2 = 1.3 %) and 'ascites' (1 = 0.7 %). Some respondents commented that a very low parasitaemia was often associated with a poor prognosis. Others observed that *Babesia* parasites in the red cells of so-called 'winter biliaries' are often characterised by 'round' forms. No mention was made of the *Ehrlichia* status of 'winter' or 'chronic' biliaries.

8. *What are the preferred antibabesials used at your practice to treat babesiosis in dogs?*

   Diminazine (137 = 87.8 %); *imidocarb* (126 = 80.8 %); *trypan blue* (127 = 81.4 %); *phenamidine* (15 = 9.6 %) (*n* = 156, most respondents indicated more than 1). One practice reported the use of antimalarials (no details were given) for the treatment of relapses.

9. *Which antibabesial do you prefer to use in severely shocked cases?*

   Diminazine (12 = 7.7 %); *imidocarb* (12 = 7.7 %); *trypan blue* (141 = 90.4 %); *phenamidine* (2 = 1.3 %); *euflavine* (1 = 0.6 %) (*n* = 156, a few respondents indicated more than 1).

10. *Which antibabesial do you use in cases with a high parasitaemia on bloodsmear and which do not appear to be in shock?*

    Diminazine (77 = 49.4 %); *imidocarb* (35 = 22.4 %); *trypan blue* (74 = 47.4 %); *phenamidine* (7 = 4.5 %) (*n* = 156, some respondents indicated more than 1).

11. *Briefly describe your treatment regimen(s) with antibabesials (dosage, route, whether dose is divided, use of more than one antibabesial, etc.).*

    Nineteen different antibabesial treatment regimens were recorded by respondents (*n* = 151, some used more than 1). Four of these were mentioned

Table 2: **Peak seasonal prevalence of babesiosis according to province** (n = 149)**.**

	Gauteng	KwaZulu-Natal	Western Cape	Eastern Cape	Free State	North West	Mpumalanga	Number of respondents
All year	–	1	4	2	–	–	–	7 = 4.7 %
Summer	51	29	8	12	8	3	3	114 = 76.5 %
Winter	–	–	5	–	–	–	–	5 = 3.4 %
Spring	1	–	5	1	2	–	–	9 = 6 %
Autumn	–	2	2	1	–	–	–	5 = 3.4 %
Spring & autumn	–	–	8	1	–	–	–	9 = 6 %
Totals	52	32	32	17	10	3	3	149
	34.9 %	21.5 %	21.5 %	11.4 %	6.7 %	2 %	2 %	100 %

once only (0.7 %). Most of the regimens utilised 1 antibabesial at the recommended dosage (Table 3). Some variations on single-drug treatment regimens, involving fractions of normal dosages repeated within hours or days, were also in use by a small number of respondents (Table 4). A number of respondents preferred combined antibabesial regimens, using follow-up doses of different drugs within 1 or more days (Table 5).

12. *Have you encountered significant side-effects with an antibabesial drug?*

No (57 = 36.5 %); *yes* (99 = 63.5 %) (*n* = 156).

13. *If 'Yes', what side-effects are associated with which drug(s)?*

The side-effects and associated drugs are listed in Table 6. Many respondents listed more than 1 antibabesial and more than 1 side-effect for each. Imidocarb was mentioned most frequently (67 = 68 %), followed by diminazene (41 = 41 %), phenamidine (13 = 13 %) and trypan blue (10 = 10 %) (*n* = 99). One practitioner had observed a number of cases (about 12) in which routine intravenous trypan blue treatment was followed 1–2 weeks by a hardening of patches of skin over the ribs or thigh or elsewhere (*i.e.* at a distance from the venipuncture site). This was followed by sloughing of the affected skin, leaving bright blue subcutaneous tissue, which then granulated and healed with or without surgical intervention. Trypan blue supplied by both commercial suppliers was incriminated. Another practitioner had a similar experience when intravenous trypan blue in conjunction with subcutaneous imidocarb (Table 5) resulted in skin sloughing at the injection site of the latter.

