Mass administration of DEC-medicated salt for filariasis control in the endemic population of Karaikal, South India: implementation and impact assessment

G. Subramanyam Reddy[1] & N. Venkateswaralu[2]

DEC (diethylcarbamazine)-medicated salt, at a concentration of 0.1 to 0.2 mg per 100 mg, was given to the entire population of Karaikal (119 978) in South India for a 4-year period from 1982. The per capita consumption of DEC in medicated salt was 13.3 grams for the entire period. The prevalence of microfilaraemia declined significantly from 4.5% in 1982 to 0.14% in 1985 and 0.4% in 1993. Vector infection declined from 0.6% in 1982 to zero after two years. The mechanism of preparation and regulated distribution of DEC-medicated salt in the locality is presented. Long-term follow-up suggests that DEC-medicated salt distribution is cheap, safe and efficient for the elimination of filariasis.

Filariasis is a major public health problem with an estimated 750 million people exposed to risk of infection and 80 million cases in the world. India accounts for about 50% of the at-risk population and about 60% of all cases (*1*). Diethylcarbamazine (DEC) has been the drug of choice and is known for its excellent microfilaricidal activity (*2–4*). Different methods of drug delivery — 6 mg/kg/day for 12 days (*5, 6*) for selected cases or mass, spaced doses in different regimens (*1, 2, 7–11*) — have been attempted with varying degrees of impact. DEC-medicated salt has been used for control of lymphatic filariasis in India (*12, 13*); the largest trial was carried out in Karaikal and the immediate and delayed epidemiological impacts have been reported (*14*). This article describes the implementation process in Karaikal and presents the epidemiological assessment data.

Materials and methods

Karaikal lies in the Union Territory of Pondicherry, 290 km south of Madras on the eastern coast of South India. According to the 1981 census, the population was 119 978 in an area of 160 square kilometers, including the urban municipal zone and five communes (semi-urban and rural). This area has been endemic for *Wuchereria bancrofti* for several decades and the National Filariasis Control Programme (NFCP) of India started a control unit in 1970. Routine control measures based on selective chemotherapy and antilarval measures have been in operation in the urban area since then.

For a period of 4 years from January 1982 a community-based trial of mass consumption of DEC-medicated salt (0.1%–0.2%) was carried out to evaluate its efficacy and impact on epidemiological and transmission parameters. This trial was implemented jointly by the NFCP and the Directorate of Health and Family Welfare, government of Pondicherry Union Territory.

Data collection

The following epidemiological and entomological data were collected:

— human infection prevalence (microfilaria rate in %);

— vector infection prevalence (vector infection and infectivity rates in %).

Data on the pre-intervention epidemiological parameters were obtained from the local filariasis control unit of the NFCP for the 10-year period, 1972–81. These data had been collected using standard guidelines by the NFCP (*15*). In January 1982,

[1] Chief Medical Officer and Head, Department of Medicine, General Hospital, Karaikal, and Senior Specialist in Medicine, Government General Hospital, Pondicherry 605 001, India. Requests for reprints should be sent to this author.

[2] Head, Department of Skin and STD, Karaikal General Hospital, and of the Filariasis Control Programme, Karaikal Region, India.

Reprint No. **5676**

surveys were carried out to collect the immediate pre-intervention data on human and vector infection status. Data during the intervention (1982–86) and in the post-intervention period (1986–93) on the same parameters were collected by the local NFCP unit.

Details of the salt-manufacturing units within the study area and of outside sources to meet the local requirements, along with the entry routes, and the mechanisms of distribution of salt from the manufacturing sites to the consumers were studied. Based on these data, a plan was drawn up for the production, quality control and distribution of DEC-medicated salt to the target population.

Role of local authorities and the community

After the programme's inauguration by the then Minister for Health and Family Welfare of Pondicherry in January 1982, a series of meetings were held in the communes and municipal zones with the local health and administrative authorities, field health staff, local political office-bearers, opinion leaders, village *Panchayat* members and social workers to explain the salient features of the medicated-salt programme and its benefits. They were told that the DEC-medicated salt was non-toxic with no harmful effects on prepared foods and shown how to identify the marks indicating DEC-medicated salt. The community was motivated through door-to-door visits and group discussions to explain the programme. Slides (35 mm) describing the programme and requesting public cooperation were projected in local cinemas, which are popular in South India. Publicity was given through public address systems on mobile vehicles and using specially designed banners.

