82/2110

ISSN 0377-4910

ICMR BULLETIN

Vol. 28, No. 7 July, 1998

# NUCLEAR MEDICINE PRACTICE AND RADIATION DOSES TO PATIENTS IN INDIA : I. STATUS OF NUCLEAR MEDICINE IN THE COUNTRY

In modern clinical practice and medical research, exposures to ionizing radiation are inescapable as they help to provide new insights into the functions of body fabric both in health and disease. Radiation exposures in medicine are predominantly to the individual undergoing diagnosis, screening or therapy. Except in radiotherapy, it is not the aim to deliver a dose of radiation to the patient, but rather to use ionizing radiation to provide diagnostic information. Nevertheless, the radiation dose is given deliberately and it cannot be reduced indefinitely without prejudicising the intended outcome. The detrimental effects of such radiation are well documented[1-4]. Although the exposures in diagnostic radiology are far greater due to rapid growth in recent times, the practice of nuclear medicine also contributes significant doses to the patient population[5,6]. Information on many aspects of nuclear medicine practice for a large number of countries (mainly countries of higher health care–category I) is available. For India, despite the fact that nearly all types of *in vitro* and *in vivo* programmes including basic research and patient service are being carried out in major metropolises, and excellent nuclear medicine facilities exist that are at par with the rest of the world, yet authentic data on the type and frequency of nuclear medicine investigations and on the resultant radiation dose, are very sparse. Further, the frequency and total medical irradiation is expected to increase over the next decades due to the growth of population and urbanization particularly in countries like India. Such a deficiency or lack of data was also pointed out in the earlier report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1988)[5]. To supplement the available data on medical radiation exposure statistics, UNSCEAR undertook a survey in 1990-91 of medical radiation usage and exposures world-wide. Due to the efforts initiated by the Division of Radiological Protection, Department of Atomic Energy, Government of India, some useful and much needed information was provided for the Indian scenario (UNSCEAR 1993)[6]; however, it was far from adequate[7]. Keeping in view the deficiency of the data and its necessity in health planning in the country, the Indian Council of Medical Research sponsored a project on Nuclear Medicine Practice and Radiation Doses to Patients in India with the objectives to (i) compile data on various aspects of nuclear medicine practice in the country with the help of a broad based questionnaire; (ii) estimate effective dose (that reasonably reflects the health risk associated with radiation exposures) due to some selected and widely used nuclear medicine investigations carried out in the country; and (iii) transform these estimated radiation effective doses (that are true for an ICRP reference man that is a

Division of Publication & Information, ICMR, New Delhi - 110029

596
26/9/98

Caucasian and a Western European or North American in habitat and customs) to an average Indian.

The findings of this study will be presented in a series of articles. This write-up provides information collected with reference to the first objecting of the study.

Nuclear medicine is that field of medical practice in which unsealed radioactive substances are used for diagnosis, therapy and clinical research. Diagnosis that is the major part of this discipline involves two approaches *viz* (i) *in vivo* studies in which radioactive substances are administered to the patient either to evaluate the functioning of an organ or to provide an image of it and employs, as a rule, radionuclides with short half lives. Information on the amount of radioactivity employed in various diagnostic nuclear medicine procedures carried out at different centres in the country, and the resultant radiation doses to patients was collected; (ii) *in vitro* methods, in which body fluids or tissues are analysed by radioimmunoassay or allied techniques. In these methods, radioactive substances are not administered to the patient and therefore do not contribute to his/her radiation dose. However, being important constituent of nuclear medicine procedures, information on this aspect of nuclear medicine was also collected.

**Data Collection**

Basic information on the nuclear medicine centres of the country was collected using a broad based, closed ended and exhaustive questionnaire. It was designed to elicit information on the nature and structure of the nuclear medicine centres, their staffing pattern, types of available instrumentation and investigations carried out, nature and amount of radioactive material used in each investigation, the existing radiation protection, human resource development as well as waste disposal system. Information was also solicited regarding the gender and age distribution of the patients. The questionnaire was sent repeatedly to the heads of various nuclear medicine centres, and was also published twice in the Indian Journal of Nuclear Medicine[8,9].

**Nuclear Medicine Centres**

A total of 120 centres or clinics situated in 45 cities were stated to be functioning where *in vivo* and *in vitro* nuclear medicine was practiced, however, only 102 centres could be contacted. It was observed that although such centres/clinics were located through out the country, their spatial distribution was very uneven. Slightly less than half the centres were located in Mumbai, Calcutta, Delhi and Chennai. Table I gives the list of cities where four or more nuclear medicine centres/clinics are located.

