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Short communication

A retrospective study of rabies in humans in Zimbabwe, between 1992 and 2003

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Abstract

This study aimed at examining the epidemiological features of rabies in humans in Zimbabwe. The data were taken from internal reports of the department of veterinary technical services at Harare covering the period 1st January 1992–31st December 2003 inclusive. Positive cases were examined in relation to age and sex of the victim, animal vector involved, season, and land-use categories. The majority of the confirmed positive human cases (85.7%) were recorded in communal areas. The 5–19 year age group and males constituted a highly vulnerable group. Over 90% of the cases were due to dog bites with jackals (*Canis adustus* and *C. mesomelas*), and honey badgers (*Mellivora capensis*) also contributing to the positive cases. Rabid cats and rabid wild animals had a high relative risk (RR) of biting humans. Animal-to-human transmission was highest during the dry months of July to November.

Keywords: Epidemiology; Human rabies; Zimbabwe

1. Introduction

Rabies, a fatal disease to humans and other mammals constitute a public health problem throughout the world, particularly in the tropics, where its control is restricted by inadequate infrastructure, and financial resources. The first irrefutable diagnosed cases of rabies in Zimbabwe occurred in 1902 (Bingham et al., 1999a), and domestic dogs were the principal species involved. Due to a large-scale destruction of stray dogs and strict dog laws that were introduced to control the disease (Swanepoel et al., 1993), rabies was no longer present after 1913, and it was not diagnosed in the country until 1950 when it was reintroduced across the southern–western borders by dogs (Bingham et al., 1999a).

In southern Africa, at least two distinct biotypes of the rabies virus exist (King et al., 1993, 1994; Nel et al., 1993, 2005; Sabeta et al., 2003). The first, called the canid viruses infect carnivores of the family Canidae such as domestic dogs (*Canis faniliaris*), jackal species (*Canis adustus* and *C. mesomelas*), and bat-eared foxes (*Otocyon megalotis*). The second biotype referred to as the mongoose viruses cycle in carnivores of the family Herpestidae mainly the yellow mongoose (*Cynictis penicillata*) and the slender mongoose (*Galerella sanguinea*).

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To date, canid rabies is maintained in domestic dogs and jackals in Zimbabwe, which together represented approximately 75% of all confirmed rabies cases between 1950 and 1986 (Foggin, 1988; Kennedy, 1988; Bingham et al., 1999a,b). Dog rabies appears to be maintained in communal (subsistence farming) areas of Zimbabwe (Foggin, 1988; Kennedy, 1988; Bingham et al., 1999a). Urban dog rabies does not appear to be important except in the city of Mutare (eastern Zimbabwe), which is adjacent to large communal areas with susceptible dog populations (Bingham et al., 1999a). Jackal rabies is important in large commercial farming sectors of Zimbabwe, where the black-backed jackal (*C. mesomelas*) supports canid rabies cycle in the southern border with South Africa, western, and central regions and the side-striped jackal (*C. adustus*) in the north and east of the country (Bingham et al., 1999b). The bat-eared fox appear not to be an important reservoir of canid rabies in Zimbabwe as only two (0.03% of 6061) laboratory-confirmed cases were reported in the country for the 36-year period of 1950–1986 (Foggin, 1988).

The principal vector for the mongoose viruses in Zimbabwe is the slender mongoose (Foggin, 1988). However, mongoose rabies has been reported to contribute only about 2% (96/6061) of the total rabies cases confirmed for the period 1950–1986, and these came from either commercial farms or urban areas with the majority (80%) originating from the latter (Foggin, 1988).