Separate meetings were held with the local salt manufacturers, wholesale salt dealers of imported salt from Vedaranyam and Tuticorin, transport operators (lorry owners and drivers), municipal revenue authorities located at check posts in the study area, local grocery shop owners, cooperative society stores and salt vendors (selling a head load of salt from door to door). These persons were motivated to ensure that the entire quantity of salt was medicated with DEC before it reached the consumers.

The process of medication necessitated the unloading of all incoming salt, mixing with DEC, and reloading after packing. This resulted in some time lost for the salt-carrying lorries. Financial compensation was provided for the waiting time of the lorries, labour charges for loading and unloading the salt, and also for the marginal reduction in the volume of the salt due to the mixing.

The implementation was monitored by frequent meetings of the NFCP with the local health and administrative authorities to take decisions on day-to-day activities.

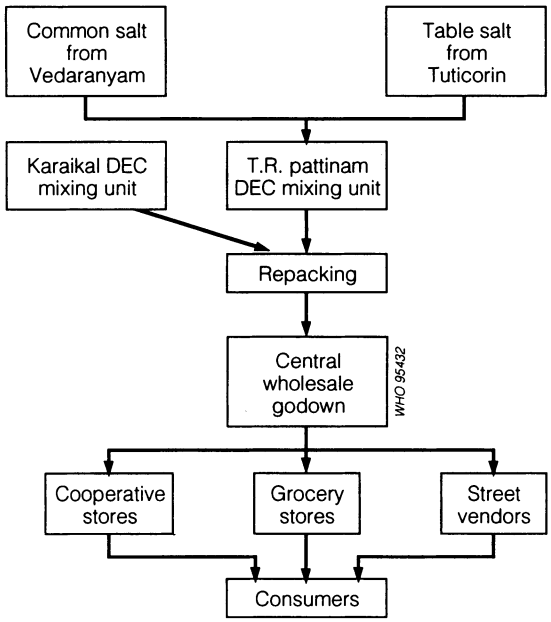
Medication of salt with DEC

Medication with DEC was carried out at two sites: in the salt manufacturing unit in Karaikal and in Thirumalairyanampattinam, which is at the entry point for outside sources of salt into the Karaikal region. All the locally manufactured salt was packed in gunny bags, weighed and transported to the mixing unit. Based on the salt weight the required amount of DEC (at 0.1% for the first three months, 0.15% in the next three months, and 0.2% for the remaining period) was added and mixed in the following manner. The salt was loaded into a concrete mixer drum and after starting the mixing process (by switching on the motor), the required quantity of DEC powder was sprinkled slowly on the salt. The mixing was continued at the rate of 40 rotations per minute for 3 minutes. This was standardized to get a uniform mixture with minimal changes in the volume of salt, which was very important from the local traders' point of view, since they sell salt by volume measures. The DEC mixed salt was loaded back into the bags and stitched with an identification printed slip giving details about batch number and date of DEC mixing, so that any testing of salt samples for DEC content after distribution could be verified. The salt brought in from Vedaranyam and Tuticorin by lorry was unloaded at the mixing unit in Thirumalairyanampattinam where DEC was mixed using the same procedure as above. In the case of table salt, after mixing, one kilogram packets were made in polythene bags with identification slips within the bag itself.

The DEC-medicated salt was then transported to the wholesale godowns at Karaikal, from where the local traders collected their requirements. The salt mixed at Thirumalairyanampattinam was also transported by lorries to the same wholesale godowns. The consumers purchased their salt requirements from local traders (Fig. 1).

Monitoring of the salt for uniform medication was done by regular weekly chemical assays of the 31 salt samples for their DEC content at the Public Health Laboratory, Pondicherry. A second check was also carried out by estimating the DEC content in 20 salt samples every month at the Regional Filaria Laboratory in Calicut, Kerala.

Fig. 1. **Flow chart on the preparation of DEC-medicated salt.**



Results

Pre-intervention assessment

Analyses of the available data from local NFCP unit sources for a decade (1972–81) showed that the prevalence of microfilaraemia ranged from 4.5% to 11.0%. The 10-man-hour density of *Culex quinquefasciatus*, the vector of filariasis, ranged between 27.0 and 77.0. The vector infection and infectivity rates ranged from 0.7% to 10.2% and from 0.3% to 1.0%, respectively (Table 1). The immediate pre-control survey carried out just before the intervention showed that the mf rate was 4.5% and the vector infection and infectivity rates were 0.6% and 0.3%, respectively.

