Update/Le point

Economics of human and canine rabies elimination: guidelines for programme orientation*

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Analysis of the present situation in canine-rabies-infected countries shows that in most cases the levels of activities for controlling the disease in man and in dogs are far too low to prevent human deaths due to rabies and to eliminate the disease in the dog population. This article compares the two major orientations of a rabies control programme, i.e., prevention of the disease in man by intensifying and modernizing post-exposure treatment (strategy A) and canine rabies elimination by controlling the disease in the animal reservoir (strategy B). The operation of both strategies (A+B) together is also analysed.

Based on the available data and assumptions for calculations of the costs, the results show that when the strategies are applied independently of each other, the annual cost of strategy B amounts to 25–56% of that of strategy A. When the two strategies are applied together, the actual annual spending related to the implementation of A+B becomes less than that of strategy A alone as from the fifth year following programme initiation. The sensitivity of the results was tested against selected fluctuations in the assumptions. An estimation of the costs of control activities per avoided death, according to the strategy applied, is also given.

In countries where resources allocated to rabies control are inadequate in both the health and veterinary sectors, the comparison in costs and effectiveness of the two programme strategies for rabies elimination strongly suggests that consideration should be given to a national programme of dog rabies elimination. On the other hand, for obvious ethical reasons, if attention is paid to improvement of post-exposure treatment, then the national authorities should consider a planning horizon close to 15 years.

Introduction

With the exception of some areas in the South Pacific, rabies persists as a major public health hazard in many countries throughout the world. Global estimates show that about 35 000 persons die from rabies and about 3.5 million receive post-exposure treatment (PET) every year. Almost all the reported deaths occur in the developing countries and most cases of treatment (89.5%) are also there (*1*).

According to the FAO/WHO/OIE Animal Health Yearbook for 1986, 87 countries and territories, with a total population of about 2.4 billion, are infected by canine rabies. Even today, most developing countries concentrate the essential part of their resources allocated to rabies control on post-exposure treatment. In these countries, in spite of an average of 800 to 900 persons annually treated per million inhabitants, the rate of human deaths due to rabies is very close to 5 per million inhabitants (*2*). At the same time, vaccination coverage of the dog population hardly exceeds 15%, which is far too low for eliminating the disease in dogs. National statistics indicate that such levels of activity do not lead to a marked reduction of human rabies cases or of the number of PETs.

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* A French translation of this article will appear in a later issue of the *Bulletin*.

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Reprint No. **5073**

To improve this situation all governments desiring to embark on an effective human and canine rabies control programme should first define their policy on that issue. This paper provides comparative data, both financial and technical, on the two major orientations of such a programme. It should serve as guidelines for health policy-makers and help them in their decision-making process. The two programme orientations under investigation are specified as follows:

- *Strategy A*. Prevention of the disease in man by intensifying and modernizing post-exposure treatment.

This entails maximum coverage of the human population by PET. This may be done through an extended network of vaccination centres provided with appropriate storage conditions and stocked with highly potent human vaccines as well as rabies immunoglobulin (*3*). Once established, this high vaccination coverage must be continued by the national health authorities if no canine rabies elimination activities are conducted simultaneously.

- *Strategy B*. Canine rabies elimination by controlling the disease in the animal reservoir.

This entails countrywide immunization of dogs through mass vaccination campaigns or continuing vaccination schemes and adequate dog population management.[a]

Basic data

Strengthened PET delivery and human death rate

In Guayaquil (Ecuador) where the health infrastructure and surveillance system are functioning well, the high number of PETs delivered in 1983 and 1984 (i.e., about 2000 per million inhabitants)[b] did not prevent the annual occurrence of 4 human deaths per million inhabitants. An evaluation in eight countries (Algeria, Brazil, El Salvador, Honduras, Sudan, Thailand, Tunisia and Turkey), with well organized reporting systems for human rabies exposure and care, showed about 2000 PETs administered and 2.7 human deaths due to rabies reported per million inhabitants (*1*).

Dog rabies control programme and human health

Programmes being coordinated by WHO in three developing countries with human populations ranging from 7 to 16 million show that the number of human deaths may decrease rapidly when appropriate control measures are taken to stop circulation of the virus among the canine population. In Sri Lanka the average number of human deaths reported for the whole country was halved between the period 1980–83 and the four years following the initiation in 1984 of the new "Accelerated Intensive Rabies Control Programme",[c] whilst in Tunisia the annual average of 10 deaths from rabies in 1978–82 (prior to the launching of the national programme) decreased to 4 during the period 1983–87 (*4*).[d] In Guayaquil, Ecuador, where the rabies control project was initiated in September 1985, no human rabies cases have been reported since May 1986.[e]

Dog population and dog accessibility

In general, North American and European countries report a dog/inhabitant ratio of between 1:10 and 1:6;[f] data available from 14 developing countries of Africa, Asia, South and Central America give an average of 1:8.[f]

The accessibility of dogs, i.e., the proportion of dogs which can be vaccinated and those which are unsupervised, has been studied during WHO-coordinated research projects on dog populations in project areas of Asia, Africa and Latin America. These studies have shown the following.

