

Control of rabies in Jaipur, India, by the sterilisation and vaccination of neighbourhood dogs

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A programme to sterilise and vaccinate neighbourhood dogs against rabies was established in Jaipur, India. Neighbourhood dogs were captured humanely, sterilised surgically, vaccinated against rabies and, when they had recovered, released where they had been caught. Between November 1994 and December 2002, 24,986 dogs were treated in this way. Direct observational surveys of the local dog population indicated that 65 per cent of the females were sterilised and vaccinated, and that the population declined by 28 per cent. The records of human cases of rabies seen in the main government hospital of the city between January 1992 and December 2002 showed that the number of cases had declined to zero in the programme area but increased in other areas.

RABIES is a viral neurological disease affecting all mammals, including human beings, which is invariably fatal once the clinical signs have developed. It can be prevented by vaccination but people continue to die from this distressing disease. Official figures may underestimate the true number of human cases by up to 100 times (Fekadu 1991, Cleaveland and others 2002). Rabies accounts for approximately 20,000 human deaths annually in India alone (Anon 2004a). The main vector of the disease is the domestic dog, and 94 per cent of human cases in Asia are due to dog bites (Blancou 1988). About 45 per cent of human rabies cases are children under 15 years old, and many more males than females are affected (Fekadu 1991, Dutta 2002).

The World Health Organization (WHO) has classified dogs according to their degree of dependence and the restrictions imposed on them by people (Anon 1988). In India, over 60 per cent of dogs are considered to be 'neighbourhood dogs', being either semidependent or independent of people for food and shelter and unrestricted in their movements. These neighbourhood dogs account for about 60 per cent of reported dog-bite injuries (Sudarshan and others 2001).

The treatment of human dog-bite victims in India is poor, only 47.9 per cent received any postexposure rabies vaccination, and nearly half of these received only nerve tissue vaccine (Anon 2004a), which is not recommended by the WHO (Anon 2004b). Immunoglobulins were received by only 2.1 per cent of the patients, and compliance in completing the course of postexposure vaccination was only 40.5 per cent (Anon 2004a). Thus, the most cost-effective, long-term approach to the control of rabies would be to remove the disease from the animal reservoir (Perry and Wandeler 1993).

It is difficult to control neighbourhood dogs, but several methods have been tried. The physical removal of dogs has proved to be ineffective, and it is often carried out inhumanely (Anon 1988, Anon 2004b). In Ecuador, major removal campaigns were followed by increases in the fecundity of bitches and the survival of pups, and an overall increase in the number of rabid animals (Beran 1991). Any actions that cause instability in the dog population encourage an increase in the transmission of rabies (Blancou 1988, Beran 1991). However, the removal of dogs by culling remains a popular method of supposed dog and disease control in India. In countries with large populations of neighbourhood dogs, vaccination programmes must be conducted on a heroic scale to control rabies. Largi and others (1988) cite one South American programme that vaccinated over a million animals annually for five to six years to eliminate rabies.

A threshold level of 70 per cent immune animals must be maintained if the transmission of rabies is to be controlled (Anon 2004b). Coleman and Dye (1996) calculated that the proportion of vaccinated dogs needed to control outbreaks would be between 39 and 57 per cent, and Fekadu (1991) cited a figure of 80 per cent if no dogs were to be removed concurrently with vaccination. Rabies reappeared in a previously controlled area when the percentage of vaccinated dogs dropped to 21 per cent (Beran 1991). In South America, Largi and others (1988) claimed that vaccination of 70 to 80 per cent of neighbourhood dogs controlled rabies. Anderson and others (1981) predicted that a policy of vaccination combined with population reduction would mean that a smaller proportion of animals would need to be vaccinated or removed than if only one of these control measures was applied.

The stability of the dog population is important in controlling rabies. In Ecuador, dogs under 11 months of age constitute 18 per cent of the population but account for 52 per cent of cases of rabies, whereas adult dogs constitute 67.6 per cent of the population but only 39.8 per cent of the cases of rabies (Beran 1991). In Tunisia, an annual turnover of 37 per cent of a dog population was reported by Seghaier and others (1999), and in West Bengal, Pal (2001) reported 82 per cent mortality in dogs of less than one year of age. Studies on populations of cats suggest that sterilising group members leads to a lower population turnover, increased social bonds and a decrease in aggressive behaviour (Neville and Remfry 1984, Zaunbrecher and Smith 1993).

