ISSN 0377-4910

ICMR BULLETIN

Vol.38, No.10-12 October-December, 2008

Integrating Mass Drug Administration with Vector Control for the Elimination of Lymphatic Filariasis

Lymphatic filariasis (LF), caused by the nematode parasites Wuchereria bancrofti, Brugia malayi and B. timori, is a major public health problem in many developing countries world-wide, including India[1]. Over 1.1 billion people (20% of the world's population) live in known filariasis endemic areas and one-fourth of them are likely to be infected[2]. However, with the advent of cost-effective control strategies, the disease seems to be eradicable. Therefore, the World Health Organization (WHO) has launched a Global Programme to Eliminate Lymphatic Filariasis (GPELF) by the year 2020 in accordance with resolution WHA 50.29 of the 50th World Health Assembly[3]. The strategy of GPELF has two components: first, to stop the spread of infection (ie., interrupt transmission), and secondly, to alleviate the suffering of affected individuals (i.e., morbidity control). In order to interrupt the transmission, districts in which lymphatic filariasis is endemic must be identified, and then community-wide (mass treatment) programmes be implemented to treat the entire at-risk population. In most of the countries, the programme is based on once-yearly administration of single dose of two drug combination given together for 4-6 years: albendazole plus either diethylcarbamazine (DEC) or ivermectin, the latter in areas where either onchocerciasis or loiasis may also be endemic. An alternative community-wide regimen with equal effectiveness is the use of common table/cooking salt fortified with DEC in the endemic regions for a period of one year.To alleviate the suffering caused by the disease, it will be necessary to implement community education programmes to raise awareness in affected patients. India being a signatory to GPELF programme has set its target for national elimination by the year 2015[4]. Nineteen states/union territories in India are known to be endemic for lymphatic filariasis and 454 million people are at risk of infection with 29 million filarial cases and 22 million microfilaria carriers accounting for 40 per cent of the global burden[5].

The occurrence of filarial disease depends on high rates of disease transmission and continued endemicity. It has been calculated that statistically an average of several thousands of bites by infective vector (range 2700 to > 100,000) take place before a new human case of infection is established[6]. For Culex quinquefasciatus transmission of W. bancrofti[7], it was estimated that about 2,765 infective bites would be the average exposure leading to patent microfilaraemia where the mean annual biting rate (ABR) exceeded 80,000 bites/person/year and the microfilaraemia rate among adults of different ethnic groups reached 4-11%. Realization that a high proportion of LF cases are contracted during childhood, years before microfilaraemia develops[8], indicates that LF incidence can be caused by far fewer infective mosquito bites than was previously believed necessary. Hence targeting of young children in the mass drug administration (MDA) programme should be emphasized[9].

In many tropical situations, with various vectors it has been observed that, below a critical number of infective bites, LF is not sustained as an endemic disease. For example in cities with good environmental management (e.g., Singapore and Mumbai) and islands such as Cuba, Trinidad, Guam and Mauritius, LF disappeared - apparently as a result of improved sanitation limiting the vector density. Moreover, in the Solomon Islands, parts of Togo and Papua New Guinea, interruption of filariasis transmission resulted from insecticide house-spraying operations by the anti-malaria programme[10,11]. Generally, by application of standard methods of mosquito control, it is possible to greatly reduce the risks of filaria transmission, if not to prevent it altogether.

Culex Vectors of Wuchereria bancrofti

About half of the world's burden of LF is transmitted by Culex species and in India 98% of LF parasite is transmitted by Cx. quinquefasciatus, which bites only in darkness and transmits only nocturnally periodic W. bancrofti in most endemic urban areas. Culex quinquefasciatus typically breeds in stagnant, organically polluted water. In many urban areas, the majority of Culex breeding sites are in flooded pit latrines and soakage pits, which can be targeted for specific control measures[12,13]. In low-lying areas, especially where monsoon climate causes prolonged extensive flooding of ditches and gulley, source-reduction of Culex is virtually unmanageable. Where possible, keeping open drains flowing has been demonstrated to effectively suppress the adult Cx. quinquefasciatus biting populations (e.g. in Pondicherry, India, and Tanga, Tanzania), but this needs sustained effort and expenditure[14]. Upgraded sanitation and drainage is undoubtedly the long-term solution to the urban Culex problem. Although expensive, the broader benefits to social progress and health (against other enteric diseases and helminth infections) make sanitation systems more cost-effective in the long-run. In economically advanced situations (e.g. Singapore, Costa Rica, Trinidad), Culex has been readily reduced to levels where LF transmission breaks down. In developing countries more cost-effective methodology needs to be implemented to reduce the burden of cost on government funding agencies to tackle Culex problem.