—Firstly, the proportion of dogs not associated with particular household(s) and person(s) is less than 10% of the total dog population and these animals do not seem to play a significant role in the reproductivity of this population.

—Secondly, 70–75% of dogs are accessible to control measures, particularly vaccination, if the approach is adapted to the dog–man relationship and the community is fully involved in the rabies elimination programme, i.e., veterinary policing measures should be largely replaced or supplemen-

[a] *Report of a WHO Consultation on Dog Ecology Studies Related to Rabies Control.* Geneva, 1988 (unpublished document WHO/Rab.Res./88.25, 1988).

[b] **Provincial Health Administration of Guayas.** *Monthly reports, Zoonoses Section.* Guayaquil, Ecuador, 1983, 1984 (in Spanish).

[c] **G.L.A. Colonne.** *Statistical profile of rabies in Sri Lanka.* Colombo, Ministry of Health, 1988.

[d] **Ministère de l'Agriculture, Direction de la Production Animale.** *Bulletin épidémiologique trimestriel de la rage en Tunisie*, Vol. 1, No. 1–4, 1986; Vol. 2, No. 5–8, 1987 (in French).

[e] **Provincial Health Administration of Guayas.** [*Evaluation of a Pilot Rabies Control Programme in the city of Guayaquil.*] Guayaquil, Ecuador, 1985–86, 1986–87 (in Spanish).

[f] The dog population in urban and rural areas. In: *Guidelines for dog rabies control.* Geneva, 1983 (unpublished WHO document VPH/83.43), pp. 2.1–2.27.

ted by active community participation in rabies control activities.

—Thirdly, the density of a dog population cannot significantly be reduced by dog catching and killing activities. In general, programmes to reduce the dog population do not remove more than 3–5% of the dogs annually, so that the influence on the population density is insignificant if not counterproductive owing to increased mobility and contact rates of the dogs and rejuvenation through increased reproductivity. Unless specific ecological situations indicate the contrary, dog population control should not be achieved by controlling stray dogs but rather by promoting responsible dog ownership.[g]

Vaccine prices and administration costs

Human vaccines. Few data are available concerning administration costs. According to D.N. Regmi (personal communication, 1985), vaccine administration costs in Nepal were estimated at about US$ 0.80 per injection, including personnel, syringes, needles, and cold chain facilities. Therefore, the delivery cost might be at least $1 per injection in developing countries. Several types of safe and highly potent vaccines are now available, e.g., human diploid-cell vaccine (HDCV), highly purified duck-embryo vaccine (DEV), purified chick-embryo cell vaccine (PCEC) and Vero cell rabies vaccine (*5*). Vaccine prices (FOB) vary from $7.85 to $16.00 per dose; approximately 25% should be added for packing, freight and insurance (PFI) (costing for human rabies vaccines given by Supply Services, WHO, Geneva, May 1988). Considering the actual decreasing trend in the prices of the human antirabies vaccine, a mean price of US$ 10 (CIF) will be used in the following calculations. Therefore, cost of a complete 5-dose regimen (plus administration costs) will be US$ 55.

Veterinary vaccines. In Thailand and Tunisia vaccine administration costs per dose range from US$ 0.52 to 0.95 (see Table 1). In Sri Lanka, in 1985, a similar calculation gave a value of approximately $0.63. The differences between Asian and north African countries are mainly due to the cost of manpower (see salary component of Table 1). The upper limit of the above range ($0.95) will be used in the following.

The vaccines applied in these cost estimates were imported liquid, adjuvanted products containing at least 2 I.U. per dose. A single inoculation of this vaccine should provide an immunity for at least 2 years (*6*). These vaccines cost between $0.27 and $0.43 per dose (including packing, freight and insurance) (costing for canine rabies vaccines given by Supply Services, WHO, Geneva, June 1988). This gives an average price per dose of $0.35.

The total cost per vaccinated dog will therefore be US$ 1.30.

[g] See footnote *a* on page 282.

Table 1: **Costs of vaccine application in dogs**

	Bangkok (Thailand)[a] (36 668 dogs) (US$)	Nabeul (Tunisia)[b] (53 534 dogs) (US$)
Salary	7480.40	41 598.00
Vehicles (cost per year considering a 5-year amortization)	7143.90	6234.50
Petrol	3791.90	
Public education and information	769.20	687.90
Vaccination certificates	–	1304.30
Miscellaneous expenses	–	776.40
Material for vaccination	–	256.20
Total	19 184.90	50 857.30
Cost per dog	0.52	0.95

[a] Data obtained from Dr Ch. Kulganchewin, Bangkok Metropolitan Health Centre, Bangkok.
[b] In: *Bilan des trois premières années d'exécution du Programme national de lutte contre la rage en Tunisie (1982–83–84).* Tunis, Ministère de l'Agriculture, Direction de la Production Animale, August 1984.