This paper describes the effects of an eight-year rabies control programme in a northern Indian city. The programme combined the sterilisation and vaccination of neighbourhood dogs and was conducted along WHO and World Society for the Protection of Animals (WSPA) guidelines (Anon 1990). During the study the number of human rabies deaths in the programme's area was reduced to zero and the population of neighbourhood dogs was reduced by 28 per cent.

MATERIALS AND METHODS

The study was conducted in Jaipur, the rapidly expanding capital city of Rajasthan, India, which has a population of approximately 2.5 million people. The city has a semidesert climate with an annual temperature range from 3°C to 46°C, and 90 per cent of the annual rainfall occurs during a monsoon period lasting two months.

Veterinary Record (2006)
159, 379-383

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TABLE 1: Numbers of dogs dealt with annually by the Animal Birth Control programme in Jaipur between November 1994 and December 2002, including all the dogs caught by the staff of Help in Suffering (HIS) and the municipal authorities

	1994	1995	1996	1997	1998	1999	2000	2001	2002	Totals
Dogs received at HIS	250	1409	2828	2558	3070	3319	4109	3627	3816	24,986
Dogs vaccinated against rabies	223	1202	2394	2280	2723	2941	3780	3377	3522	22,442
Bitches spayed	223	1169	2183	1559	1910	2441	2414	2221	2325	16,445
Male dogs sterilised (includes 10 vasectomies)	0	0	2	0	16	10	885	977	794	2684
Total number of operations	223	1169	2185	1559	1926	2451	3299	3198	3119	19,129

The Animal Birth Control (ABC) programme was started as a pilot project in a small area of Jaipur in November 1994 by Help in Suffering, an animal welfare organisation. In 1996 the pilot project was expanded to cover a larger area of the city. The area covered by the ABC programme, and this study, is approximately 14 km by 8 km. For the purposes of the study, the city was divided into a number of distinct areas along major geographical features such as main roads, railway lines and waterways. These areas varied in size but were approximately 2.3 km by 1.7 km, approximately 4 km².

Sterilisation and vaccination

The ABC programme focused on the sterilisation and vaccination of captured female and prepubescent male dogs.

Neighbourhood dogs were captured humanely from a given area, and the exact location of each dog's capture was recorded. The dogs were caught by using the minimum safe restraint necessary; some dogs were caught by hand, holding the scruff, but most were caught by using a hessian sack (1 m deep by 1.26 m wide) with a rope drawstring around the opening. Catching efforts were concentrated on one distinct area at a time, and a new area was selected only when no further dogs could be caught from the initial area. The new catching area was usually adjacent to the previous area because this facilitated the release of the dogs efficiently and accurately back into their territories. All the captured dogs were transported to the ABC facility, where they were individually kennelled and examined by a veterinary surgeon. Details of the animals' location, sex, description, and health status were recorded. After a rest period of between 15 and 30 hours the animals were prepared for surgery. The dogs were premedicated with triflupromazine administered intramuscularly, and general anaesthesia was then induced and maintained by the intravenous infusion of either 2.5 per cent thiopentone solution, or a mixed solution of ketamine and xylazine. Before the surgery the dogs were given long-acting antibiotics and non-steroidal anti-inflammatory drugs. For identification purposes, each animal was given an individual alphanumeric, four-character tattoo in its right ear, and a small semicircular notch was removed by a thermocautery device from the leading edge of its left ear. The surgical site was shaved and prepared for surgery. A 1 ml dose of an inactivated, adjuvanted, cell-culture rabies vaccine (Rabigen Mono; Virbac) was administered either subcutaneously or intramuscularly with a one inch, 22 G needle into the biceps femoris muscle or the dorsal lumbar musculature. The intramuscular route was used from 2001, when Coyne and others (2001) suggested that using this route to give the vaccine induced longer lasting immunity.

Bitches were sterilised by complete ovariohysterectomy (spay) through a right flank incision; males were castrated through a single prescrotal incision. All fit females were sterilised, including animals more than three to four months old (weighing approximately 7 kg or more), pregnant animals and animals in oestrus. Only prepubescent males more than three to four months old (weighing approximately 7 kg or more) were castrated. Any animal that was found to be suffering from an incurable condition, or whose welfare was