14. *What supportive treatment do you use in uncomplicated, complicated and severely shocked cases of babesiosis?*

The responses are recorded in Table 7. In most cases the respondents used broad terminology, *e.g.* 'liver support', or 'diuretics'. These broad terms are used in the table and include more specific preparations that were mentioned by some, such as 'lipotropic agents' (*e.g.* methionine and choline), 'Bykahepar', 'essential phospholipids', 'phosamine stimulans', 'post-biliary tonic' and 'Lasix' or furosemide. Other treatments used rarely (1–2 respondents), and not included in the table, included mannitol, millophylline, anabolics, oxygen, dimethylsulphoxide (DMSO), dextrose saline, bicarbonate, atropine, antihistamines, tranquillisers, flunixin meglumine, phenylbutazone, morphine and total blood replacement. The justification for the use of corticosteroids was usually stated to be prophylactic for immune-mediated haemolytic anaemia (IMHA). In uncomplicated cases, the justification usually given for supportive treatment was to aid quicker recovery.

15. *If you make use of blood transfusion, approximately what percentage of your babesiosis cases is treated in this way?*

a) routine (uncomplicated) cases: 0 (54 = 35.3 %); *1–10* (83 = 54.2 %); *11–20* (10 = 6.5 %); *21–30* (3 = 2 %); *31–40* (2 = 1.3 %); *41–50* (1 = 0.7 %); *51–100* (0) (*n* = 153).

b) complicated cases (as in Question 7): 0 (40 = 29.2 %); *1–10* (59 = 43.1 %); *11–20* (7 = 5.1 %); *21–30* (8 = 5.8 %); *31–40* (4 = 2.9 %); *41–50* (10 = 7.3 %); *51–60* (1 = 0.7 %); *61–70* (5 = 3.6 %); *71–80* (2 = 1.5 %); *81–90* (1 = 0.7 %); *91–100* (0) (*n* = 137).

c) severely shocked cases: 0 (13 = 9.1 %); *1–10* (33 = 23.1 %); *11–20* (12 = 8.4 %); *21–30* (9 = 6.3 %); *31–40* (5 = 3.5 %); *41–50* (19 = 13.3 %); *51–60* (6 = 4.2 %); *61–70* (6 = 4.2 %); *71–80* (11 = 7.7 %); *81–90* (10 = 7 %); *91–100* (19 = 13.3 %) (*n* = 143).

According to some respondents,

Table 3: **Antibabesial treatment regimens** (*n* = 151)**.**

Drug	Dose	Route	Respondents
Diminazene	3.5 mg/kg	i.m. or s.c.	93 = 62 %
Imidocarb	6 mg/kg	s.c.	72 = 48 %
Trypan blue	10 mg/kg	slow i.v.	50 = 33 %
Phenamidine	20 mg/kg	s.c.	9 = 6 %
Euflavine	Not given	i.v.	1 = 0.7 %

i.m. = intramuscular; s.c. = subcutaneous; i.v. = intravenous.

Table 4: **Variations on single drug treatment regimens** (*n* = 151)**.**

Drug	Dose	Repeat (respondents)
Diminazene	Half[a]	8 h (7 = 4.7 %)
	2.3 mg/kg	24 h (2 = 1.3 %)
Imidocarb	Half	8 h[b]
	Full	1–4 d[b]
Trypan blue	Half	8 h[b]
Phenamidine	Quarter to half	8 h[b]

Note: some practices add an equal quantity of lignocaine to the syringe containing the imidocarb. Prednisolone and antihistamines are sometimes used as premedication.
[a]The exact dosages were not mentioned; 'quarter', 'half' or 'full' were the responses given.
[b]These variations are according to comments made by a small number (0.7–4.7 %) of the respondents (see Table 3 for overall percentages). These regimens are used in critical cases where the 2nd dose is given once the animal is stabilised.

Table 5: **Combined antibabesial treatment regimens** (*n* = 151)**.**

Drug	Dose	2nd drug	Dose	Respondents
Diminazene	Full[a]	Imidocarb	Full (1–7 d later)	42 = 28 %
	Half	Imidocarb	Half[b]	1 = 0.7 %
	Full	Trypan blue	Full (next day)	5 = 3.3 %
Imidocarb	Full	Diminazene	Full (1–2 d later)	7 = 4.7 %
Trypan blue	Full	Diminazene	Full (2–14 d later)	40 = 27 %
	Full	Imidocarb	Full (1–7 d later)	28 = 19 %
Phenamidine	Half	Diminazene	Full (2 d later)	1 = 0.7 %
	Half	Imidocarb	Half (next day)	1 = 0.7 %

[a]See footnote Table 4.
[b]Repeat injections of both drugs given 24 h later.

transfusion was indicated when the haematocrit dropped to below 0.2 ℓ/ℓ, or even 0.08 ℓ/ℓ. Some practitioners observed that icteric dogs were more likely to die after a blood transfusion than non-icteric dogs.