**Table I : The cities where four or more nuclear medicine centres/ clinics are located (data upto 1996).**

| City | Number of nuclear medicine centres | % of the total centres |
|---|---|---|
| Mumbai | 17 | 16.7 |
| Calcutta | 13 | 12.7 |
| Delhi | 11 | 10.0 |
| Chennai | 7 | 6.9 |
| Cuttack | 5 | 5.0 |
| Hyderabad | 5 | 5.0 |
| Chandigarh | 4 | 4.0 |
| Bangalore | 4 | 4.0 |
| Other cities(32) | 36 | 35.2 |

Of the 102 centres contacted, 58 situated in 28 cities responded. These centres were well distributed through out the country. Of these, 14 were government institutions, 19 were government aided and the rest (25) were in the private sector. Chronological analysis of this limited data was suggestive of the trend that in recent times, growth of private medical institutions with nuclear medicine facilities had been faster in comparison to either government aided or government hospitals, however, the possibility of a better response selectively from private centres could not be ruled out. In the event that, this conclusion is confirmed on further studies and taking cognizance of the fact that most such medical institutions do not have a full time radiological safety officer on the staff, the apprehension, that under excessive patient load and working stress, radiation safety may be compromised, should be considered seriously. This apprehension was confirmed by a recent incident which occurred in one of the fairly large hospitals situated in the capital.

The available data showed that at 23 medical institutions (mostly in metropolises), independent nuclear medicine departments were carrying out the work. The patient is seen directly or is referred by other departments and hospitals for special investigations. In all such places, the department was headed by a professor or a consultant and on an average there were 7 persons (5-11) in the department. The average investigations carried out at these places were 1100 (500-1600) per month. At 20 other places, the departments were part of the radiotherapy and oncology, radiology, pathology or medicine departments. The departments headed by an associate professor or a consultant had on an average 4(3-6) persons and each gave service to about 450 patients per month. The remaining 15 centres (or clinics) were manned either by a single trained person or by one whole time trained clinician and one or two part

time workers and each clinic, it was claimed, provided service to about 200 patients per month.

*In vivo* investigation for thyroid disorders were carried out at all the centers – small or large. More than 50% of thyroid investigations were carried out using reactor produced radioactive iodine (Iodine - 131). In 26 centres (mostly in metropolises) the use of Iodine-131 has progressively decreased and due to many attractive features, most of such and other investigations are carried out using Technetium-99m and Technetium-99m based radiopharmaceuticals. In the centers for which the information was available, 87% of nuclear medicine *in vivo* investigations were carried out using Iodine-131 and Technetium-99m based radiopharmaceuticals. The other isotopes used at these centers for *in vitro* and for other clinical/research activities were Chromium-51, Thallium-201, Iodine-125, Phosphorus-32 Gallium-67 and Selenium-75. Thallium-201 and some Technetium-99m based radiopharmaceuticals for renal and cardiac studies were imported and the rest of the radioactive substances and radiopharmaceuticals were procured from local sources. None of the centres provided information on the use of Indium-111 although application of the radionuclide has been mentioned in a few publications. Organ imaging which accounted for more than 85% of administration of radioactive material to patients was a routinely performed investigation in the country. The most frequent radioimaging procedures that are being carried out in the country are for the thyroid (59%), kidneys (13%), heart (9%), bones (6%), brain (4%), liver and blood vessels (3% each) and lungs, GIT tumours/abscesses (1% each). Data obtained on *in vitro* studies were not adequate except to demonstrate that radioimmunoassay tests pertaining to thyroid disorders were far greater in number in comparison to other investigations.

**Instrumentation**

As per information, 75 gamma cameras and gamma cameras with single photon electrical computer tomography (SPECT) facilities were operating in the country, however, detailed information could be obtained for 45 gamma cameras and gamma cameras with SPECT facilities that were located in 21 centers. Besides thyroid disorder investigations, renal function tests, cardiac function studies, bone scanning and hepatobiliary and pulmonary investigations were also performed. Here the consumption of unsealed radioactive substances at each centre exceeded 500 mCi per month. The dose to a patient was so calculated that the dose per kg body weight remained more or less constant. At 17 places only thyroid disorders studies and renal function tests were carried out using rectilinear scanner and thyroid uptake system. Here the consumption of radioactive material was between 100-500 mCi per month at each centre. At the remaining 18 centres, the patient investigations were confined to thyroid disorders and the activity of radionuclide varied from 2-6 mCi per month at each center. At all the centres *in vitro* tests were carried out using the standard radioimmuno-kits supplied either by Board of Radiation and Isotope Technology (BRIT) or by other companies.