Immunoglobulin prices and administration costs

The price of rabies immunoglobulin (RIG) of human origin (HRIG) varies from US$ 80 to $ 275 (FOB) for a patient weighing 50 kg (20 I.U. per kg of body weight) (costing for rabies immunoglobulins given by Supply Services, WHO, Geneva, October 1987). This gives a mean price of $160 (PFI and delivery costs of $ 2 included). RIG of equine origin (ERIG) (purified) is available at a lower price, i.e., $50 total cost for a 50 kg patient (40 I.U. per kg of body weight). According to the type of RIG applied, the cost of associated passive and active immunization (RIG and vaccine) for a patient of 50 kg would range from $ 105 to $ 215.

Total costs for post-exposure treatment have been kept to a minimum as only few data are available for a better evaluation. However, when cost of transportation of a patient to the vaccination centre, as well as costs of accommodation on the spot, plus job opportunities lost are included, the costs of the vaccine doses applied represent only 30% of the total cost of the treatment as found by S. Chutivongse in Thailand (personal communication, 1989).

During a recent WHO Consultation on improvement of rabies post-exposure treatment[h] the participants proposed new definitions to characterize the nature of the exposure to rabies. Exposure, which would call for vaccine and serum application, was defined as any bite or scratch penetrating the skin or any lick on the mucous membrane. Under such conditions it is assumed that 50% of the patients coming to a rabies treatment centre in most countries infected with canine rabies should receive both vaccine and serum. This percentage will be used in the calculations given below.

Model conditions

Surveillance system

Both strategies A and B require an efficient rabies surveillance system. Control of rabies in the canine reservoir may be achieved during the first phase of programme implementation with minimum epidemiological surveillance. The latter would, however, have to be strengthened considerably for the detection and control of residual foci of infection. Obviously, intensive PET will lead to satisfactory results if associated with highly efficient surveillance of the disease in animals. The costs related to epidemiological surveillance are not included in the following calculations since laboratory and specimen collection services exist in all countries and will only require strengthening according to the efficiency level to be reached, irrespective of the control components which are compared below.

Status of health infrastructure

It is assumed that, at the time of programme implementation:

—the medical services are functioning and necessary health infrastructures have been established;
—the veterinary services are well organized and need only to set up appropriate animal vaccination services.

Parameters

The following parameters are used:

(i) *Dog/inhabitant ratio*: 1/8.

(ii) *PET/inhabitant ratio*: 200/100 000 before effective canine rabies control is initiated.

(iii) *Cost of a vaccination regimen* (5 doses) without immunoglobulin: US$ 55.

(iv) *Proportion of patients receiving HRIG or ERIG in addition to vaccine*: 50%.

(v) *Cost of immunoglobulin and its application*: US$ 160 for HRIG, and US$ 50 for ERIG.

(vi) *Dog vaccination requirements.* Vaccination campaigns using canine rabies vaccines protecting for at least two years should reach 75% of the total dog population at risk every two years. In intermediate years, dogs that have since grown up or have not yet been vaccinated will be scheduled for vaccination (about 25% of the total population). Thus, on average about 50% of the total dog population will have to be vaccinated annually.

(vii) *Dog accessibility*: 80%.

(viii) *Cost of dog removal and elimination.* Removal and elimination of dogs are considered feasible and reasonable in rabies control only for enforcement of certain veterinary measures but not for reduction of the dog population density. In general, less than 5% of the dog population are affected each year by removal programmes. It is not recommended to increase this level.[i] It is assumed that the costs of vaccination or removal of a dog are of the same order of magnitude, so that these two control measures cannot be distinguished in the model.

(ix) *Effectiveness of a dog rabies elimination programme on the number of human deaths and PET demand and delivery.* From the various canine rabies control projects coordinated by WHO, it seems realistic to assume that, in a given area, the number of human deaths would decrease quickly and reach zero level after 2–3 years, provided that a well planned comprehensive canine rabies control programme is correctly implemented. As observed in countries where effective rabies control activities are carried out, the number of PET increases during the 2–3 years following the first dog mass vaccination campaign, because of increased public awareness of the rabies threat, and then decreases. An increase of 25% of the PET demand over the first 3 years has been taken into consideration in this model. The decrease should be progressive. Routine PET delivery services should remain available until confirmation of the rabies-free status of the area is secured. This calls for the operation of a very effective surveillance system. It is assumed that 50% of the initial PET level (i.e., 1000 PET per 1 million) may be reached during the 5th year following the first dog vaccination campaign, and a minimum number of PET (5% of initial level) may be permanently delivered each year as

[h] *Report of a WHO Consultation on Rabies (European Bat Rabies, Postexposure Treatment and Potency Testing for Rabies Vaccines).* Essen, 1988 (unpublished document WHO/Rab.Res./88.30, Rev.1).