For the period 1950–1986, canid and mongoose rabies has been associated with human rabies in Zimbabwe. During that period 130 human cases were confirmed in the laboratory, and 90.5% (95/105) were caused by dog bites, with cats, a jackal, and a mongoose also contributing to the cases (Foggin, 1988). Although the number of human rabies cases due to jackals is relatively small compared to dogs, jackals have been reported to be a potential zoonotic threat as 26% (254/971) of rabid jackals confirmed for the period 1950–1996 had bitten people (Bingham et al., 1999b). Due to the importance of dog rabies, vaccination of dogs is compulsory in Zimbabwe and owners are required to have them immunized at three and 12 months of age and thereafter within every three years (Kennedy, 1988). In communal areas the majority of dog vaccinations are administered during annual mass vaccination campaigns conducted free of charge by the department of veterinary services, while urban dogs are vaccinated by the government or private veterinarians (Foggin, 1988).

The epidemiology of rabies in Zimbabwe has mainly been focused on dogs and jackals (Bingham et al., 1999a,b). Of considerable concern is the re-emerging of rabies in Africa (Cleaveland, 1998). This trend has been attributed to rapid population growth with parallel dog population growth, for example an annual growth rate of 4.7% in the dog population of Zimbabwe between 1954–1986 (Brooks, 1990), mobility of human populations, high rates of urbanization, and a disintegration of veterinary rabies control. The latter is of particular importance as dog rabies vaccination is a more cost-effective measure for preventing human rabies than reliance on postexposure prophylaxis for dog-bite victims (Bogel and Meslin, 1990). The aim of this retrospective study was to assess the epidemiological features of human rabies in Zimbabwe.

2. Materials and methods

2.1. Sampling of specimens and laboratory diagnosis

The central veterinary laboratory (CVL), the only approved laboratory in the country performs rabies diagnosis on animal and human rabies-suspect samples. Samples are submitted to the laboratory accompanied by accurately completed specimen forms, stating the full history of the rabies-suspect case, and the circumstances surrounding collection of the specimens. Specimen forms are obtained at the CVL, and distributed to all district government veterinarians, and animal health management centers located throughout the country. Government veterinarians, animal health inspectors, and veterinary livestock technicians collect the samples, and fill in the specimen forms.

Experienced veterinary diagnosticians carry out rabies diagnosis using the fluorescent antibody test (FAT), which is 99% reliable in experienced hands (Bishop et al., 2002), and is the standard diagnostic test used. A positive case was defined as the demonstration of rabies virus antigens in brain smears by means of immunofluorescence using antirabies fluorescein conjugate. Supplementary diagnostic techniques include mouse inoculation and histopathology. All the information pertaining to all submitted rabies-suspect samples is recorded and compiled by the CVL within the department of veterinary technical services.

2.2. Data collection

The data collected covered the period from 1st January 1992–31st December 2003. These data were drawn from the monthly and annual rabies records of the CVL. The records were perused with regard to total number of human samples submitted, number confirmed positive, age, and sex of positive cases, animal vector involved, month of transmission and land-use origin of the sample. In addition, data on the rabies status of domestic and wild animals reported to have bitten humans during the period under study were also collected. To determine the relationship between dog vaccination coverage and cases of rabies in dogs, annual dog vaccination returns from the department of veterinary (field) services and corresponding annual confirmed dog rabies cases from rabies records of the CVL during the period under study were also collected.

2.3. Statistical analysis

The overall number of positive cases was calculated from the total number of samples tested over a 12-year period (1992–2003), and expressed as a percentage. Positive cases were examined in relation to age and sex of the human victim, clinical signs, animal vector involved, seasonal animal-to-human transmission, incubation periods, and land-use categories.

Age and sex categories were generated as follows: six for age (0–4, 5–9, 10–14, 15–19, 20–24, and >25 years), and two for sex (male and female). To determine the seasonal trends in animal-to-human transmission, the transmission months for the positive cases over the 12-year period were counted. Incubation periods were defined as the time interval between transmission and the onset of clinical signs, and this was divided into three possible ranges: 0–30, 31–90, and over 91 days. However, due to the small size of the data and difficulties in obtaining bite site of the victims, mean incubation periods by category of bite site could not be done. Frequencies of clinical signs of positive cases reported in unsolicited histories of the submitted samples were calculated, and expressed as a percentage.