Despite the fact that the Electronic Corporation of India Ltd (ECIL) has been functioning for the last three decades and has the mandate to develop and market nuclear medicine instruments in the country, yet its market presence for such instrumentation is very small. Most of the instruments used in private hospitals for clinical investigations, were imported. In all the places such instruments were placed in air conditioned areas. Quite a few government hospitals and government aided hospitals had imported as well as indigenous equipment. Regarding the equipment, the general complaint had been that (i) the supply schedule was hardly maintained and the instrument never became functional in time, and (ii) service facilities (except in a very few selected cities) were generally not good.

On account of the stringent stipulations of the Directorate of Radiation Protection, Bhabha Atomic Research Center, Mumbai, at all the places for which data were available at present, a good radiation protection system was operational. Each centre that responded had at least one person trained in radiation protection procedures and was covered under Thermo-luminiscence Dosimetry (TLD)/ Film Badge type personnel monitoring. In addition, the centres had survey meters, contamination monitor, adequate waste disposal system and facilities required to meet radiation emergencies. However, the in-house training programmes were not very popular. The lack of such programmes affects radiation hazard awareness of the workers and perhaps might be one of the causative factors for the radiation incident that occurred in one such centre in the capital.

In all, based on 6 radionuclides, 20 radiopharmaceuticals were being used in the country (Table II). At 13 places radiopharmaceuticals were prepared at the centre sites and some preparations were imported for medical and clinical research. Thallium-201 and some Technetium-99m based radiopharmaceuticals for renal, cardiac and cerebral studies were invariably imported. At the other places, radioactive diagnostic agents were procured

from the Regional Radiopharmaceutical Centers of the BRIT, Department of Atomic Energy or directly from BRIT.

**Table II : Radiopharmaceuticals used in the country (data upto 1996)**

| | |
|---|---|
| 131 I-Sodium Iodide | 99mTc-large colloid (sulphur colloid) |
| 99m Tc pertechnetate | 99mTc DMSA |
| 99m Tc DTPA | 99mTc IDA |
| 99m Tc glucohaptonate | 51Cr EDTA |
| 99m Tc HAS | 99m Tc HMPAO* |
| 99m Tc phosphonate | 67 Ga citrate* |
| 131-I-hippuran | 99m Tc MAG3* |
| 201 Tl chloride | 99m Tc MIBI* |
| 99m Tc MAA | 75 Sc methionine* |
| 99m Tc RBC | 99m Tc denatured RBC |

* Use of these radiopharmaceuticals was restricted to only a few centres due to their limited availability and prohibitive cost.

## Conclusions

About 35,000 nuclear medicine *in vivo* investigations were being carried out per month at 58 centres located in 28 cities in the country, with slightly less than 50% of them being located in the four metropolises. Examination pertaining to thyroid disorders were carried out by all centres, however, in the metropolises, excellent facilities existed or were being build up to cahrry out the full spectrum of *in vivo* and *in vitro* nuclear medicine investigations. There appeared to be a rapid expansion of the facilities in the private sector. All the centres about which the information was available, had good radiation safety facilities for patients as well as for staff. Most of the centres used imported instruments and indigenous radiopharmaceutical preparations. None of the centres provided any worthwhile data on the distribution of patients as a function of age, sex and socio-economic status.

## References


1. National Academy of Sciences. *Health Effects of Exposure to Low Levels of Ionizing Radiation.* BEIRV. Report National Academy Press, Washington, DC 1990.
2. *Report of the National Institutes of Health Ad Hoc Working Group to Develop Radioepidemiological Tables.* NIH Publication No. 85-2748. US Department of Health and Human Services, Washington DC 1985.
3. Upton, A.C. Risk estimates for carcinogenetic effects of irradiation . *Ann ICRP 22* : 1, 1991.
4. Smith, H. The detrimental health effects of ionizing radiation. *Nucl Med Commun 13(4):* 10, 1992.
5. UNSCEAR. *Sources, Eeffects and Risks of Ionizing Radiation.* Report to the General Assembly with Annexes. United Nations, New York, 1988.
6. UNSCEAR. *Sources and Effects of Ionizing Radiation.* Report to the General Assembly with Annexes. United Nations, New York, 1993.
7. Gupta, M.M., Nagaratnam, A., Jain, S.C. and Reddy, A.R. Nuclear medicine practice and radiation exposure therefrom : A synoptic view of world-wide scenario (summary of UNSCEAR 1993 data) *Indian J Nucl Med 10* : 145, 1995.
8. Gupta, M.M. Questionnaire to gather information about NM facilities in India. *Indian J Nucl Med 8* : 118, 1993.
9. Gupta, M.M. Questionnaire to gather information about NM facilities in India. *Indian J Nucl Med 10* : 227, 1995.