Intervention Strategies for Culex quinquefasciatus

Various methods are available to control the breeding of Cx. quinquefasciatus. At least 2/3 of this vector production is from flooded pits and application of expanded polystyrene beads (EPBs) to the pits is recommended for prolonged suppression of vector potential. This approach would be inadequate in situations (areas with monsoon climate) where the majority of vector Culex breeding-sites are in flooded ditches, surface pools and water storage containers. Habitual use of insecticide treated nets is essential wherever LF remains endemic (being popular against nuisance mosquitoes as well giving substantial protection against malaria and other mosquito-borne diseases), particularly where Culex and other mosquitoes are left uncontrolled. Improved sanitation and drainage systems, where affordable, greatly reduce transmission risks of LF as well as other helminth and enteric diseases. Various options available for vector control are outlined in the present write-up.

Use of chemical insecticides

For larval control, extensive use of organophosphate insecticides (e.g. fenthion, temephos) has been made, but the widespread development of resistance reduces their effectiveness against Culex populations. Oiling is seldom suitable because the lighter 'mosquito larvicidal oils' (MLOs) are readily emulsified by detergents often present in polluted waters preferred by Cx. quinquefasciatus, while heavier oils tend to clog soakage pits. To avoid selection pressure on immature stages of mosquitoes (larvae and pupae), pyrethroid insecticides should never be used for larviciding - since pyrethroids are invaluable adulticides. Even so, adult Culex mosquitoes are relatively more tolerant than other types of mosquitoes against most insecticide applications, making adulticidal control of Culex rather ineffective. Generally larviciding programmes, with high costs of chemicals, equipment and labour, are uneconomical and unsustainable against Culex vectors of W. bancrofti. In situations where Culex breeds prolifically in flooded drains and sites that cannot be readily treated, larviciding cannot be expected to have sufficient impact to reduce filariasis prevalence, particularly where monsoon climate and periodic flooding cause extensive breeding sites to be unmanageable except by major drainage improvements[15].

Use of expanded polystyrene beads

An excellent method of Culex control employs floating layers of expanded polystyrene beads which create a physical barrier to egg-laying adult Culex while suffocating larvae and pupae. Floating EPBs are extremely durable, giving prolonged suppression of Culex populations[16]. EPBs can only be used effectively in habitats where stagnant water is confined within walls, e.g. pit latrines, soakage pits, cess pits, flooded cellars, etc. Sustainable control of Cx. quinquefasciatus has been demonstrated over several years among communities in Zanzibar, Tanzania[17,18], and Tamil Nadu, India[19,20], where the application of EPBs in all pits found to be breeding-sites of Cx. quinquefasciatus virtually eliminated the Culex nuisance mosquito problem. In these situations the vector control (VC) operations were transferred to the community, and the youth volunteers were involved in monitoring the breeding of filariasis vectors in cess pits. One application of EPBs to each pit resulted in few years of control in East African towns. Most importantly, this simple method for sustained control of Culex greatly enhanced the impact of time-limited MDA, by preventing resurgence after MDA ceased[21]. In St. Vincent and the Grenadines, West Indies, this method was applied using shredded waste polystyrene (SWAP) to give long-lasting control of Cx. quinquefasciatus in pit latrines[22]. Floating carpets of EPBs or SWAP are not suitable for flood-prone areas and exposed breeding-sites from where they may be flushed away. In places where at least 2/3 of Culex breeding is attributed to breeding-sites in pits suitable for polystyrene treatment, this method should be applied to control the filariasis vector population in situations where improving the sanitation system (e.g., water closet with mains drainage or well maintained mosquito proof septic tanks and cess pits) is not feasible to prevent breeding of mosquitoes and flies.