The distribution of positive cases was assessed according to land-use categories. Excluding urban centers, Zimbabwe can be conveniently divided into three main land use types: wildlife and forest areas, communal lands, and commercial farming areas. Wildlife and forest areas comprise of wildlife land (Safari areas), national parks, and parks, where human population is very light. Interference with natural vegetation is minimal, and there is relatively little disturbance of wildlife since domestic animals are not permitted in these areas (Foggin, 1988). The majority of the people of Zimbabwe live in communal lands (subsistence farming areas), which lie off the central plateau. Much of the land is of marginal agricultural potential with high numbers of domestic animals particularly dogs, cattle, and goats. Commercial farming land lies on the central plateau, and is divided into relatively well-managed units ranging from 500 to over 100,000 hectares in extent. Human population in these areas is small, being made up mostly of farm labour (Foggin, 1988). However, recently some commercial farms have been taken over under agrarian reforms, where families from the overpopulated communal lands have been given land. These units are now more heavily populated than they were as commercial farms.

Association between the number of human bites in relation to the rabies status of domestic and wild animals reported to have bitten humans during the period under study was evaluated by calculating the relative risk (RR), 95% confidence intervals (CI), and attributable fraction among exposed using win episcope version 2.0. Simple linear regression analyses were carried out to evaluate the relationship between dog rabies vaccine doses administered per year and the total annual dog cases.

3. Results

3.1. Rabies cases in humans

A total of 57 rabies-suspect human samples were examined and 42 (73.7%) were positive. The 15–19 year age group had the highest number of cases followed by the 5–9 and 10–14 year age groups (Table 1). Males contributed approximately 74% of the total cases (Table 1). The mean (±s.e.) incubation period ($n = 38$) was 50.4 ± 5.3 days (range 10–210) with the shortest being recorded from a 2-year old boy and a 4-year old girl, both bitten in the head area and the longest from a 46-year old man bitten on the ankle. The highest number of victims (55%) had incubation periods ranging from 31–90 days (Table 2). Drooling of saliva, abnormal behavior, mental confusion, aggression, and headache ranked high in the clinical signs recorded in the victims (Table 3). Over 10% of the victims exhibited abdominal

Table 1
Age and sex distribution of positive human rabies cases between January 1992 and December 2003

Age in years	Sex		Total (%)
	Number of males (%)	Number of females (%)	
0–4	3	1	4 (9.5)
5–9	5	3	8 (19.0)
10–14	7	1	8 (19.0)
15–19	8	2	10 (23.8)
20–24	2	1	3 (7.1)
>25	3	2	5 (11.9)
Unknown	3	1	4 (9.5)
Total	31 (73.8)	11 (26.2)	42

Table 2
Incubation periods of 38 confirmed human rabies cases between January 1992 and December 2003

Incubation period (days)	Number of human rabies cases (%)
0–30	12 (31.6)
31–90	21 (55.3)
>90	5 (13.2)
Total	38

pain, paralysis, biting humans, and other foreign objects, hydrophobia, not eating, unusual vocalization, unconsciousness, vomiting, and difficult swallowing.

3.2. Animal vectors involved

All the 42 positive rabies cases were transmitted through bite contact. Domestic dog (*Canis familiaris*) bites caused 90.5% of the positive human cases and other animals acting as sources were two jackals (*Canis mesomelas* and *C. adustus*) and two honey badgers (*Mellivora capensis*).

Table 3
Frequencies of clinical signs reported in unsolicited histories submitted for 35 of the 42 confirmed human rabies cases between January 1992 and December 2003