(To be contd.)

# ABSTRACTS

## Some Research Projects Completed Recently

**Effects of apolipoprotein E polymorphism on the lipid and lipoprotein levels related to risk for cardiovascular disease.**

The study was carried out on unrelated individuals of Kshatriya (182) and Mala (38) communities from Andhra Pradesh to identify the apolipoprotein (apo) E genotypes and allele frequencies in these population.

Among the Kshatriya, five apo E genotypes (3/3, 3/4, 3/2, 4/2 and 4/4) were observed in males and (3/3, 3/4 and 3/2) in females. But in Mala population only three genotypes (3/3, 3/4 and 3/2) were observed in both the sexes. There was no significant gender differences in the frequencies of apo E genotypes in both the populations as well as between two population groups. The 4/2 and 4/4 genotypes were found to be less frequent and observed only among 2 individuals each (missing in female Kshatriya and both sexes in Mala). The gene frequencies of the three alleles designated apo $\Sigma$ 2, $\Sigma$ 3 and $\Sigma$ 4 for the Kshatriya (male and female pooled together) were

0.0522, 0.8516 and 0.0962 and for Malas 0.0395, 0.9210 and 0.0395 respectively. Gene frequencies for three alleles for the pooled population of Kshatriya and Malas were 0.0500, 0.8636 and 0.0864 respectively.

In the apo E genotypes, the apo E 4 homo or heterozygotes showed higher levels of cholesterol compared to other genotypes. The influence of each of the three common apo E alleles ($\Sigma$ 2, $\Sigma$ 3, $\Sigma$ 4) on cholesterol and HDL cholesterol levels was evaluated by the test o f average allelic effects. The $\Sigma$ 2 and $\Sigma$ 4 alleles showed lowering and elevating effects respectively on cholesterol levels. But there was no evidence for a consistent relationship between apo E genotypes and HDL cholesterol. The study also supports the assumption that lower $\Sigma$ 4 frequency may be associated with lowered risk of cardiovascular disease in rural population.

P. Venkatramana
P. Chengal Reddy
Deptt. of Anthropology
S.V. University
Tirupati.

**Study of the natural history and seizure outcome in patients with solitary cysticercus granuloma and seizure.**

A prospective study was carried out in 183 patients with seizures to determine the natural history of solitary cerebral cysticercus granuloma (SCG) and seizure outcome after the resolution of the granuloma and simultaneous or early withdrawal (2 to 3 months after resolution) of antiepileptic drugs. Only those patients who fulfilled all the diagnostic criteria (clinical and computerised tomographic for SCG) were included in the study.

One hundred and twenty nine (70.5%) patients presented with partial seizures with or without secondary generalization, 53 (29%) with generalized seizure and 1 (0.5%) with partial complex seizure. Of these, 78.1% patients had 5 or less seizures, 16.9% had 6-10 and 4.9% >10 seizures at initial presentation. Most of the patients had their initial CT scan within one month of their first ictus. Majority (93%) of patients could be managed with a single antiepileptic drug (monotherapy). Breakthrough seizures occurred in 30 (16.4%) patients who needed increased dose of the drug or an additional drug.

ELISA for cysticercus antibodies in serum was of limited value as it was found to be negative in a majority of patients. The CT lesions were typically between 5-15 mm in maximal dimension and were usually associated with mild to moderate oedema. The parietal lobe was the most favoured site of lodgement of the granuloma.

SCG was found to have a varied natural history and the granulomas resolved spontaneously though at different rates in individual patients. Kaplan Meier analysis of lesion resolution in the present study showed that at 3 months after first CT scan, 96.7% patients had persistent granulomas (though smaller in size in nearly 40% patients), at 6 months 75.5% patients and even after 12 months 46.5% patients had persistent granulomas.