[i] See footnote *a* on page 282.

from the 7th year (people exposed in border zones and overseas).

(x) *Phases of a national canine rabies control programme.* For realistic planning and smooth implemention of a programme, a decision should be made on the size of the initial area to be covered by mass vaccination, and on plans for the expansion of control activities to other parts of the country. In most countries, the infrastructure of veterinary and community services will permit initiation of the programme in areas of 1 million inhabitants (i.e., 125 000 dogs). Systematic programme development may begin with operational research covering 20 000 to 30 000 dogs. Following initial trials such areas should, however, be sufficiently large to recognize a rabies-free situation and thus allow for the reduction of the rate of PET. The programme expansion will largely depend upon the availability of trained staff and dog rabies vaccine.

In each area the sequence of vaccination activities is as follows:

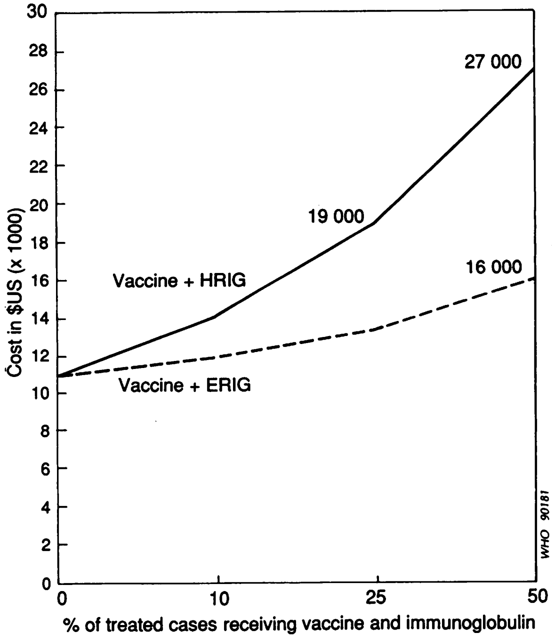
—An attack phase of two years aiming at establishing coverage in the dog population through crash mass vaccination campaigns (see costs for dog vaccination on page 283).

—A consolidation phase of four years during which the same immunization coverage of 75% (as described for the attack phase) is maintained. The methodology may be different from that of the attack phase (e.g., dog vaccinations evenly distributed over the year). In addition, this phase should ensure the elimination of the residual foci of infection by active search and special control activities wherever needed. This is particularly necessary if the rabies elimination zone is bordering on areas still infected or in earlier phases of programme development.

—The maintenance phase, which should definitely ensure the canine rabies-free status and be characterized by (*a*) intensive surveillance, (*b*) outbreak preparedness, and (*c*) continuing vaccination of a proportion of the dog population which is at particular risk (national borders, international travellers). This proportion of the dog population is assumed to be 20%.

The actual annual costs of PET administration in an area of 100 000 inhabitants and of dog rabies elimination programmes over a period of 10 years are shown in Fig. 1 and 2, respectively. The evolution of the annual costs of a PET programme when a dog rabies elimination programme is launched in parallel is shown in Fig. 3.

Fig. 1. **Cost of post-exposure treatment programmes according to the percentage of treated cases receiving vaccine and equine rabies immunoglobulin (ERIG) or human rabies immunoglobulin (HRIG), per 100 000 inhabitants (for assumptions, see p. 283).**