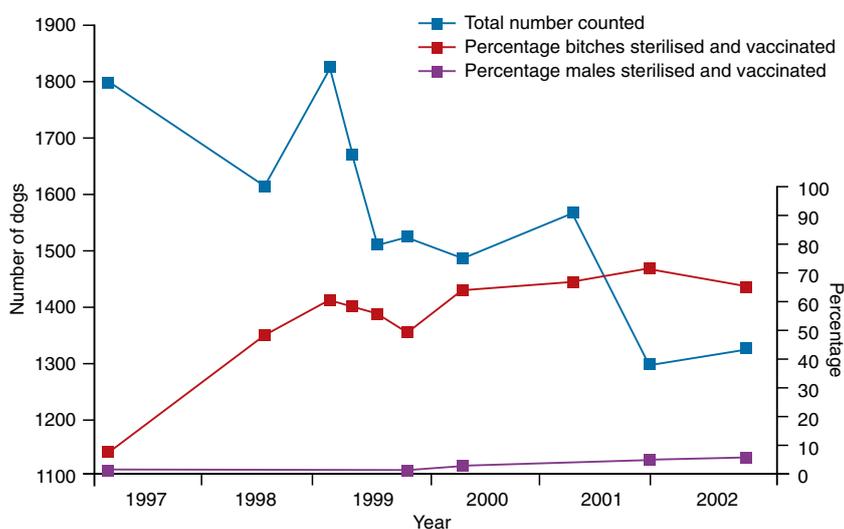
severely compromised, or was deemed dangerously aggressive, was humanely euthanased. Any animal found to have been previously sterilised and vaccinated received only a booster rabies vaccination.

After surgery, the animals were returned to their kennels to regain consciousness; they were examined daily by a veterinary surgeon and the date of their release, usually three to five days after surgery, was determined by these examinations. The dogs were released at the exact location from which they had been captured.

A register was maintained in which the details of all the captured dogs were recorded, so that the programme could be monitored in detail, and data on the behaviour of neighbourhood dogs could be collected.

Population surveys

The area selected for the population surveys was the old, partially walled, city of Jaipur known as the 'Pink City'. It was chosen because it had only limited potential for further development, contained a cross-section of residential, commercial and civic areas, and was considered to be representative of the larger modern city. Direct observational counts of the numbers and types of dogs were made every six months at climatically benign times of the year, in March/April and September/October. To minimise counting variables, each survey was performed between 06.30 and 09.00 by the same staff, following the same route through the area. The Pink City was subdivided into six subareas, each of which was counted on consecutive days, mainly on foot, in the two-and-a-half-hour period by two teams, each consisting of a recorder, usually a veterinary surgeon, and an experienced animal technician. The dogs were recorded as males, females, and puppies, and further subdivided into those with ear notches (which had been through the ABC programme) and those without. A puppy was defined as a young dog with an

**FIG 1: Total numbers of dogs counted in the Pink City area of Jaipur, and the percentages of the males and females that were sterilised and vaccinated against rabies**

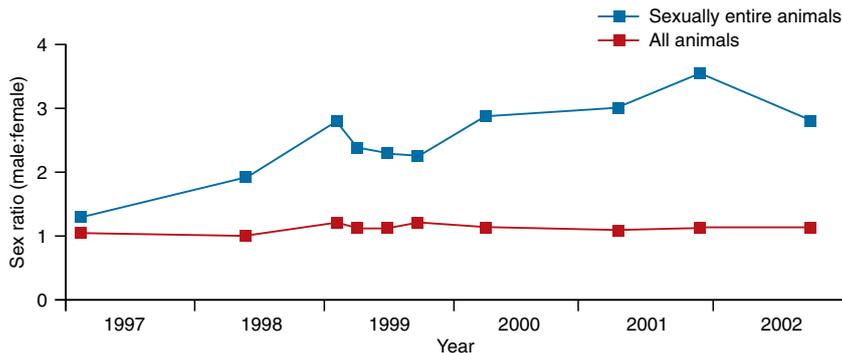


FIG 2: Effects of the programme of sterilisation on the sex ratio of the population of neighbourhood dogs in the Pink City area of Jaipur between February 1997 and August 2002

estimated weight of less than 7 kg; dogs of this size were not caught for the ABC programme.

Human rabies mortality data

The records of the Infectious Diseases Unit of the Sawai Man Singh (SMS) Hospital (the main government hospital) in Jaipur were reviewed over six visits to the unit during 2002/03 to extract information on patients with rabies admitted to the hospital. The records from January 1, 1992 to December 31, 2002 inclusive were reviewed, and all the information on these patients was documented. The patients' records were then arranged by area of residence, separating those patients who came from within the area of Jaipur included in the ABC programme (the ABC area) and those patients that originated from outside the ABC area but still within the administrative area of Jaipur (the non-ABC area). The total number of symptomatically rabid patients treated at the hospital was also recorded, regardless of their place of residence and including patients coming from throughout Rajasthan state. Attempts to verify the information recorded in the hospital records were made by visits to a number of the patients' families. The diagnoses were not routinely confirmed postmortem owing to the lack of expertise and facilities in the hospital.