Clinical sign	Number	Percentage
Salivation/drooling saliva/froth	30	85.7
Behavioral changes/abnormal behavior	27	77.1
Restlessness	22	62.9
Mental confusion/ hallucinations/delirious	13	37.1
Aggression	11	31.4
Headache	9	25.7
Abdominal pain	7	20.0
Paralysis	6	17.1
Biting humans	5	14.3
Biting/eating objects	5	14.3
Hydrophobia	5	14.3
Not eating	5	14.3
Bucking/screaming/irrelevant talking/unusual vocalization	5	14.3
Unconsciousness	4	11.4
Vomiting	4	11.4
Difficult swallowing	4	11.4
Pyrexia/fever	3	8.6
Sexual excitement	3	8.6
Convulsions	3	8.6
Insomnia	2	5.7
Leg spasms	2	5.7
Malaria-like symptoms	2	5.7
Photophobia	2	5.7
Psychotic episodes	1	2.9
Sensitive to noise	1	2.9
Spasmic cough	1	2.9
Stiffness	1	2.9
Weakness	1	2.9

Rabid wild animals with an overall attributable fraction of 50% among exposed were more likely to bite humans (RR = 2.0) compared to rabid domestic animals (RR = 1.6) (Table 4). Of the rabid domestic animals, dogs and cats (95%) were the most important cause of these bites. Other rabid domestic animals recorded to cause bites, in order of decreasing importance were donkeys, goats, horses, and cattle. Compared to rabid dogs (RR = 1.5) rabid cats with attributable fraction of 69.6% were more likely to bite humans (RR = 3.3) (Table 4).

Rabid jackals (RR = 9.3) and rabid honey badgers (RR = 2.1) with attributable fraction of 89.2 and 52.7% among exposed, respectively were more likely to bite humans than respective nonrabid animals (Table 4). Other rabid wild animals recorded to cause human bites, in order of decreasing importance were civet cat (*Civettictis civetta*), serval (*Felis serval*), hyena (*Crocuta crocuta*), wildcat (*Felis lybica*), genet (*Genetta genetta* and *Genetta tigrina*), aardwolf (*Proteles cristatus*), leopard (*Panthera pardus*), and mongoose (*Galerella sanguinea*). Five of the positive human rabies cases were involved in biting other humans.

3.3. Trends in human and dog rabies cases and dog vaccination coverage

During the same period, there was an inverse relationship between dog vaccination coverage and dog rabies cases (Fig. 1a). For example, the number of dog vaccinations appeared to be greatly reduced in 1994, resulting in a dramatic increase in the number of dog rabies cases during 1994 and 1995. However, the negative relationship ($r = -0.102$) was not significant ($p > 0.05$).

There has been a general increase in the number of confirmed dog rabies cases (Fig. 1a) with the last 6-year period (1998–2003) recording a higher mean (±s.e.) annual number of cases (175 ± 11.3) than the first (161.2 ± 21.7) 6-year (1992–1997) period, but the trend and difference was not significant. Similarly, the number of human rabies cases showed a general increase over the study period (Fig. 1b) with the last 6-year period (1998–2003) recording a significantly ($p = 0.03$) higher mean annual number of cases (4.8 ± 0.7) than the first (2.2 ± 0.9) 6-year (1992–1997) period. In contrast, the number of dog vaccinations showed a general decline (Fig. 1a), but the trend and the difference in mean annual number of vaccinations between the first 6-year period and the succeeding 6-year period was not significant.

Table 4
Association between human bites and rabies status of the animal vector involved for the period January 1992–December 2003

Animal vector	Positive + human bite/Total positive	Negative + human bite/Total negative	RR	CI 95%	Attributable fraction among exposed (%)
All domestic	834/3534	544/3590	1.6	1.4–1.7	37.5
Cats (*Felis domestica*)	82/109	58/254	3.3	2.6–4.2	69.7
Dogs (*Canis familiaris*)	725/1993	400/1682	1.5	1.4–1.7	33.3
Others	27/1432	86/1654	0.4	0.2–0.6	63.7
All wild animals	437/1540	96/677	2.0	1.6–2.4	50.0
Jackals (*Canis mesomelas* and *C. adustus*)	366/1398	10/354	9.3	5.0–17.2	89.2
Honey badger (*Mellivora capensis*)	16/27	7/25	2.1	1.1–4.3	52.4
Others	55/115	79/298	1.8	1.4–2.4	44.4