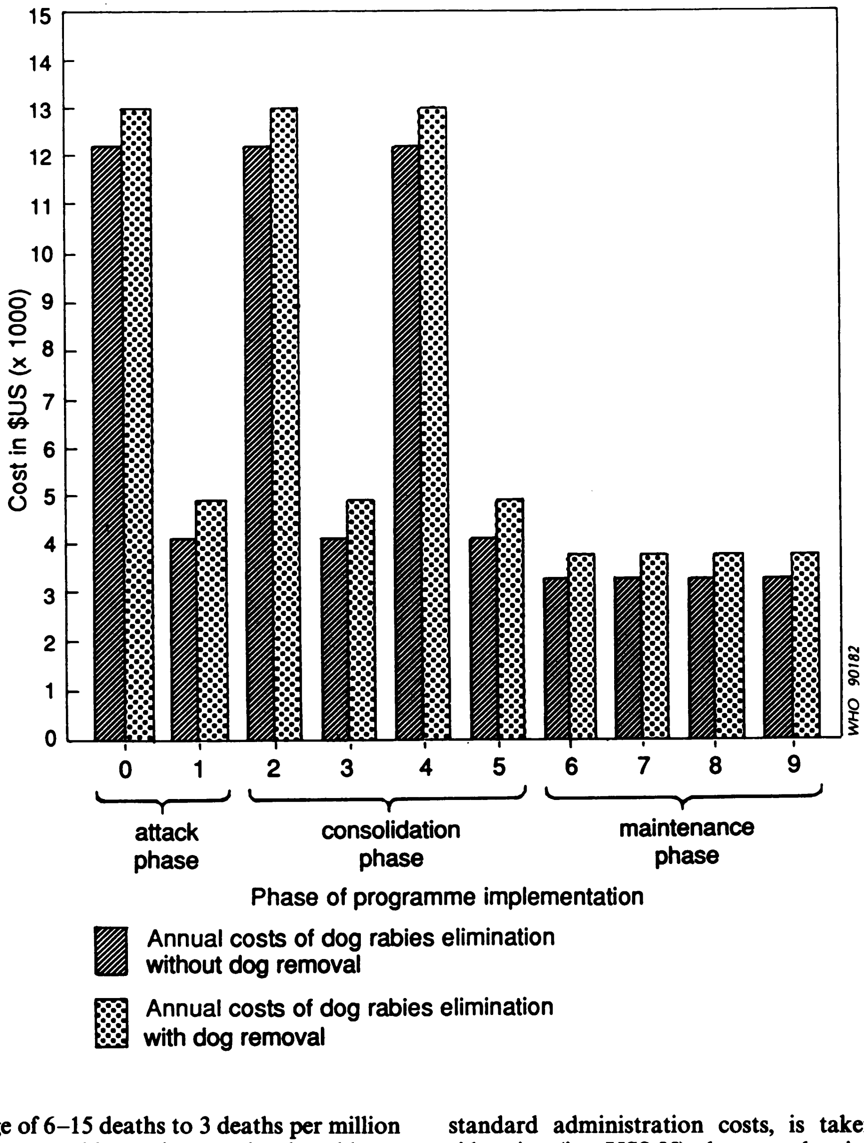
Control strategies: results

Comparison of the costs of the two strategies

The objective of a canine rabies elimination programme is the elimination of human rabies, thereby controlling the disease in the animal reservoir. This objective cannot be met by an intensified PET programme as described in this paper. Ranking analysis of mortality data collected in areas with negligible impact from dog vaccination shows that between 6 and 15 human cases per million inhabitants are recorded annually. The same technique applied to data on post-exposure treatment (PET) shows that areas with a relatively high rate of PET record approximately 3 deaths per million inhabitants annually.[j] Therefore, an intensified PET programme may lower the mortality level from an

[j] **Motschwiller, E.** [*Epidemiologic and economic aspects of canine rabies and its control in Third World countries.*] Inaugural dissertation, Veterinary Faculty of Ludwig-Maximillians University, Munich, 1988, pp. 24 and 31 (in German).

Fig. 2. **Evolution of actual annual costs of a dog rabies elimination programme (with or without dog removal) over a 10-year period, per 100 000 inhabitants or 12 500 dogs (for assumptions, see p. 283 and section (x) on p. 285).**