Biocide application

Bacillus sphaericus (Bs) can kill Culex larvae in polluted water, and may have some recycling potential, whereas Bacillus thuringiensis israelensis (Bti) is not effective in such habitats. These biopesticides are commercially available, mainly for use against pest mosquitoes in wetlands of prosperous countries. In practice, for LF vector control, B. sphaericus in open breeding sites did not contribute usefully to adult Culex suppression beyond what was achieved with EPBs applied to pits in the same areas (of Zanzibar and Tamil Nadu). There have been problems with B. sphaericus quality control and rapid development of resistance against it by Cx. quinquefasciatus. Field resistance to B. sphaericus was observed in a population of Cx. quinquefasciatus in Kochi, south India, exposed to 35 rounds of spraying with a formulation of B. sphaericus 1593M over a 2 year period[23]. Enthusiasm for these bioproducts

seems to be inappropriate for LF vector control in poor economic situations in developing countries. Among the insect growth regulators (IGRs), pyriproxyfen is most potent[24] and could be used to suppress immature Culex populations.

Insecticide impregnated materials

Measures that restrict access of Cx. quinquefasciatus into houses, such as the installation of ceilings, or the use of eaves curtains impregnated with insecticides, have been shown to reduce Culex biting. Insecticide treated bed nets divert Culex to bite birds and hence reduce the transmission potential of W. bancrofti to humans. It was demonstrated that pyrethroid impregnated bed nets killed very few Cx. quinquefasciatus but reduced significantly their feeding rate success[25]. In the Kenyan coast a shift from human to animal feeding was observed after the use of pyrethroid impregnated bednets[26]. Statistically significant reductions of indoor-resting and man-biting densities of the mosquitoes An. subpictus and Cx. quinquefasciatus were observed for 14 weeks, in two field trials using hessian curtains impregnated with deltamethrin in south India[27]. In filaria endemic areas where stagnant polluted drains are the potential breeding grounds for Cx. quinquefasciatus, implementation of pyrethroid impregnated materials will greatly reduce the man-vector contact.

Mass drug administration and vector control

Vector control (with EPS beads in soakage pits and larvivorous fishes in unused wells) in Tirukoilur, south India, when used as an adjunct to MDA given annually, brought about reduction in filariometric indices, and provided a strong evidence of the benefit of integrating vector control with MDA[19,20]. Vector density greatly decreased in villages where vector control was used as an adjunct to MDA and almost no infective mosquitoes were found in the small numbers still remaining in Tirukoilur. During the first year, the reduction in transmission potential (estimated from mosquito landing catches) was more rapid when MDA was combined with VC, which was equalized in the second year. In the absence of MDA in the third year, the transmission reduction was sustained in MDA+VC villages, while in MDA alone villages a resurgence in filarial infection variables was noticed[21] (Fig. 1).

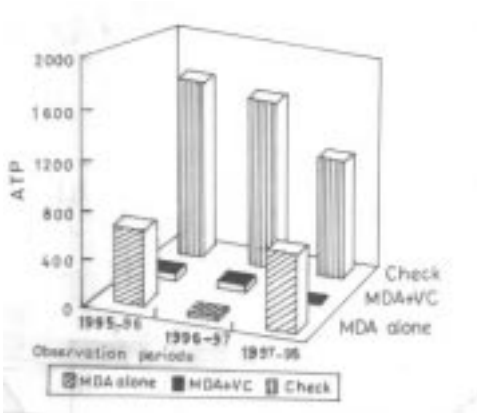

Fig.1. Impact of intervention strategies on annual transmission potential (ATP)