16. *If you make use of blood transfusion, do you cross-match donor and recipient before transfusing?*
No (132 = 86.3 %); *sometimes* (16 = 10.4 %); *mostly* (3 = 2 %); *always* (2 = 1.3 %) (*n* = 153).

17. *If you make use of blood transfusion, in what percentage of your cases is there a transfusion reaction?*
<1 % (120 = 81.6 %); *1–5 %* (21 = 14.3 %); *6–10 %* (4 = 2.7 %); *11–20 %* (2 = 1.4 %); *>21 %* (0) (*n* = 147).

18. *Do you consider drug resistance to be a factor in the treatment of babesiosis in dogs?*
No (90 = 57.7 %); *yes* (66 = 42.3 %) (*n* = 156).

19. *If 'Yes', which antibabesial do you implicate in* Babesia canis *resistance?*
Diminazine (54 = 81.8 %); *imidocarb* (19 = 28.8 %); *trypan blue* (23 = 34.8 %); *phenamidine* (23 = 34.8 %) (*n* = 66, most respondents indicated more than 1). A few respondents commented that babesiosis cases 10 or 12 years ago seemed to respond well to diminazine or phenamidine. Nowadays, however, they claimed that only trypan blue and imidocarb seemed to be effective.

20. *Do some of your babesiosis cases 'relapse' after treatment?*
No (26 = 16.7 %); *yes* (130 = 83.3 %) (*n* = 156).

21. *If 'Yes', which antibabesial(s) do you associate with relapses?*
Diminazine (84 = 67 %); *imidocarb* (56 = 44 %); *trypan blue* (66 = 52 %); *phenamidine* (22 = 17 %) (*n* = 126, some respondents indicated more than 1 drug).

22. *In your practice, what is the approximate percentage mortality in cases which have been treated with an antibabesial, with or without supportive treatment?*
a) routine (uncomplicated) cases: 0 (70 = 46.1 %); *1–10* (81 = 53.3 %); *11–20* (1 = 0.6 %); *21–100* (0); (*n* = 152).
b) complicated cases (see Question 7): 0 (9 = 6.3 %); *1–10* (40 = 28.2 %); *11–20* (23 = 16.2 %); *21–30* (23 = 16.2 %); *31–40* (7 = 4.9 %); *41–50* (15 = 10.6 %); *51–60* (0); *61–70* (3 = 2.1 %); *71–80* (9 = 6.3 %); *81–90* (7 = 4.9 %); *91–100* (6 = 4.2 %) (*n* = 142).
c) severely shocked cases: 0 (3 = 2 %); *1–10* (30 = 19.9 %); *11–20* (24 = 15.9 %); *21–30* (30 = 19.9 %); *31–40* (11 = 7.3 %); *41–50* (18 = 11.9 %); *51–60* (7 = 4.6 %); *61–70* (15 = 9.9 %); *71–80* (6 = 4 %); *81–90* (6 = 4 %); *91–100* (1 = 0.7 %) (*n* = 151).
According to respondents who supplied accurate data, mortality ranges from about 4 % to 37 % (mean 6.5 %). A number of respondents noted that the mortality in cerebral or 'red' cases is usually over 80 %.

23. *What is the average cost to the client for the treatment of a canine babesiosis case?*
The responses are analysed in Table 8.

24. *Does canine ehrlichiosis (caused by* Ehrlichia canis*) occur in your area?*
No (29 = 18.5 %); *yes* (111 = 70.7 %); *don't know* (17 = 10.8 %) (*n* = 157).
The urban and regional distribution of 'Yes' respondent practices is given in Table 9.

25. *Do you regard ehrlichiosis as an important complicating factor in babesiosis cases seen at your practice?*
No (69 = 44.5 %); *sometimes* (65 = 42 %); *commonly* (21 = 13.5 %) (*n* = 155).

26. *If you answered 'Sometimes' or 'Commonly' in Question 25, on what basis is such a diagnosis made?*
Ehrlichia canis *parasites on blood smear* (77 = 89 %); *white cell count normal or low* (20 = 23 %); *thrombocytopenia* (36 = 42 %); *monocytosis / active monocytes* (61 = 71 %) (some respondents indicated more than 1 option; *n* = 86).

27. *When treating canine babesiosis cases, do you also treat for ehrlichiosis even when the latter has not been confirmed?*
No (97 = 61.8 %); *sometimes* (47 = 29.9 %); *commonly* (13 = 8.3 %) (*n* = 157).