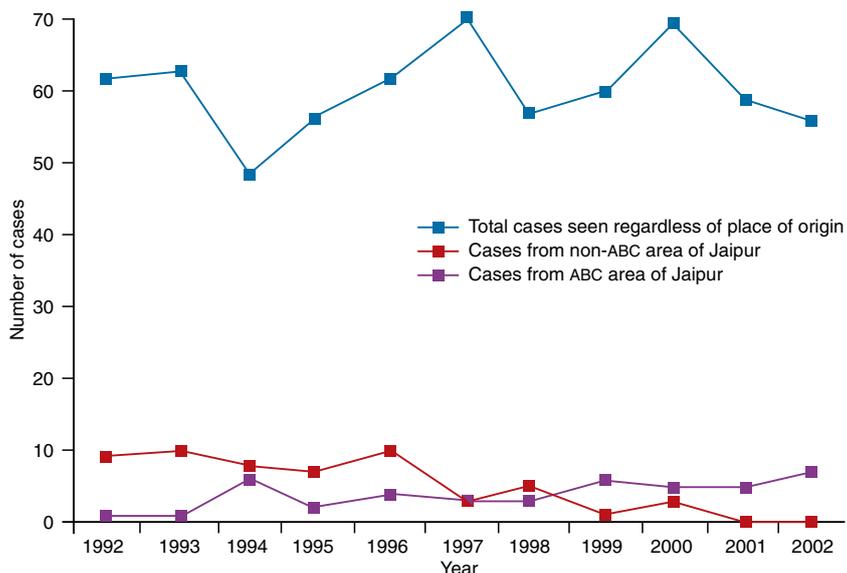


FIG 3: Numbers of human cases of rabies recorded in the Sawai Man Singh Hospital in Jaipur from all regions, from the area of Jaipur covered by the Animal Birth Control (ABC) programme and from the non-ABC areas of Jaipur

RESULTS

Sterilisation and vaccination

Between November 1994 and December 2002 inclusive, a total of 22,442 dogs were vaccinated against rabies and 19,129 sterilisation operations were performed, of which 86 per cent were ovariectomies (Table 1). Of the animals captured, 10.3 per cent were humanely destroyed after veterinary examination as being unfit for sterilisation and vaccination by reason of illness, injury or temperament; this proportion remained constant throughout the study. The numbers of animals passing through the programme increased annually, from 1409 in 1995 to 3816 in 2002. During each of the last three years of the study, over 3100 dogs were vaccinated, sterilised and released, nearly nine animals per working day. The total cost of each sterilisation and vaccination was about ₹4.80 at 2004 rates.

Population surveys

During the eight-year study period a decline in the neighbourhood dog population of 28 per cent was recorded between the peak and the last surveys (Fig 1), an average annual decline of 3.5 per cent. The proportion of surveyed female dogs that had been sterilised and vaccinated increased from zero at the beginning of the study to 65.7 per cent in 2002 (Fig 1), and the proportion that had been sterilised exceeded 65 per cent during the last three years of the study. Because only prepubescent male dogs were sterilised and vaccinated, the proportion of sterilised male dogs surveyed in the population increased more slowly (Fig 1). The ratio of sexually entire males to sexually entire females increased from 1.21:1 at the beginning of the study to 2.68:1 in 2002, although the ratio of genotypically male to genotypically female dogs remained approximately 1 (Fig 2).

Human rabies mortality data

During the study period the number of human rabies cases from the ABC area of Jaipur declined from a maximum of 10, and from October 2000 to December 2002, no cases of human rabies originating from the ABC area were reported in the Infectious Disease Unit of the SMS Hospital (Fig 3). However, the number of human rabies cases reported annually in residents of the non-ABC area of Jaipur increased during the study, and the total numbers of human rabies cases recorded annually, including those coming from throughout Rajasthan, remained approximately constant (Fig 3).

DISCUSSION

The data collected during this eight-year study provide evidence that rabies can be controlled in an Indian city through a combined vaccination and sterilisation programme of the neighbourhood dog population.

The programme endeavoured to follow WHO guidelines with respect to the vaccination of neighbourhood dogs against rabies. Dogs were revaccinated whenever the opportunity presented itself. Coyne and others (2001) reported that vaccination provides protection against challenge for up to 41 months if the vaccine is administered intramuscularly; for most neighbourhood dogs this period will exceed their lifetime (Butler and Bingham 2000, Pal 2001). The Jaipur ABC programme has been using the intramuscular route for vaccination since those studies were published.