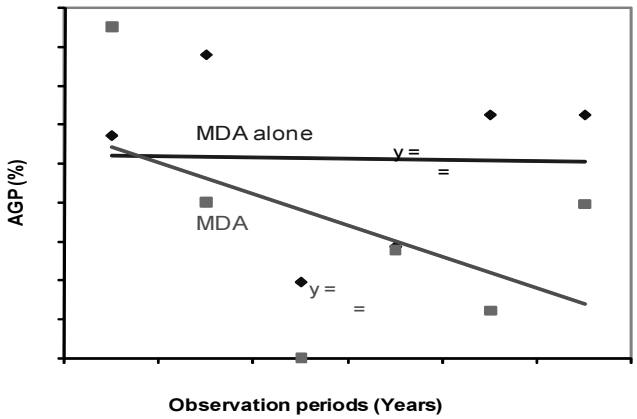

Fig.2. Antigenaemia prevalence changes in 2 treatment arms in 2-5 years

Filarial antigenaemia was low and continued to decrease significantly in the age group 15-25 years in villages receiving MDA+VC in contrast to villages receiving only MDA. A definite impact of vector control was observed in the age group 15-25 years among villages receiving MDA with vector control. In the youngest age group of 2-5 years, the regression equations for MDA alone and MDA+VC demonstrated significant differences (Fig. 2). In MDA+VC the line demonstrated a steep slope downwards with b=-0.81.

Considerable numbers of filarial larvae (including L3 stages) were found in the mosquitoes caught in the villages receiving MDA alone. Very few or no filarial larvae were found in villages receiving MDA with vector control but very few mosquitoes were available for dissection here. This indicates that the children in MDA+VC villages are receiving low/nil infective bites.

Annual MDAs alone decreased the filarial infection load in the community if there were no lapses. However, residual microfilaraemia of 0.4% and antigenaemia positivity of 4.6% were observed even after 36 years of filariasis control in French Polynesia[28]. MDA with DEC drug combination was found to be more effective than DEC alone in decreasing filarial infection variables[29]. Vector control was found to be important during any lapse in the MDA programme[21]. The importance of vector control methods has been emphasized, as they play a key role in the prevention of disease transmission. In China, the campaign against LF turned successful when vector control was integrated with other intervention measures, such as DEC administration (selective and mass treatment, and as fortified salt), resulting in the interruption of filarial transmission without any resurgence.

It seems unlikely that MDA would be sufficient for sustained interruption of transmission in areas of Culex transmission of lymphatic filariasis, due to their high vectorial efficiency[30]. Therefore, vector control would be an important supplement to sustain the interruption of transmission in some epidemiological settings[31]. In Makunduchi, Zanzibar, the Culex mosquito population decreased by about 98% after applying EPS beads to all the wet pit latrines, without any change in a nearby untreated community[17]. One round of MDA with DEC resulted in decreasing the proportion

of mosquitoes with third-stage larvae (L3) causing an overall 99.7% decrease in the number of infective bites per year in the treated area and microfilaraemia remained low for 10 years. Integration of vector control with MDA can decrease the time required for filariasis elimination by complementing the benefits brought about by MDA. Achievement of <100 ATP and <0.5 TII, are considered as levels necessary for preventing the occurrence of new infections[32]. This low transmission level should be maintained for a sufficiently long period to interrupt transmission and it is a more affordable and sustainable way to eliminate filariasis, especially when communities can be empowered to carry out simple vector control operations along with MDA.

Integrated vector control

In Pondicherry, India, in a five year integrated vector control (IVC) programme, various measures were taken to prevent vector breeding included closing of wells, application of expanded polystyrene beads in overhead tanks and sanitation structures. Biological control methods by the release of larvivorous fishes in suitable habitats were also included. In the few areas were chemical larvicides were required, fenthion was chosen in addition to juvenile hormone analogues. After 5 years of IVC, the indoor resting density of Cx. quinquefasciatus was reduced by 90% and the prevalence of microfilaraemia decreased by 60%[14]. An analysis of the costs showed that the integrated control methods compared favourably with control using conventional insecticides. But the withdrawals of the strategy lead to the resurgence of the vector species.