28. *What purebred dog breeds do you consider most susceptible to babesiosis?*
All breeds (30/121); *Rottweiler* (26/121);

Table 6: **Side-effects of antibabesials most frequently noted by practitioners (number of respondents out of total for applicable antibabesial).**

Drug	Side-effect
Diminazene (*n* = 41)	Nervous signs (29 = 71 %) Anaphylaxis (9 = 22 %) Vomition (7 = 17 %)
Imidocarb (*n* = 67)	Vomition (38 = 57 %) Pain on injection (22 = 33 %) Anaphylaxis (18 = 27 %) Local reactions (lump/cold abscess/slough) (16 = 24 %) Salivation (10 = 15 %) Diarrhoea (9 = 13 %)
Trypan blue (*n* = 10)	Shock if administered too quickly (6 = 60 %) Periphlebitis (3 = 30 %)
Phenamidine (*n* = 13)	Vomition (6 = 46 %) Nervous signs (5 = 38 %) Anaphylaxis (4 = 31 %) Diarrhoea (2 = 15 %) Urticaria (2 = 15 %)

Table 7: **Supportive treatment.**

Uncomplicated cases (*n* = 155)	**Complicated cases** (*n* = 122)	**Shocked cases** (*n* = 151)
None (6 = 3.9 %)	Corticosteroids (81 = 66 %)	Corticosteroids (108 = 72 %)
Corticosteroids (101 = 65 %)	Ringer's lactate (54 = 44 %)	Blood (100 = 66 %)
Vitamins (89 = 57 %)	Diuretics (36 = 29 %)	Ringer's lactate (74 = 49 %)
Liver support (79 = 51 %)	Liver support (24 = 20 %)	Plasmalyte B (36 = 24 %)
Antibiotics (39 = 25 %)	Blood (24 = 20 %)	Liver support (32 = 21 %)
Tetracyclines (8 = 5 %)[a]	Heparin (21 = 17 %)	Diuretics (28 = 18 %)
	Vitamins (17 = 14 %)	Heparin (17 = 11 %)
	Antibiotics (16 = 13 %)	Tetracyclines (6 = 4 %)[a]
	Plasmalyte B (15 = 12 %)	Packed red cells (1 = 0.7 %)
	Tetracyclines (7 = 6 %)[a]	
	Packed red cells (1 = 0.8 %)	

[a]Although antibiotics, tetracyclines are categorised separately because of practitioners wanting to treat for possible ehrlichiosis concurrently.

Table 8: **Costs to client for treatment (1994 figures).**

	Uncomplicated	**Complicated**	**Shocked**
Range	R30–R250	R45–R850	R65–R1500
Mean	R90	R230	R350
Standard deviation	R40.80	R157.70	R189.10
Mode	R150	R250	R250
Median	R75	R200	R300

German shepherd (19/121); *Staffordshire bull terrier* (17/121); *Border collie* (16/121) (these were the top 5; some respondents indicated more than 1 breed, *n* = 121).

29. *What purebred dog breeds do you consider most resistant to babesiosis?*

None (32/82); *ridgeback* (16/82); *fox terrier* (9/82) (these were the top 3; some respondents indicated more than 1 breed, *n* = 82).

30. *What problem(s) pertaining to canine babesiosis would you like to see researched?*

The following aspects were mentioned the most frequently:

Vaccination (77 = 50 %); treatment of shocked, icteric and cerebral cases, and relapses, as well as peracute babesiosis in pups (28 = 18 %); safety and efficacy of antibabesial drugs (26 = 17 %); IMHA (15 = 10 %); tick control (14 = 9 %) and *Babesia canis* strain variations (11 = 7 %) (*n* = 155). An easier way to diagnose ehrlichiosis, apart from the time-consuming examination of blood smears, was desirable for a few respondents.

31. *Would you/your practice be interested in cooperating/collaborating in a research project(s) involving canine babesiosis?*

No (31 = 20.1 %); *yes* (123 = 79.9 %) (*n* = 154).

32. *Two* Babesia canis *vaccines, produced overseas, appear to give limited protection against certain* B. canis *strains. Would you/your practice be interested in field trials of these and future vaccines?*

No (28 = 18.3 %); *yes* (125 = 81.7 %) *(n = 153).*

33. *Have any of your clients displayed an interest in contributing towards the costs of research on canine babesiosis?*

No (154 = 98.7 %); *yes* (2 = 1.3 %) (*n* = 156).