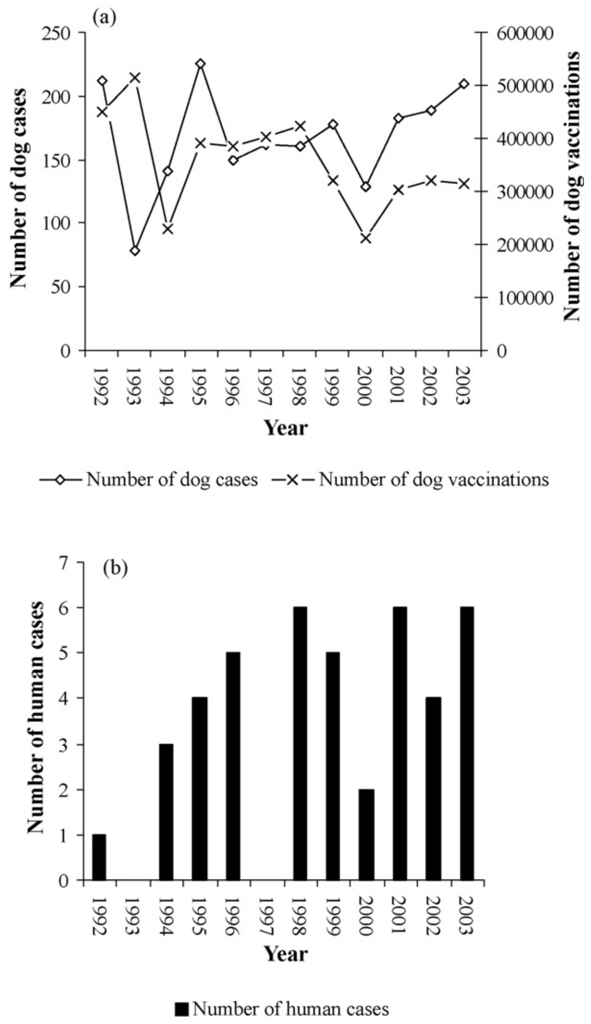

Fig. 1. Dog rabies cases and dog rabies vaccinations (a) and human rabies cases (b) against year for the period January 1992–December 2003.

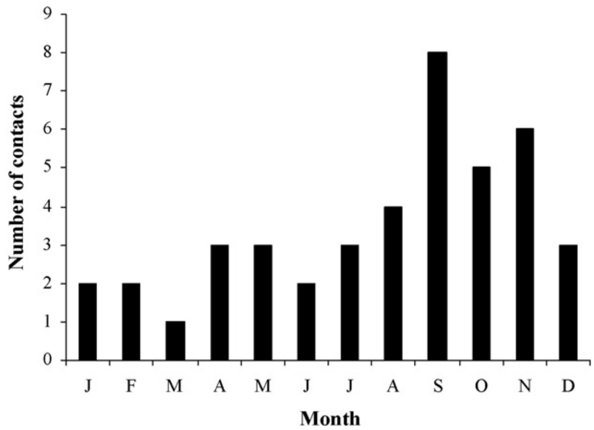

Fig. 2. The count by month of animal-to-human transmissions of the 42 human positive rabies cases reported from January 1992 to December 2003.

3.4. Seasonal and land-use variations

Animal-to-human transmission was highest during the dry months of July to November (Fig. 2). The majority of cases (85.7%) were recorded in communal areas.

4. Discussion

Human rabies cases detailed in this study include only those that were laboratory confirmed. Many rabies cases, especially in communal areas may go untested and unreported, thus, the reported cases in this study only provide an index of the magnitude of the disease, and could be an underestimate of the extent of the problem.