Involvement of Community

Involvement of the community for the success of vector control programmes assumes greater significance as the problem revolves mostly around human and his environment. The individuals, families and the community have to be progressively informed, involved and educated. All vector control programmes should begin with formation of a core or co-ordination committee, comprising of various heads of government agencies and leaders of local society. Public health officials will be concerned with transmitting technical subjects of the programme to these functionaries, who can inspire individuals, families and local leaders to participate actively in the task of elimination of vector breeding in and around their houses, which will ultimately lead to disease (vector-borne) free society. The government should provide the resources to the community leaders, who can arrange for volunteers to accomplish the tasks when individual families cannot. In motivation of community involvement in a local vector control programme, a prime question to be answered is the reason for their involvement in spite of the little time they can spare due to other pressing priorities locally. For community to participate in any programme, their expected role should be spelt out. A continued dialogue is a pre-requisite between the health personnel and the people, aimed at motivation of the attitudes of the community so that people may accept the control programme as the people's programme.

Conclusions

Effective vector control would be important supplementary approach to expedite interruption of transmission and also can sustain the gains of MDAs. It is the most cost-effective option when unit costs of individual case detection and treatment become progressively greater as case numbers decline. Vector control can achieve twin goals of reducing vectorial capacity and minimizing the opportunities for human-vector contact. In India the vector control towards Cx. quinquefasciatus should be appropriately implemented depending on the prevailing local conditions, so as to sustain the control methods employed. Vector control can be made cost-effective by spatial and temporal targeting of the vectors. Community should be empowered to participate from the planning stage itself and education should form the integral part of the vector control strategy. There are a number of challenges for MDA-based LF elimination programmes and these challenges can be met by integrating vector control with MDA. The potential benefits of VC has been spelled out as (i) suppressing LF transmission without identifying individual foci of infection; (ii) minimizing risk of resurgence; (iii) reducing risk of drug resistance; and (iv) enhancing community support by reduced mosquito nuisance[31].

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This write-up has been contributed by Dr. I.P. Sunish, Research Officer, Dr. R. Rajendran, Scientist D, Mr. A. Munirathinam, Technical Officer and Dr. B.K. Tyagi, Scientist F and Officer-in-Charge, Centre for Resarch in Medical Entomology, Madurai.

ICMR NEWS

Dr. V.M. Katoch took over as the First Secretary of the newly created Department of Health Research, Ministry of Health and Family Welfare, Govt. of India and the Director-General of the Indian Council of Medical Research w.e.f. November 18, 2008.

Dr. Katoch, a microbiologist of international repute was earlier working as the Director of the Council's National JALMA Institute for Leprosy and Other Mycobacterial Diseases at Agra. He has contributed significantly in the field of Leprosy, Tuberculosis and HIV/AIDS research. He is a recipient of many prestigious Honours and Awards. Notable among them are ICMR JALMA Trust Fund Oration Award, Dr. C.G. Iyer Oration Award, Ranbaxy Science Foundation Award, Sher-e-Kashmir Shaikh Mohammad Abdullah Oration Award, Dr. S.C. Agarwal Oration Award, etc. He has published more than 170 research papers in journals of International repute.

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The following meetings of various Technical Groups/ Committees of the Council were held:

Meetings of Project Review Group (PRG)/Task Forces (TFs)/ Expert Groups (EGs)/and Other Meeting held at New Delhi

TF on Establishment and Characterization of Cell Basis from Primary Breast Cancer	September 10, 2008
TF on Suicide Behaviour	September 17, 2008
PRG to Review ICMR-INSERM Collaborative Projects in the Field of Cardiovascular Diseases, Diabetes and Neurosciences	October 8, 2008

TF on Urban Mental Health Problems and their Service Needs	October 24, 2008
Meeting on Registry of People with Diabetes in India with Young Age at Onset	November 11, 2008
EG for Formulating the Sub-Sample Study from a Cohort of MIC Patients Registered in 1985	November 19, 2008

Meetings of Project Review Committees (PRCs) held at New Delhi

PRC on Oncology	September 10, 2008
PRC on Geriatrics	September 16, 2008

Participation of ICMR Scientists in Scientific Events

Dr. R.S. Paranjape, Director, National AIDS Research Institute (NARI), Pune, participated in the CAVD CA-MIMC Full Group/ SAB Meeting at Durham (September 5-6, 2008). He also participated in the US-Japan Cooperative Medical Science Programme AIDS Panel Meeting at Awaji Islands, Japan (September 10-12, 2008).