Assessment during and after the intervention

Totals of 3374 891 kg of common salt and 30000 kg of table salt were medicated with 6388 kg of DEC during the 4-year period of intervention. The per capita consumption of DEC was estimated at 13.3 grams of DEC in the entire period.

The prevalence of microfilaraemia declined drastically from 4.5% in January 1982 to 0.24% in December 1983. The levels continued to be low and reached 0.14% in 1985 at the end of the project. Eight years after closing the distribution of DEC-medicated salt, the mf rate was only 0.4% in 1993 (Table 2).

The vector infection rate, which was 0.6% in 1982, fell to 0.4% in the first year and gradually declined to zero at the end of the study. The vector infectivity rate declined from 0.3% to zero in the second year itself and remained at this level for the next four years. These results indicate the successful interruption of transmission during DEC salt administration. In the post-intervention period, the vector infection rate increased marginally to 0.1% in 1990, but declined again in 1993. However, it is important to note that infective larvae were detected only rarely. In 1993, the vector infectivity rate was still zero, showing that effective transmission remained interrupted.

A total of 5612 salt samples were collected at the rate of 6 samples from each of the two mixing units, 5 samples from vendors, 5 from groceries and cooperative stores, and 15 samples from households every week. After the initial three months, the DEC content was within the expected range (0.15–0.20%) in 64.2% of samples; it was lower (<0.15%) in 25.6% of samples and higher (>0.2%) in the rest (10.2%).

Table 1: **Pre-intervention epidemiological data**

Year	Vector density[a]	Infection rate (%)	Infective rate (%)	No. of persons examined	No. positive for mf	mf Rate (%)	No. positive for disease	Disease rate (%)
1972	77.04	10.19	0.95	2120	235	11.08	35	1.65
1973	46.09	6.68	0.93	2081	243	11.68	52	2.49
1974	42.68	5.50	0.68	818	49	5.99	5	0.61
1975	58.73	1.76	0.47	1119	87	7.77	18	1.61
1976	40.64	1.89	0.34	252	29	11.51	3	1.19
1977	31.52	1.72	0.32	2928	213	7.27	19	0.69
1978	27.00	1.47	0.65	2242	148	6.60	15	0.66
1979	34.20	1.66	0.69	1421	90	6.28	4	0.28
1980	36.32	0.32	0.14	4114	214	5.20	25	0.61
1981	38.76	0.65	0.33	14963	678	4.53	74	0.19

[a] Vector density per 10 man-hours.

Table 2: **Epidemiological data during the intervention and post-intervention phase**

Year	Vector density[a]	Infection rate (%)	Infective rate (%)	No. of persons examined	No. positive for mf	mf Rate (%)	No. positive for disease	Disease rate (%)
1982	40.15	0.62	0.29	22232	998	4.49	86	0.39
1983	51.79	0.38	0.03	2478	6	0.24	3	0.12
1984	46.07	0.24	0.00	6649	4	0.06	2	0.03
1985	44.28	0.06	0.00	1430	2	0.14	0	0.00
1986	40.14	0.00	0.00	20454	16	0.08	23	0.11
1987	50.01	0.00	0.00	11930	38	0.32	22	0.18
1988	40.62	0.03	0.03	4814	16	0.33	12	0.25
1989	45.11	0.06	0.00	3091	12	0.39	29	0.94
1990	42.07	0.12	0.04	3375	9	0.27	0	0.00
1991	41.88	0.07	0.07	22068	56	0.25	19	0.09
1992	43.03	0.04	0.04	14595	40	0.36	15	0.10
1993	46.31	0.06	0.00	9444	38	0.40	13	0.14

[a] Vector density per 10 man-hours.

Discussion

This study shows beyond doubt the effectiveness of DEC-medicated salt and that it should be possible to control filariasis. The sharp decline in filariometric indices confirms that this method should reduce infection to a sufficiently low level, permitting the elimination of transmission. DEC-medicated salt is not only efficient but also cheap, the per capita cost in 1981 of DEC consumed being Rs 1.04 with an operational cost of Rs 1.50, making a total of Rs 2.54, while the cost of 12 doses of DEC treatment for a whole population in an endemic area in Kerala was Rs 4.56 per capita (*12*). This medicated salt is most acceptable to the community.