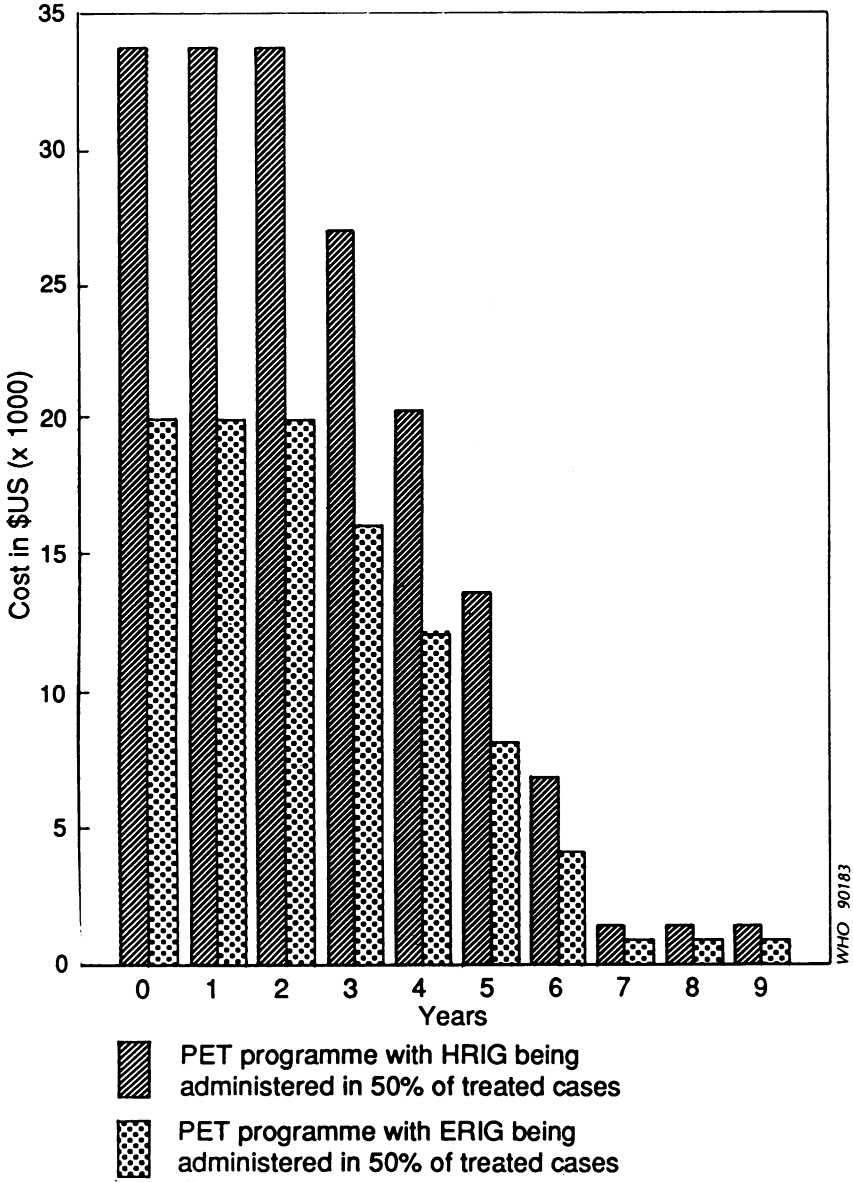


annual average of 6–15 deaths to 3 deaths per million inhabitants, but would not in practice be able to prevent the remaining 3 deaths per year (*1*). The prevention of these 3 deaths would require enormous strengthening of the rabies surveillance system and public awareness, the cost of which is not taken into consideration in the models presented here.

(*a*) *When one strategy is applied independently of the other.* If only the mean price of safe and potent human vaccines of the new generation, including standard administration costs, is taken into consideration (i.e., US$ 55), the annual estimated cost of an intensified PET programme using rabies vaccine alone or in association with RIG is higher than that of a dog vaccination/dog removal programme.

Per 100 000 inhabitants, over a 10-year period, the annual average cost of dog rabies elimination ranges from US$ 6800 to US$ 6200 (mass immunization of dogs with and without dog removal and elimination). Annual costs for each individual year over the 10-year period are indicated in Fig. 2.

Fig. 3. **Evolution of the annual costs of a post-exposure treatment programme launched in parallel with a dog rabies elimination programme, per 100 000 inhabitants (for assumptions, see p. 283 and section (ix) on p. 284).**



By comparison, for an area of 100 000 inhabitants and 200 patients, according to the assumption, the cost range of an intensive PET programme varies from US$ 11 000 (modern vaccine alone) to US$ 27 000 (vaccine and HRIG in 50% of the treated cases) per year (see Fig. 1). In the absence of effective canine rabies control measures, these annual costs are assumed to remain stable over the 10-year period.

Comparison of Fig. 1 and 2 shows that (i) if human vaccines are applied alone, without immunoglobulin, the average annual cost (over 10 years) of the dog rabies elimination programme amounts to

Table 2: **Comparison of actual annual costs of strategies A+B versus strategy A alone (per 100 000 inhabitants)**

Year	Annual cost of strategy (A+B)[a] (US$)	Annual cost of strategy A[b] (US$)
0	32 190	16 000
1	24 063	16 000
2	32 190	16 000
3	20 063	16 000
4	24 190	16 000
5	12 063	16 000
6	7 250	16 000
7	4 050	16 000
8	4 050	16 000
9	4 050	16 000
10	4 050	16 000

[a] Dog rabies elimination +PET (ERIG in 50%).
[b] PET (ERIG in 50%) alone.

about 56% of the cost of the PET programme; and (ii) this average annual cost of the dog rabies elimination programme (without dog removal) amounts to 39% of that of an intensive PET programme using ERIG in 50% of the treated cases and to only 23% of that of a PET using HRIG in 50% of the treated cases.

(*b*) *When the two strategies are applied in association.* In countries or areas where resources would allow the strict application of the two strategies, the execution of a dog rabies elimination programme should improve the epidemiological situation and induce a decrease in PET administration in a very progressive way as described in the assumptions. As can be seen from Table 2, the actual annual spending related to the implementation of an intensified PET programme using ERIG in 50% of the treated cases and associated with a dog rabies elimination programme (strategy A+B) will be less than that for a PET programme (same characteristics as above) conducted alone as from the 5th year following initiation. However, in view of the additional expenses incurred from year 0 to year 4, the accumulated cost of the strategies A+B will approximately equal that of strategy A after 10 years of implementation (see Table 3).

Discounting these annual flows (using a 10% rate of discount) to produce a net current cost for each option confirms that the preferred strategy is sensitive to the time horizon chosen. If the planning horizon is less than 16 years, strategy A is less costly. For any larger horizon, A+B is the preferred option. Fig. 4 shows the flow of the cumulative current costs of strategy A+B, and strategy A alone.

(*c*) *Sensitivity of the results to assumptions.* In view of the uncertainty of the assumed parameters, the sensitivity of the results given by our model has been tested vis à vis some assumptions made for the computation of the individual costs of strategy A and strategy B.