The shortest period recorded for the resolution of lesion was 64 days after the initial CT scan whereas the longest duration of a persistent lesion seen in the CT scan was 429 days. Antiepileptic drugs were withdrawn within 2-3 months, after resolution of granuloma was seen on the CT scan. Of the 60 patients who could be followed up after withdrawal of the drugs (median follow up period 10 months), 57 were symptom free, and recurrence of seizures was noted in 3 patients at 3 to 10 months after withdrawal of drugs.

It can be concluded that SCG, a common cause of seizures in Indian patients, is a spontaneously resolving lesion with a variable rate of involution ranging from weeks to a year or more. The first follow up CT scan can be delayed for up to 6 months to decrease the number of scan examinations. Patients with SCG generally have a benign seizure prognosis and the antiepileptic drugs can be withdrawn after resolution of granuloma. However, a longer follow up is necessary to arrive at a definite conclusion regarding the long-term seizure outcome in these patients.

V. Rajshekhar
Department of Neurosurgery
Christian Medical College
Vellore

# ICMR NEWS

**Meetings of the Project Review Committee (PRC)/Task Force (TF) held at New Delhi:**

| | |
|---|---|
| PRC on Oncology and Pathology | June 30, 1998 |
| TF on Control Programme for Thalassaemia by Antenatal Screening | July 13, 1998 |

**Participation of ICMR Scientists in Scientific Events:**

Dr. A. Roy Chowdhury, Dy. Director, Regional Occupational Health Centre, Calcutta, participated in the XXV National Work Medicine Conference at Strasbourg (June 23-26, 1998).

Dr. Srikanth Tripathy, Asstt. Director, National AIDS Research Institute, Pune, and Dr. M.A. Khan, Sr. Research Officer, Institute of Cytology and Preventive Oncology, New Delhi, participated in the XII World AIDS Conference at Geneva (June 28 - July 3, 1998).

Dr. K. Satyanarayana, Director and Dr. B.V. Babu, Sr. Research Officer, Regional Medical Research Centre, Bhubaneswar and Dr. K.D. Ramaiah, Sr. Research Officer, Vector Control Research Centre, Pondicherry, participated in the data analysis meeting of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases, on community directed treatment of filariasis (Phase I studies) at Pune (July 10-18, 1998).

# ICMR AIDED SYMPOSIA/SEMINARS/WORKSHOPS/COURSES/CONFERENCES

| Symposium/Seminar/Workshop/ Course/Conference | Date & Place | Contact Address |
|---|---|---|
| International Symposium on Frontiers of Genetics and Development | July 7-8, 1998; (at Bangalore) | Dr. U. Vijayaraghavan, Convenor of the Symposium, Department of Microbiology and Cell Biology, Indian Institute of Science, Bangalore-560012. |
| International Symposium on Temporomandibular Joint Disorders and Chronic Orofacial Pain | October 30-31, 1998; (at Mangalore) | Prof. P.K. Dayal, Organising Secretary of the Symposium, KMC College of Dental Surgery, Mangalore-575001. |
| Symposium on Current Trends in Autoimmune Diseases Immunology | October 30-31, 1998; (at Lucknow) | Prof. S. Naik, Department of Immunology, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow-226014. |

# COUNCIL'S TRAINING PROGRAMMES FOR 1998-99

**Leprosy**

*At the Central JALMA Institute for Leprosy, Agra:*

- Multidrug Therapy Orientation Course in Leprosy for Medical Officers (August 17-28, October 26-November 6; and December 7-18, 1998).

**Virology**

*At the National Institute of Virology, Pune:*

- Diploma in Medical Virology (July 1998-May 1999).

**Reproductive Biology**

*At the Institute for Research in Reproduction, Mumbai:*

- Workshop on Andrology for Clinicians (November 16-30, 1998)

**Endocrinology**

*At the National Institute of Nutrition, Hyderabad:*

- Annual Certificate Course on Endocrinological Techniques and their Applications (August 1-September 15, 1998).

**Nutrition**

*At the National Institute of Nutrition, Hyderabad:*

- Postgraduate Certificate Course in Nutrition (December 1, 1998-February 28, 1999).

**Occupational Health**

*At the National Institute of Occupational Health, Ahmedabad:*

- Training Course on Environmental Hygiene Practice (November 16-20, 1998).