The direct observational counts of the neighbourhood dog population, made along defined routes, are not ideal. Censuses by this method were initiated when the programme was in development, and alternative methods of counting the dogs have since been suggested. However, no means have been found of correlating the data from any revised method with

the data from the original method, and the census data have therefore continued to be collected by the method adopted originally.

The most recent population surveys indicate that 65.7 per cent of the currently alive female dogs and 5.8 per cent of the males have been vaccinated and sterilised. Figures from the most recent population survey imply that the vaccination coverage of the whole population is 35.5 per cent; this ignores a few animals that were vaccinated only, and is thus a low estimate of the total vaccination coverage. This figure is only slightly lower than the percentage cited by Coleman and Dye (1996) required to control the disease. If it is assumed that rabies transmission has been controlled at these vaccination coverage levels, they are substantially lower than the levels reported from other areas where sterilisation methods were not employed, for example, 83 per cent vaccination coverage in the Philippines and 60 per cent in Ecuador (Beran 1991). The data presented here are therefore consistent with Anderson and others (1981), who predicted that the threshold proportion for rabies control would be lower if vaccination and population reduction were practised together.

The Help in Suffering ABC programme has targeted dogs included in the lowest WHO categories of dog: neighbourhood dogs, unrestricted/unsupervised dogs and truly feral dogs. Most reported rabies control programmes concentrate on family and pet dogs, yet even with these more biddable groups, 11 to 15 per cent of the dogs are reported to be uncatchable (Anon 1988, Seghaier and others 1999). Despite intensive, skilful catching efforts, approximately 30 per cent of bitches in Jaipur are uncatchable by current techniques. The ABC programme's catching efforts may exert a selection pressure on the dog population in favour of undesirable behavioural traits; solutions to this problem are being investigated.

Dogs less than one year old are over-represented in rabies cases (Beran 1991); the affinity between children and young dogs may explain the large numbers of cases of rabies in children. The importance for rabies control of timing vaccination efforts to ensure that animals are vaccinated as young as possible has been stressed by Anderson (1986), MacInnes (1988) and Brochier and others (1991). The Jaipur ABC programme sterilises and vaccinates puppies that are estimated to be over four months of age (7 kg bodyweight). Stubbs and Bloomberg (1995) have shown that there are no veterinary or developmental problems associated with the sterilisation of young dogs except hypothermia during general anaesthesia. In Jaipur and elsewhere on the Indian subcontinent, breeding in neighbourhood dogs is highly seasonal, with the peak whelping season in Jaipur being October and November (Pal 2001, Chawla and Reece 2002); as a result, many puppies could be caught for the ABC programme during the winter. The risk of hypothermia in young animals has been found to be real, and the programme has had to balance the desire to vaccinate and sterilise as many young animals as possible against the welfare problem of hypothermia.

The unreliability of human rabies data collected in many countries where the disease is endemic, including India, is recognised. The decline in human rabies cases within the ABC area of Jaipur may be an artefact; however, the disease reporting procedures and records would have been expected to become more accurate over the period of the study. The population of the city has doubled during the study period. Increases in public awareness due to the programme's daily activities in residential areas may be a further factor confusing the apparent reasons behind the findings. The hospital workers recording data on individual human cases were independent of the ABC programme, and were, for much of the time, unaware of the programme. The veracity of the finding that the Jaipur ABC programme has caused a decline in human

rabies cases within the ABC area of Jaipur is supported by the increases in human rabies cases reported in the non-ABC areas of the city; these non-ABC areas are rapidly expanding residential developments on the periphery of the city.

The authors believe that the combined sterilisation and vaccination procedure of the ABC programme may be an effective and humane method for controlling rabies in endemic areas with large populations of neighbourhood dogs, and may also create a more stable, smaller population.

ACKNOWLEDGEMENTS

The assistance of Dr Devi Shankar Rajoria and Dr Kailash Chandra, numerous volunteer veterinary surgeons, and Mr J. Townend in record-keeping and data collection is gratefully acknowledged. J. F. R. is supported by grants from the Humane Society International. The ABC Programme at Help in Suffering is supported by Mme J. Vogler and Animaux Secours, France, and by grants from the Government of India and the Animal Welfare Board of India, all of whom are thanked for their continued support. The authors thank Professor D. Briggs for her great encouragement, and Professor J. E. Cooper for commenting on the manuscript.

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