The sensitivity of the model was tested:

—for strategy A against (i) variations of the percentage of treated cases receiving ERIG (from 50% to 25% and 10%), and (ii) decrease in the cost of a human vaccine dose (from $10 to $8 and $4);
—for strategy B against a decrease of the cost of vaccine administration to dogs (from $0.95 per dog to $0.65).

Table 3: **Comparison of the cumulative costs of strategies A+B versus strategy A alone (per 100 000 inhabitants)**

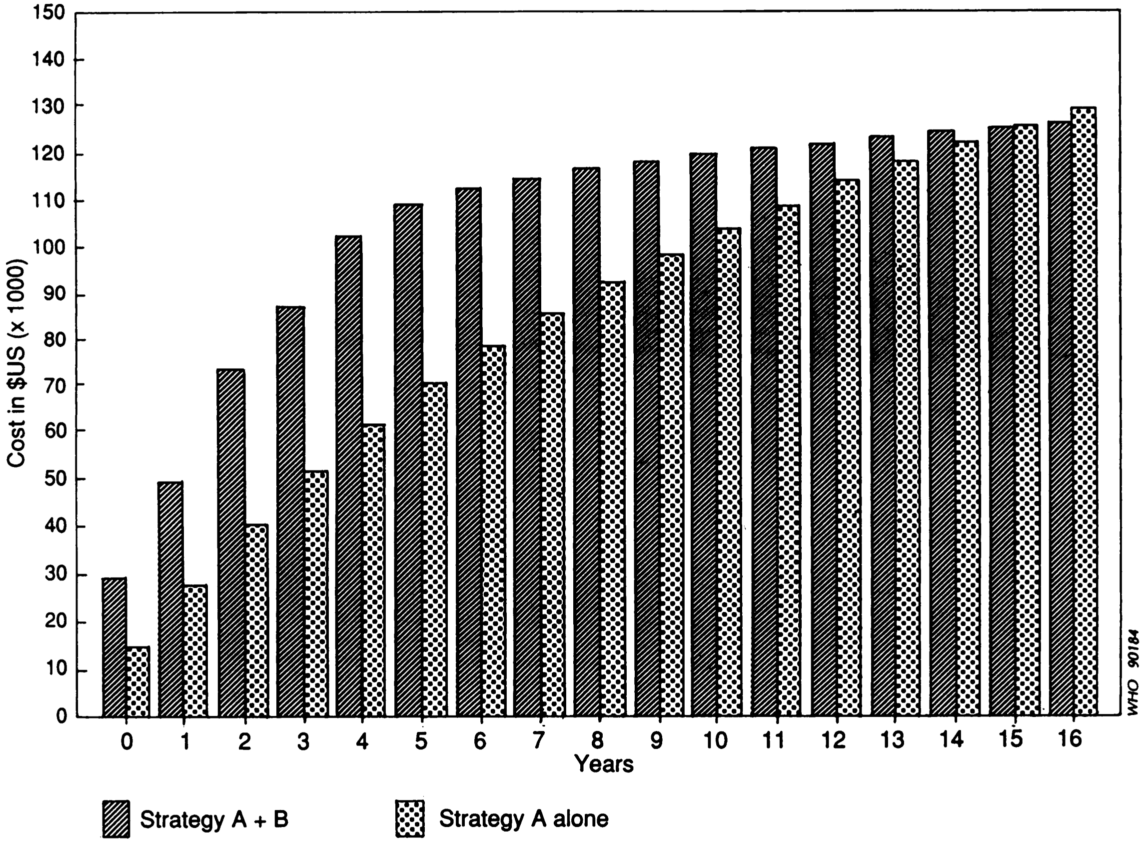
Year	Cumulative costs of strategy (A+B)[a] (US$)	Cumulative costs of strategy A[b] (US$)
0	32 190	16 000
1	56 253	32 000
2	88 443	48 000
3	108 506	64 000
4	132 696	80 000
5	144 759	96 000
6	152 009	112 000
7	156 059	128 000
8	160 109	144 000
9	164 159	160 000
10	168 209	176 000

[a] Dog rabies elimination+PET (ERIG in 50%).
[b] PET (ERIG in 50%) alone.

The sensitivity of the results to fluctuations in the assumptions was evaluated by considering their impact on the period of time necessary for the accumulated actual costs of strategy A+B to equal those of strategy A applied alone. As shown in section (*b*) above, this period is 10 years for our model. Any decrease in the costs of strategy A (cost of strategy B remaining constant) will lengthen this period. Any decrease in the cost of strategy B (costs of strategy A remaining constant) will shorten this period. The reverse will also be true. It appears that variations (increase or decrease) in the cost of a strategy by about 1% will change the period (lengthened or shortened time) by approximately one month.