Dr. Samiran Panda, Scientist E, National Institute of Cholera and Enteric Diseases (NICED), Kolkata, participated in the meeting on Research Work related to United Nations Office on Drugs and Crime Project RAS/H13 at Phuentishaling, Bhutan (September 9-15, 2008).

Drs. Byomkesh Manna, T. Ramamurthy and Dipika Sur, Scientists E, NICED, Kolkata, participated in the Investigators Meeting for the Global Enterics Multi Centre Study at Seattle (September 10-12, 2008).

Dr. Mamta Chawla Sarkar, Scientist C, NICED, Kolkata, participated in the III European Influenza Conference at Vilamoura (September 14-17, 2008).

Dr.A.K. Mukhopadhyaya, Scientist C, NICED,Kolkata, visited the Laboratories of Prof. John D. Clemens to Assess Quality Control and Quality Assurance of Laboratories at Pemba and Unguja, Janzibar (September 22-26, 2008).

Dr. R.S. Jadi, Scientist C, National Institute of Virology (NIV), Pune, participated in the XIX Global Meeting and Rubella Laboratory Network Meeting of WHO at Geneva (September 23-25, 2008).

Dr. Pradeep Das, Director, Rajendra Memorial Research Institute of Medical Sciences, Patna, participated in the Meeting of Laboratory Network for the Evaluation and Quality Assurance of Rapid Diagnostic Test for Visceral Leishmaniasis at Antwerp (September 24-26, 2008).

Dr. A.C. Mishra, Director and Dr. N.S. Wairagkar, Scientist E, NIV, Pune, participated in the WHO Influenza Virus Traceability Mechanism Meeting at Ottawa (September 24-26, 2008).

Dr. Sekhar Chakrabarti, Scientist F and Dr. Dipika Sur, Scientist E, NICED, Kolkata, participated in the PDVI Field Site Consortium Investigators Meeting at Jeju Island, Seoul September 25-27, 2008).

Dr. Neena Valech, Scientist F, National Malaria Research Institute (NIMR), Delhi and Dr. S.K. Ghosh, Scientist E, NIMR Field Station, Bangalore; Dr. K. Narain, Scientist D and Dr. K. Rekha Devi, Scientist C, Regional Medical Research Centre (RMRC), Dibrugarh, participated in the XVII International Congress of Tropical Medicine and Malaria at Jeju Island, Seoul (September 29 - October 3, 2008).

Dr. Jyayati Mullick, Scientist D, NIV, Pune, participated in the Sequencing of Avian Influenza Viruses Workshop at Legnaro (September 29 - October 3, 2008).

Dr. G. N. V. Brahmam, Scientist F, National Institute of Nutrition (NIN), Hyderabad, participated in the WHO Consultation on the Dietary Management of Moderate Malnutrition at Geneva (September 30 - October 3, 2008).

Dr. Vrinda V. Khole, Scientist F and Officer-in-Charge, National Institute for Research in Reproductive Health (NIRRH), Mumbai, participated in the Conference on Orphan Mechanisms of Primary Ovarian Insufficiency Passion for Participatory Research at Maryland (October 2-3, 2008).

Drs. M.K. Bhattacharya and T. Ramamurthy, Scientists E, and Dr. A.K. Mukhopadhyaya, Scientist C, NICED, Kolkata, participated in the Meeting of Forum of Research Centres on Infectious Disease at Hanoi (October 6, 2008).

Dr. Beena E. Thomas, Scientist B, Tuberculosis Research Centre (TRC), Chennai, participated in the NIMH Annual Internal Research Conference on the Role of Families in Preventing and Adapting to HIV/AIDS in Providence at Rhode Island (October 6-8, 2008).