As reported earlier, (Belcher et al., 1976; Fekadu, 1982; Szyfres et al., 1982; Acha and Arambulo, 1985; Foggin, 1988) the present study also revealed that the majority of rabies cases occur in children and males. Due to the nature of the study being retrospective, obtaining bite site data of the victims proved difficult, and hence, detailed analysis of mean incubation periods by category of bite site could not be done. However, from the available data, the period of incubation was shortest (10 days) in two children bitten in the head area. In children, 25.6% of the bites are inflicted in the head and neck compared to 11.7% in adults (Szyfres et al., 1982), and deep or multiple bites, particularly to the head and neck may result in an incubation period of less than two weeks (Bishop et al., 2002). Clinical signs observed were similar to those reported earlier (Warrel et al., 1976; Mills et al., 1978; Foggin, 1988), and generally facilitated diagnosis before confirmation by diagnostic tests. The predisposition of males may be due to the fact that men have a closer association with dogs, especially for hunting, and that they may also be called upon to deal with vicious or rabid dogs (Foggin, 1988). Children and males, therefore, constitute a highly vulnerable group to rabies and public awareness among others is of great importance.

In accordance with earlier reports, (Siongok and Karama, 1985; Tomori and David-West, 1985; Foggin, 1988) the results of this retrospective study demonstrated the central role that dogs play in the transmission of rabies to humans. The number of human and dog rabies cases showed a general increase, while the dog vaccination coverage showed a general decline during the study period. However, the inverse relationship between dog vaccination coverage and the number of dog rabies cases was not significant, although earlier studies have demonstrated a significant correlation (Bingham et al., 1999a). The nonsignificant negative correlation would probably be explained by the use of national figures, which may obscure significant relationships present in local areas. More convincing results could be obtained by using limited areas of uniform socio-ecological characteristics such as urban areas or communal blocks, but unfortunately vaccination figures for specific areas were not available. Nevertheless, the data indicates that the control of dog rabies would lead to a decrease in the number of cases of human rabies. Vaccination of at least 80% of dogs in many communities in the tropics resulted in disappearance of human rabies (Szyfres et al., 1982). The two classic approaches employed to control canine rabies in Zimbabwe are destruction of stray dogs and vaccination of pet dogs. It is regrettable that the above activities are not sustained continuously. However, periodic campaigns are launched annually in communal areas, commercial farming areas, and towns.

In Kenya, wildlife involvement in transmission of rabies to humans is small, but the jackal followed by the honey badger has been reported as the most important rabid wild animals spreading rabies to humans (Siongok and Karama, 1985). During the period under review, even though wildlife involvement was small, four human rabies cases resulted from jackal and honey badger bites. Foggin (1988) reported only two human cases due to wild animals (a mongoose and a jackal) for the period 1950–1986 in Zimbabwe. However, even though none of the confirmed human cases were known to have resulted from cat bites, and only four cases resulted from wild animal bites, of interest to note is that rabid cats and wild animals were more likely to bite humans compared to other rabid animals. This could probably be explained by the fact that an attack by a wild animal or cat may probably elicit a positive response by the victim to seek medical treatment, whereas dog bites are probably often ignored (Foggin, 1988). Given the very high risk of these animals being positive, educational awareness must be maintained to ensure that victims of cat and wild animal bites continue to seek postexposure prophylaxis. Awareness must also be improved for victims of dog bites to ensure that these bites are not ignored.

A distinct peak of animal-to-human transmission was recorded during the dry months of July to November. Similar seasonal peaks have been reported elsewhere (Fagbami et al., 1981; Addy, 1985; Siongok and Karama, 1985; Sehularo, 1995; Kitala and McDermott, 1997). This pattern is related to the months with the highest diagnosed dog rabies cases in Zimbabwe (Foggin, 1988; Bingham et al., 1999a), and elsewhere in the southern hemisphere (Malaga et al., 1979; Gummow and Turner, 1986). Hence, coordinating rabies control programmes and public awareness campaigns with this seasonal transmission peak may increase efficiency.

The land-use distribution of human rabies shows similarities with the distribution of dog rabies. Fifty-six percent of Zimbabwe's human population, and the majority of Zimbabwe's dog population exist in communal lands (Brooks, 1990; Butler, 1995). Public awareness campaigns and targeted control measures particularly in communal areas need to be vigorously intensified.

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