For example, a decrease by 27% of the cost of strategy B due to a lesser cost of vaccine administration will shorten the time period by about two years

Fig. 4. **Comparison of cumulative current costs of strategy A versus strategy A+B, per 100 000 inhabitants.**



or 20% of the time required in our model (see section (*b*) above), whereas a decrease by 15% of the cost of a PET programme due to the application of ERIG in only 25% of the treated cases will increase the above time period by about one year (11 years instead of 10). If variations of similar magnitude moving in the same direction (decrease or increase) are observed in the costs of each strategy (for example, PET programme with ERIG in 10% of the treated cases and dog rabies elimination with a cost per vaccinated dog of only $1), then no change is observed in the above period of time which remains as 10 years after the year of implementation.

Number of human deaths avoided and cost per avoided death

The model conditions described in this paper permit an estimation of the costs of control activities, according to the strategy applied, in order to avoid one human death due to rabies. The assumptions used to calculated this cost are as follows:

(i) Rabies mortality rates prior to the initiation of control activities are assumed to range from 6 to 15 per million inhabitants (see above).

(ii) When a PET programme with a coverage of 2000 PET per million is applied in isolation (strategy A), then 3 human deaths are reported annually.

(iii) Rabies vaccination of dogs (strategy B) aiming at the elimination of the disease is assumed to reduce the disease incidence in man to zero during the third year of programme implementation. During the first two years a death rate due to rabies representing 20% of the initial rate is taken into consideration in Table 4.

(iv) When an intensified post-exposure treatment programme is carried out in association with dog rabies elimination (strategy A+B), then the incidence of the disease is expected to reach zero during the

Table 4: **Costs per avoided deaths**

Strategy/ control measure	Annual average cost of control measure (US$)	Reduction in annual number of human deaths		Mean annual number of avoided deaths	Cost per death avoided (US$)
		From	To		
Strategy A:					
Intensified PET using ERIG in 50% of treated cases (PET coverage of 2000 per million)	160 000	15	3	12	13 330
		6	3	3	53 330
Strategy B:					
Dog rabies elimination (without dog removal)	62 000[a]	15	0[b]	14.4	4 300
		6	0[b]	5.8	10 690
Strategy A+B:					
Intensified PET using ERIG in 50% of treated cases plus dog rabies elimination	164 200[a]	15	0[c]	14.7	11 170
		6	0[c]	5.9	27 830

[a] During a 10-year programme (see Table 3 and Fig. 2).
[b] A 20% mortality rate will be reported during the first two years of programme implementation.
[c] A 20% mortality rate will be reported during the first year of programme implementation.

second year of project implementation. During the first year a death rate equal to 20% of the initial rate is still expected to be reported (see Table 4).

Strategies B and A+B compare favourably with strategy A, whether the initial mortality rate is high or moderate. Costs per death avoided in the dog rabies elimination programme remain within the range of those of some common health interventions (e.g., for malaria eradication, community water supply, sanitation).

Conclusions

Comparison of the costs and effectiveness of the two programme components for rabies elimination or optimum PET is largely theoretical in the cost computations since no situation exists in which either the one or the other measure is taken alone. However, in recent years the health services of a number of countries have paid considerable attention to rabies PET in the course of the development of primary health care and public health. Ethical reasons appear to predominate in this process and lead to an explosive increase in costs, particularly when the governments decide to provide, instead of classical nervous tissue vaccine, the new generation of human vaccines which are safer and more potent.

On the other hand, the veterinary health services are often facing major problems in animal production due to the absorption of available resources for mass vaccination programmes against other diseases in livestock while dog rabies elimination is neglected. It is a general observation that resources are often inadequate both for the elimination of rabies in dogs and for the PET service.

However, the results of this analysis strongly suggest that consideration should be given to a national programme of dog rabies elimination for simple economic reasons. This appears to be particularly important in countries where at present the allocated resources are inadequate in both the health and veterinary sectors so that the problem of rabies persists without a marked improvement in spite of the measures taken.

Ethical and economic reasons call for intersectoral cooperation and in particular the leading role of the agriculture/veterinary sector in rabies elimination since an intensive PET programme using vaccine alone cannot prevent about 3 human cases of rabies per million annually or reduce the fear of the disease in all those who are exposed and treated. Substantial expenses for PET delivery can and should be avoided.

In some countries it may take 5–10 years, following the elimination of dog rabies in large areas, before the health service can significantly reduce the treatment of persons after animal bites. In other countries, rabies surveillance data are regularly assessed by an interdisciplinary/sectoral rabies or zoonoses committee which also advises on the provision and use of vaccines and immunoglobulin in humans. Recognition of rabies-free areas, if well identified, can soon reduce the costs for PET services.

This analysis provides convincing arguments for the adoption of a national intersectoral strategy which, by concentrating the available resources, will reduce the burden to national budgets and lead to increased health and an improved infrastructural service. In particular, countries which are planning to replace classical (and unsatisfactory) procedures for human post-exposure treatment should choose the positive cost-effectiveness approach shown in this analysis. The results should also encourage research workers to continue their efforts to develop cheaper human vaccines and immunoglobulins.

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