34. *Any other comments?*

Responses here were varied and numerous. A number of unverified breed-related observations, which may or may not have substance, were made by respondents. These included posterior paresis in Scottish terriers, 'red' biliaries and shock lung in Staffordshire bull terriers, chronic 'winter' biliaries in German shepherds, chorea in Jack Russell terriers and Staffordshires and increased susceptibility to diamidine toxicity in poodles. Note that the survey did not include a question to determine whether or not dogs were weighed in order to calculate the correct antibabesial dosages.

DISCUSSION

All of the respondents diagnosed cases of canine babesiosis at their practices. Consequently, according to this survey, the distribution of canine babesiosis corresponds to that of the respondent practices (Table 1). However, the *Babesia* status at those practices that did not return questionnaires, and in the Northern Cape and Northern Province, is unfortunately not known. Both of these provinces, however, are generally drier than elsewhere and canine ehrlichiosis would be expected to have a higher prevalence than babesiosis.

This survey has shown that most prac-

Table 9: **Distribution of confirmed canine ehrlichiosis according to respondents to this survey.**

Province	**Town/city, suburb or region**
Gauteng	Benoni, Boksburg, Bracken Gardens, Brakpan, Bryanston, Centurion, Edenvale, Florida, Gallo Manor, Glenstantia, Hatfield, Honeydew, Johannesburg, Jukskei Park, Kilner Park, Krugersdorp, Lynnwood Glen, Lynnwood Ridge, Magalieskruin, Midrand, Muldersdrif, Noordwyk, North Riding, Onderstepoort, Ontdekkers, Parktown North, Pretoria North, Rant-en-dal, Rynfield, Sandton, Southdale, Sunninghill, Vereeniging, Waterkloof, Waterkloof Glen
KwaZulu-Natal	Amanzimtoti, Ballito, Brighton Beach, Camperdown, Chatsworth, Dundee, Durban, Durban North, Empangeni, Gillitts, Howick, Kloof, Kokstad, KwaZulu, Ladysmith, La Lucia, Lower Tugela, Malvern, Mandini, Margate, Newcastle, Pietermaritzburg, Pinetown, Port Shepstone, Shelly Beach, Umfolozi, Vryheid, Westville
Western Cape	Bredasdorp, Caledon, Fish Hoek, Kenilworth, Malmesbury, Mossel Bay, Newlands, Piketberg, Plettenberg Bay, Southfield, Worcester
Eastern Cape	Adelaide, Amalinda, Bathurst, Bedford, Despatch, East London, Fernglen, Gonubie, Grahamstown, Humansdorp, Middelburg, Nahoon, Port Alfred, Port Elizabeth, Queenstown, Uitenhage, Walmer
Free State	Bloemfontein, Bothaville, Clocolan, Kroonstad, Ladybrand, Reitz, Tweespruit
Northwest	Brits, Rustenburg
Mpumalanga	Carolina, Lydenburg

tices see 1000–5000 sick dogs, including 100–500 babesiosis cases, each year. Most cases occur in summer in Gauteng, KwaZulu-Natal, Eastern Cape, Free State, Northwest and Mpumalanga. In the Western Cape, a winter-rainfall area, cases occur throughout the year. It also revealed that babesiosis cases are always confirmed by examination of blood-smears at 83 % of practices.

Regarding complicated cases, two-thirds of practices encounter them rarely while 27 % see them commonly. The most prevalent are the cerebral, enterorrhagic, 'red' or haemoconcentrated, acute renal failure, pulmonary or 'shock lung', purpura, cardiac and anasarca forms. Others include the muscular, IMHA, posterior paresis, ascites, chronic and diarrhoea forms, as well as 1 characterised by necrosis of the tips of the ears and tail. These complicated forms have been described previously[4,23,26,27,34,40].

The most popular antibabesials, used in over 80 % of practices, are diminazene, imidocarb and trypan blue. Trypan blue is used for severely shocked patients at 90 % of practices, while diminazene and trypan blue are preferred where there is a high parasitaemia in the absence of shock. Of the 19 different antibabesial regimens described, those most commonly used, all of which involve full doses, are diminazene, imidocarb, trypan blue, diminazene followed by imidocarb 1–7 days later, and trypan blue followed by diminazene 2–14 or imidocarb 1–7 days later. In the light of the unverified side-effect alluded to in Question 13, it would be prudent *not* to use trypan blue and imidocarb concurrently. Combined antibabesial regimens are warranted in some circumstances[26,31]. Concerning combined antibabesial treatments, it is interesting to note that the administration of a full dose of diminazene, followed a day or more later by a full dose of imidocarb (used by more than a quarter of the respondents – Table 5), would sterilise the infection[31]. This would be an undesirable outcome in endemic areas, as the development of premunity would be impaired[31]. In addition, splitting the dose of diminazene (Table 4) may contribute to the development of drug resistance[39]. All of the practices using phenamidine isothionate appear to use it at 20 mg/kg instead of at the recommended dose of 15 mg/kg[39]. Phenamidine followed by diminazene 2 days later (as used by 1 respondent) is contra-indicated because the toxic effects of the aromatic diamidines are cumulative[11,39] and could easily result in the development of irreversible neurotoxicity[29]. Side-effects of antibabesial drugs were encountered by 63 % of respondents. Side-effects were most commonly seen with imidocarb; this drug is also potentially toxic[1,17].