Studies with DEC-medicated salt have been conducted in communities in Brazil (*16*), Japan (*17*), the United Republic of Tanzania (*18*), and China (Quenoy Island) (*10*, *11*). Studies were carried out in India at a village in Uttar Pradesh in 1968,[a] and subsequently in Andhra Pradesh (*19*), in Lucknow (*20*), and in Lakshadweep (*12*). This last one was, prior to the present study, the largest available study; it was carried out by Rao et al. in 1981 and covered a population of 25000 over a period of 104 to 130 weeks (*12*). A detailed review was published in 1994 (*21*).

In the present study 119978 people were provided with DEC-medicated salt for a period of 207 weeks, followed by assessment of the filariometric indices during the past 10 years. Thus, in addition to baseline parasitological and entomological data, constant monitoring and evaluation of the various indices were carried out during the project and after completion of the project for about 8 years. Of all such studies, this one covered the largest population for the longest period, and had the highest per capita consumption of DEC and the longest follow-up period (8 years). Evaluation of the various filariometric parameters during the post-intervention period of 8 years showed that the various human and vector infection rates did not progress, which suggested that long-term DEC-medicated salt might have acted as an adulticidal or, at least, curbed the persistent release of microfilaria. Further, since the effect of the DEC salt has continued for a long period, above the known life span of 5–9 years (*22*), it can be safely concluded that DEC-medicated salt could be microfilaricidal as well as adulticidal.

At present, even after 40 years of implementation of the National Filariasis Control Programme it was not possible to carry out surveys in all endemic areas. The control programme serves only 20% of the population at risk and that too only in urban areas. Neither the logistics nor the budget allocations under the present filaria control programme will meet the present challenge of covering all the exposed people unless one takes up a community-based, cheap but cost-effective programme like the one using DEC-medicated salt (*23*). The success and participation depend on political commitment and appropriate legislation to stop the supply of unmedicated salt while ensuring the availability of medicated salt at consumer outlets. A definite breakthrough in the control of filariasis, with the possibility of ultimate eradication, is now available using this simple, rapid, safe, inexpensive and effective prophylactic method.

[a] **Raghavan NGS et al.** *A pilot study on the use of diethylcarbamazine incorporated in common salt in a village endemic for* W. bancrofti *filariasis (Parbatpur village, Varanasi district, Uttar Pradesh, India).* Unpublished WHO document FIL/68–82, 1968.

Acknowledgement

We gratefully acknowledge the kind assistance of Dr S.P. Pani, Deputy Director, Vector Control Research Centre, Pondicherry, India, in the preparation of this manuscript.

Résumé

Administration de masse de sel médicamenteux contenant de la DEC pour la lutte contre la filariose endémique dans la population de Karaikal, Inde du Sud: mise en œuvre et évaluation d'impact

Du sel médicamenteux contenant de la DEC (diéthylcarbamazine) à la concentration de 0,1 à 0,2 mg pour 100 mg a été donné à la totalité de la population de Karaikal (119 978 habitants), en Inde du Sud, pendant une période de quatre ans à compter de 1982. Pour la totalité de la période, la consommation de DEC par personne sous cette forme a été de 13,3 g. La prévalence de la microfilarémie a sensiblement baissé, passant de 4.5% en 1982 à 0,14% en 1985 et 0,4% en 1993. Le taux d'infection des vecteurs est passé de 0,6% en 1982 à zéro au bout de deux ans. L'article présente le mode de préparation et le mécanisme de distribution réglementée du sel médicamenteux dans la localité. Le suivi à long terme indique que la distribution de sel médicamenteux contenant de la DEC est un moyen économique, sûr et efficace d'éliminer la filariose.

L'évaluation des divers paramètres filariométriques pendant la période de suivi de huit ans après l'intervention a montré que les divers taux d'infection chez l'homme et le vecteur n'ont pas progressé, ce qui laisse à penser que le sel médicamenteux contenant de la DEC, administré au long cours, peut avoir agi comme adulticide ou, au moins, avoir empêché la poursuite de la libération de microfilaires. De plus, comme l'effet du sel médicamenteux s'est poursuivi pendant une longue période, au-delà de la durée de vie connue des filaires (5–9 ans), il est permis de conclure que le sel contenant de la DEC pourrait être à la fois microlaricide et adulticide.