**Medical Entomology**

*At the Vector Control Research Centre, Pondicherry:*

- Postgraduate Diploma Course in Medical Entomology (from August 10, 1998).

**Biomedical Statistics**

*At the Institute for Research in Medical Statistics, Chennai:*

- Basic Course in Statistics for Postgraduate Medical Students (July 1998).
- Basic Course in Statistics for Medical Officers (November 1998).

**Haematology**

*At the Institute of Immunohaematology, Mumbai:*

- Training Course in Transfusion Medicine for Blood Bank Medical Officers (August 11-October 9, 1998).
- Training Course in Blood Group Serology and Blood Bank Methodology for Blood Bank Technicians (August 11-September 10, 1998).
- Training Course in Advanced Haematology and Immunohaematology (September 21-October 9, 1998).

## ICMR PUBLICATIONS

| | *Price(Rs.)* Indian |
|---|---|
| Nutritive Value of Indian Foods (1985) by C. Gopalan, B.V. Rama Sastri and S.C. Balasubramanian, Revised and Updated (1989) by B.S. Narasinga Rao, Y.G. Deosthale and K.C. Pant (Reprinted 1996) | 23.00 |
| Growth and Physical Development of Indian Infants and Children (1972, Reprinted 1989) | 10.00 |
| Studies on Weaning and Supplementary Foods (1974, Reprinted 1996) | 15.00 |
| A Manual of Nutrition (Second Edition 1974, Reprinted 1995) | 6.00 |
| Low Cost Nutritious Supplements (Second Edition 1975, Reprinted 1994) | 4.00 |
| Menus for Low-Cost Balanced Diets and School-Lunch Programmes Suitable for North India (Second Edition 1977, Reprinted 1994) | 4.50 |
| Menus for Low-Cost Balanced Diets and School-Lunch Programmes (Suitable for South India) (Fourth Edition 1996) | 6.00 |
| Some Common Indian Recipes and their Nutritive Value (Fourth Edition 1977, Reprinted 1995) by Swaran Pasricha and L.M. Rebello | 10.00 |
| Nutrition for Mother and Child (Fourth Edition 1994, Reprinted 1996) by P.S. Venkatachalam and L.M. Rebello | 11.00 |
| Japanese Encephalitis in India (Revised Edition 1980) | 5.00 |
| Some Therapeutic Diets (Fifth Edition 1996) by Swaran Pasricha | 7.00 |
| Nutrient Requirements and Recommended Dietary Allowances for Indians (1990,Reprinted 1995) | 16.00 |
| Fruits (Second Edition 1996) by Indira Gopalan and M. Mohan Ram | 20.00 |
| Count What You Eat (1989, Reprinted 1997) by Swaran Pasricha | 15.00 |

| | |
|---|---|
| *The Anophelines of India (Revised Edition 1984) by T.Ramachandra Rao | 150.00 |
| Depressive Disease (1986) by A. Venkoba Rao | 58.00 |
| *Medicinal Plants of India Vol.2 (1987) | 136.00 |
| Diet and Diabetes (Second Edition 1993, Reprinted 1997) by T.C. Raghuram,Swaran Pasricha and R.D. Sharma | 18.00 |
| Dietary Tips for the Elderly (1992, Reprinted 1997) by Swaran Pasricha and B.V.S. Thimmayamma | 5.00 |
| Diet and Heart Disease(1994,Reprinted 1995) by Ghafoorunissa and Kamala Krishnaswamy | 26.00 |
| Dietary Guidelines for Indian – A Manual (1998) | 23.00 |
| पोषण नियमावली (द्वितीय संस्करण 1974, पुनर्मुद्रण 1990) | 6.00 |
| अपने आहार को जानें (1997) | 9.00 |

* 25 per cent discount allowed to individuals

These publications are available on prepayment of cost by cheque, bank draft or postal order (bank and postal charges will be extra) in favour of the Director-General, Indian Council of Medical Research, New Delhi. Money orders are not acceptable. All correspondence in this regard should be addressed to the Chief, Division of Publication and Information, Indian Council of Medical Research, Post Box No.4911, Ansari Nagar, New Delhi-110029 (India).


## EDITORIAL BOARD

**Chairman**
Dr. N.K. Ganguly
Director-General

**Members**
Dr. Padam Singh
Dr. Bela Shah
Dr. Lalit Kant
Dr. R. Ravi
Dr. V. Muthuswamy

**Editor**
Dr. N. Medappa



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