Ninety-six percent of respondents made use of supportive treatment in *all* cases of babesiosis, including uncomplicated ones. Only 6 (3.9 %) (including OVAH), did not make use of supportive treatment in uncomplicated cases. The use of corticosteroids, vitamins and liver supportive preparations in uncomplicated cases probably reflects the understanding[26,40] that such treatment hastens the return to normal appetite, habitus and body temperature. However, this is not pathophysiologically justified[16]. Indeed, corticosteroids could be contra-indicated, as their use can be a factor in the precipitation of relapses[24]. There is also no rational justification for the use of many of the drugs used as supportive treatments, especially those used rarely (Question 14).

In this survey, most respondents made use of blood transfusion in less than 10 % of uncomplicated cases, while between 0 and 100 % of patients in shock received blood. In addition, 86 % of respondents did not cross-match blood before transfusing (only 2 practices always did), and transfusion reactions are regarded as rare. As the survey questionnaire did not include details of which adverse reactions practitioners should anticipate, the reader is referred to the article by Jacobson and Lewis[15] (which also has details of a cross-match procedure).

The value of blood transfusion as supportive treatment in cases of canine babesiosis should not be underestimated. First emphasised for this purpose 35 years ago[18], it is of particular value in severely anaemic cases (haematocrit below 0.15*l/l*), those with severe clinical signs (dyspnoea and tachypnoea), IMHA (cross-matching is definitely advisable here) or the hypocoagulable phase of disseminated intravascular coagulation[15,26].

Relapses are a problem according to 83 % of respondents, while 42 % of respondents considered 'drug resistance' to be a factor. Diminazene is the antibabesial most frequently incriminated in cases where alleged drug resistance or babesiosis relapses are encountered.

Mortality ranges from less than 5 % to more than 35 % depending on whether complications or shock are present. Cerebral or 'red' cases have a poor prognosis, with over 80 % mortality.

At the time of the survey (1994), owners could expect to pay approximately R90 for the treatment of an uncomplicated case, R230 for a complicated one and R350 for one that is severely shocked (Table 8). Based on this information, a conservative estimate of the cost of canine babesiosis to the dog-owning public in South Africa exceeds R20 million per annum (an estimated 450 practices treating dogs multiplied by an estimated 300 dogs with biliary per practice per year at R150 per treatment = R20 250 000).

Concerning *Ehrlichia canis,* 71 % of respondents believed that it occurred in their area (Table 9), 11 % did not know and 18 % said it was absent. In some instances there was a marked dissimilarity in the reported incidence of confirmed ehrlichiosis cases from neighbouring practices in the same town or suburb. This clearly illustrates that the diagnostic investigation at some practices is deficient. Although 44 % of respondents did not regard ehrlichiosis as a complicating factor in babesiosis cases, 42 % sometimes found it and 13 % regarded it as a common complicator. *Ehrlichia* diagnosis is usually made by identifying the parasites on blood smear examination or by subjectively assessing monocyte activity. Sixty-two percent of respondents did not treat for ehrlichiosis if it had not been confirmed.

Since the data from this survey are incomplete, more research is needed concerning the distribution of both babesiosis and ehrlichiosis in dogs in southern Africa. Since experimental infection with *E. canis* can precipitate clinical babesiosis in *B. canis* carrier dogs[9,44], the role of concurrent ehrlichiosis, especially its role in immunosuppression and in the pathogenesis of complicated babesiosis cases, needs clarification.

A greater understanding of the pathogenesis of primary babesiosis, especially of complicated cases, is urgently needed. A vaccine, effective against the South African *B. canis* strains, would be welcomed by most respondents. There would be no shortage of potential research collaborators in the development of such a vaccine. The problem, however, is that the costs involved may be prohibitive, particularly where available funding is channelled towards production animal diseases.

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