References

1. **WHO Expert Committee on Filariasis.** *Fifth report. Lymphatic filariasis: the disease and its control.* Geneva, World Health Organization, 1992 (WHO Technical Report Series, No. 821).
2. **Ottesen EA.** Efficacy of diethylcarbamazine in eradicating infection with lymphatic-dwelling filariae in humans. *Reviews of infectious diseases,* 1985, **7**: 341–356.
3. **Pani SP et al.** Clearance of microfilaraemia following diethylcarbamazine (DEC) therapy in periodic *Wuchereria bancrofti* infection: relation with age, sex, microfilaria count and clinical status. *Tropical biomedicine,* 1991, **8**: 59–65.
4. **Krishnamoorthy K et al.** Daily diethyl carbamazine for the treatment of *Brugia malayi* microfilaria carriers. *The national medical journal of India,* 1992, **5**: 104–107.
5. *WHO Expert Committee on Filariasis. Third report.* Geneva, World Health Organization, 1974 (WHO Technical Report Series, No. 542).
6. *Lymphatic filariasis. Fourth report of the WHO Expert Committee.* Geneva, World Health Organization, 1984 (WHO Technical Report Series, No. 702).
7. **Ramaiah KD et al.** Prevalence of Bancroftian filariasis and its control by single course of diethyl carbamazine (DEC) in a rural area in Tamil Nadu. *Indian journal of medical research,* 1989, **89**: 184–191.
8. **Panicker KN et al.** Comparison of effects of mass and biannual single-dose therapy with diethylcarbamazine for the control of Malayan filariasis. *Southeast Asian journal of tropical medicine and public health,* 1991, **22**: 402–411.
9. **Balakrishnan N et al.** Efficacy of biannual administration of DEC in the control of Bancroftian filariasis. *Journal of communicable diseases,* 1992, **24**: 97–91.
10. **Fan PC et al.** Control of bancroftian filariasis by common salt medicated with DEC on little Kinmen (Quemoy) island. I. Epidemiological study. *Chinese journal of microbiology,* 1975, **8**: 36–58.
11. **Fan PC.** Filariasis eradication on Kinmen proper, Kinmen (Quemoy) islands, Republic of China. *Acta tropica,* 1990, **47**: 161–169.
12. **Rao CK et al.** Control of bancroftian filariasis with common salt medicated with diethylcarbamazine in Lakshadweep. *Indian journal of medical research,* 1981, **73**: 865–873.
13. **Narasimham MVVL et al.** Control of bancroftian filariasis by diethylcarbamazine-medicated common salt in Karaikal, Pondicherry, India. *Journal of communicable diseases,* 1989, **21**: 157–170.
14. **Subramanyam Reddy G et al.** Control of bancroftian filariasis by salt medicated with diethylcarbamazine citrate. *Journal of Indian Medical Association,* 1986, **84**: 1–3.
15. *National Filaria Control Programme: Operational manual.* New Delhi, National Malaria Eradication Programme, 1984.
16. **Hawking F, Marques RJ.** Control of bancroftian filariasis by cooking salt medicated with diethylcarbamazine. *Bulletin of the World Health Organization,* 1967, **37**: 405–414.
17. **Kanda T et al.** Pilot experiments on mass treatment of bancroftian filariasis with medicated food or drink. *Japanese journal of experimental medicine,* 1967, **37**: 141.
18. **Davis A, Bailey DR.** The effect of salt medicated with diethylcarbamazine in bancroftian filariasis. *Bulletin*

of the World Health Organization, 1969, **41**: 195–208.

19. **Rao PK et al.** Effect of diethylcarbamazine-medicated common salt on *Wuchereria bancrofti* prophylaxis. *Journal of communicable diseases*, 1980, **12**: 205–209.
20. **Sen AB et al.** Diethylcarbamazine-medicated salt in the chemotherapeutic control of filariasis due to *Wuchereria bancrofti* in an open community. *Indian journal of medical research*, 1974, **62**: 1181.
21. **Gelband H.** Diethylcarbamazine salt in the control of lymphatic filariasis. *American journal of tropical medicine and hygiene*, 1994, **50**: 655–662.
22. **Vanamail P et al.** Estimation of age-specific rates of acquisition and loss of *Wuchereria bancrofti* infection. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 1989, **83**: 689–693.
23. **Rajagopalan PK, Pani SP.** Community drug trials for lymphatic filariasis in India. *The national medical journal of India*, 1991, **4**: 71–76.