Dr. G.B. Nair, Director, NICED, Kolkata, participated in the Diahrroeal Diseases Advisory Committee Meeting at Geneva (October 7-9, 2009).

Dr. Roshan B. Colah, Scientist E, National Institute of Immunohaematology (NIIH), Mumbai, participated in the XI International Conference on Thalassaemia and the Haemoglobinopathies and XIII International TIF Conference for Thalassaemia Patients and Parents at Singapore (October 8-11, 2008).

Dr. Smita Kulkarni, Scientist D, NARI, Pune, participated in the AIDS Vaccine 2008 Conference at Cape Town (October 13-16, 2008).

Dr. N. Arunachalam, Scientist F, Centre for Research in Medical Entomology (CRME), Madurai, participated in the II International Conference on Dengue and Dengue Haemorrhagic Fever Control Network at Phuket (October 15-17, 2008).

Dr.V.M. Katoch, Director, National JALMA Institute of Leprosy and Other Mycobacterial Diseases (NJIL&MOD), Agra, participated in the WHO Workshop on Sentinel Surveillance for Refampicin and Dapsone Resistance at Hanoi, October 20-22, 2008).

Dr. S.M. Mehandale, Scientist F, NARI, Pune, participated in the Executive Committee Meeting of HIV Prevention Trials Network at Arlington (October 21-22, 2008).

Dr.V.D. Ramanatha, Scientist F, TRC, Chennai, participated in the Meeting on Pathogenesis and Control of Emerging Infections and Drug Resistant Organism at Bangkok (October 22-27, 2008).

Dr. M.V. Murhekar and Dr. Vidya Ramachandran, Scientists E and Dr. P. Manickam, Scientist B, National Institute of Epidemiology (NIE), Chennai, participated in the V TEPHINET Global Scientific Conference at Kuala Lumpur (November 1-6, 2008).

Dr.Vas Dev, Scientist E, NIMR Field Station, Guwahati, and Dr. K.V. Singh, Scientist E, Desert Medicine Research Centre (DMRC), Jodhpur, participated in the II International Forum for Sustainable Management of Disease Vectors at Beijing (November 2-4, 2008).

Dr.A.C. Mishra, Director, NIV, Pune, participated in the WHO Meeting on Consultation on Development of Bi-Regional Strategy for Health Laboratories at Manila (November 5-7, 2008).

Dr.P. Vijayachari, Director, RMRC, Port Blair, participated in the International Joint Meeting on Leptospira and Leptospirosis at Manila (November 6-7, 2008).

Dr. Atanu Basu, Scientist D, NIV, Pune, participated in the Workshop on Diagnostic Electron Microscopy in Infectious Diseases at Berlin (November 6-7, 2008).

Dr. R. Ramakrishnan, Scientist E, NIE, Chennai, participated in a Discussion on Ongoing and Future Collaborative Projects with Swiss Tropical Institute at Switzerland (November 10-11, 2008).

Dr. B. Sesikeran, Director, NIN, Hyderabad, participated in the I Plenary Meeting of ISO/TC 34/SC 16 of the Food and Agriculture Sectional Committee, at Rosernan, Chicago (November 11-13, 2008).

Dr. Neena Valecha, Scientist F, NIMR, Delhi, participated in the Technical Expert Group Meeting to Review and upgrade the WHO Guidelines for the Treatment of Malaria at Geneva (November 11-14, 2008).

Dr. Neeru Singh, Director, RMRC for Tribals, Jabalpur, participated in the Expert Group Meeting on Pregnancy Malaria: Diagnosing Infection, Predicting Disease at Annecy (November 13-14, 2008).

Dr. Seema Sahay and Dr. Sheela Godbole, Scientists D, NARI, Pune, participated in the Asian Regional Recruitment Workshop at Bangkok (November 15-16, 2008).

Dr.S.L. Chauhan, Scientist E, NIRRH, Mumbai, participated in the National Training Programme on Youth Friendly Health Services in India at Lund (November 16-22, 2008).

Dr. M.S. Chadha, Scientist E, NIV, Pune, participated in the CDC Influenza Burden Cooperative Agreement Investigators Meeting at Bangkok (November 17-18, 2008).

Dr. Alok Chandra Bharti, Scientist D, Institute of Cytology and Preventive Oncology, NOIDA, participated in the WHO HPV Laboratory Network Meeting at Geneva (November 17-19, 2008).

Dr. N.S. Chatterjee, Scientist D; Drs. R.K. Nandy, Santasabuj Das, and A.K. Mukhopadhyaya, Scientists C, NICED, Kolkata, participated in the XLII US-Japan Cooperative Science Programme on Cholera and Other Enteric Diseases at Fukuoka (November 17-19, 2008).

Dr. R.K. Phukan, Scientist C, RMRC, Dibrugarh, participated in the XXX Annual Scientific Meeting of International Association of Cancer Registries at Sydney (November 17-21, 2008).

Dr.K.D. Ramaiah, Scientist E, Vector Control Research Centre, Pondicherry, participated in the Lymphatic Filariasis Diagnostics Investigators Meeting at Atlanta (November 18-20, 2008).

Dr. A.C. Mishra, Director, NIV, Pune, participated in the X Meeting of the WHO Advisory Committee on Variola Virus Research at Geneva (November 19-20, 2008).

Dr.J.M. Deshpande, Director, Enterovirus Research Centre, Mumbai, participated in the Review of Laboratory Facilities and Work Practices for Accreditation of the Medical Research Institutes at Colombo (November 24-28, 2008).

Dr. D. Balaiah, Scientist F, and Dr. A.R. Pasi, Scientist B, NIRRH, Mumbai, participated in the WHO Workshop on Operations Research at Bangkok (November 24-29, 2008).

Dr. Roshan B. Colah, Scientist F, NIIH, Mumbai, participated in the International Symposium on Haematological Outcomes and Prospects in Thalassaemia Prevention and Care at Rome (November 26, 2008).

Prof. Arvind Pandy, Director, National Institute of Medical Statistics, New Delhi, participated in the II Meeting of the Science/ Technical Advisory Group for the Evidence to Action, HIV and AIDS Data Hub for Asia Pacific at Manila (November 27, 2008).

Training Programmes/Courses/Fellowships:

Dr.J.J. Babu Geddam, Scientist D, NIN, Hyderabad proceeded to participate in the International Course in Health Development at Royal Tropical Institute, Amsterdom for one year w.e.f. September 21, 2008.

Mr.K. Rajendran, Scientist B, NICED, Kolkata, participated in a programme to Promote Collaborative Research in Time-Series of Cholera Epidemics and Training in Time Series Analysis at Sapporo Medical University, Japan (October 17 - November 15, 2008).

Dr. Rashmi Arora and Dr. M. Roy, Scientists F, Dr.Rajni Kaul and Dr. Anju Sharma, Scientist E and Dr. Harpreet Sandhu, Scientist C, ICMR Headquarters and Dr. R. Ramakrishanan, Scientist E, NIE, Chennai, participated in the Training Programme in Bioethics at Germany (October 24 - November 9, 2008).

Dr. M.R. Thakar, Scientist D, NARI, Pune, availed Advanced Mucosal Immunology Training at Dartmouth Medical School, Lebanan, USA for one month (November 1-30, 2008).

Dr.V. Vijayalakshmi Venkateshan, Scientist D, NIN, Hyderabad, availed training on Lelca TCS SP5 Confocal Laser Scan Microscope Imaging System at Manheim, Germany (November 10-14, 2008).

Dr.P.N. Yergolkar, Scientist D, NIV, Pune, availed training on Arboviral Diagnosis Procedures at the Division of Vector-borne Infectious Diseases, US Centre for Disease and Prevention, Fort Collis Clorado (November 3 - 14, 2008). He also received training on Measles/Nipah Diagnois Procedures at CDC Atlanta (November 17-21, 2008).

SUBJECT INDEX

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Printed and Published by Shri J.N. Mathur for the Indian Council of Medical Research, New Delhi
at the ICMR Offset Press, New Delhi-110 029
R.N. 21813/71