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NUCLEAR MEDICINE PRACTICE AND RADIATION DOSES TO PATIENTS IN INDIA : PART II. RISK RELATED RADIATION DOSES TO PATIENTS

The decay of radionuclides following their administration to patients leads to deposition of energy within various organs, tissues, cells and subcellular fractions. The calculation of the absorbed dose, has therefore, been an important activity in nuclear medicine and forms the primary basis of any form of risk assessment for diagnostic nuclear medicine procedures[1,2]. Besides the health risk(s) involved, such dose estimation also helps to determine the amount of radionuclide that should be administered to patients during routine procedures. Some dosimetric quantities and concepts are given in the Appendix.

The Medical Internal Radiation Dose (MIRD) Committee of the American Society of Nuclear Medicine has developed the method of estimating organ absorbed dose which is generally referred to as MIRD Scheme[3]. This system of dose estimation assumes that the distribution of radionuclide in the organ/tissue of interest is uniform and that particulate radiation (beta and other electrons) are isotropic in their distribution and have ranges that are larger relative to typical cell diameters. Such conditions may not be always strictly true[4], however, for most of the dosimetric purposes, MIRD scheme has given valuable data on absorbed dose estimation in most of the clinical situations. For the present study, the age-dependent absorbed dose coefficient values (S-factor values) as given in ICRP Publications[5,6] for various radiopharmaceuticals, have been utilized.

Effective dose (*ie* risk related radiation dose) estimation requires reliable information on S-factor values for all the organs and radiopharmaceuticals of interest, suitable tissue/organ weighting factor values and appropriate procedures for the dose estimation. There have been only marginal changes in the S-factor or absorbed dose coefficient values for the organs/tissues of interest for most of the radiopharmaceuticals, with a few exceptions like when a new organ or biokinetic model was accepted[7] or when some discrepancies in values of basic data had occurred[8,9]. However, significant modification had been effected in the tissue weighting factor values and in the methodology of effective dose computation from the earlier recommendations of the International Commission on Radiological Protection[10]. For the present study, the values of tissue weighting factor as given in ICRP 1990[11] have been used.

The effect of the new tissue weighting factor values on the effective dose (earlier known as effective dose equivalent) due to a large number of radiopharmaceuticals, has been studied extensively[12-19] and it was observed that in case of radiopharmaceuticals used in India, either the

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effective doses had remained unchanged or had become 10-16 % lower than the previous values. On further scrutiny some discrepancies in the procedures recommended[11] for effective dose estimation, were noticed. These discrepancies and the problems that resulted by following these recommendations have been highlighted[20,21] and a new modified methodology suggested[22]. The modified methodology was further updated incorporating subsequent ICRP recommendations[23] and used for effective dose estimations. The salient features of the methodology are:

(i) Wherever the mean absorbed dose coefficients to an organ/tissue and the explicit value of tissue weighting factor assigned to it, are available, the contribution of the organ/ tissue to the effective dose is computed in the standard procedure recommended in ICRP 1990[11].

(ii) Since relative masses of the walls of the upper large intestine (ULI) and lower large intestine (LLI) are independent of age, the equivalent dose to colon – Hcolon is given as in ICRP 1995[23].

$$Hcolon = 0.57\ H_{ULI} + 0.43\ H_{LLI}$$

(iii) Tissue weighting factor value assigned to gonads is allotted to testes or ovaries which ever is getting higher equivalent dose (ICRP 1995)[23].

(iv) Tissue weighting factor values assigned to the oesophagus and skin (for which age dependent absorbed dose coefficient for many radiopharmaceuticals used in India are not available) are considered to be part of the remainder.

(v) The remainder tissue weighting factor is thought of as consisting of 0.05[11] plus 0.05 (weighting factor value of oesophagus) plus 0.01 (weighting factor value of skin). Thus the total remainder tissue weighting factor is 0.11 which is to be apportioned as per guidelines (ICRP 1995)[23]. Half the total remainder weighting factor *ie* 0.055.is assigned to any of the remaining organs/tissues that receives the highest equivalent dose of all organs, and the other half to the mass average committed equivalent dose in the rest of the remainder tissues and organs.

Using this methodology, the effective doses for a large number of radiopharmaceuticals were calculated[18,24,25]

Risk Related Radiation Dosimetry

About 35,000 nuclear medicine *in vivo* investigations were found to be performed per month at 58 centres located in 28 cities in the country. Investigations varied from simple thyroid uptake tests to sophisticated nuclear medicine procedures. The amount of radioactivity used for an investigation varied within wide limits from centre to centre, however, the amounts seldom exceeded the limits set by ARSAC[26]. The list of radiopharmaceuticals and the range of radioactivity used for commonly performed imaging procedures in the country is given in Table I. Risk related radiation dosimetry was carried out for these radiopharmaceuticals.

Table I. Radiopharmaceuticals and range of radioactivity used for commonly performed imaging procedures in the country (data upto 1996)

Radiopharmaceutical	Use	Activity (MBq)
^{99m}Tc Pertechnetate	Thyroid imaging	40-400
	First pass study	700
	Brain scanning	500-1200
^{99m}Tc DTPA	Aerosol ventilation	40
	Cisterography	70-250
	Renal imaging	200-750
	Brain imaging	350-750
^{99m}Tc Gluconate	Renal imaging	200-750
Glucoheptonate	Brain imaging	350-750
^{99m}Tc HMPAO	SPECT cerebral studies	550
^{99m}Tc HSA	Blood pool studies	500-900
^{99m}Tc large colloid	Bone marrow	200-350
(Sulphur colloid)	Liver studies	200-350
^{99m}Tc DMSA	Renal imaging	200
^{99m}Tc Phosphates	Bone imaging	500-1000
^{99m}Tc RBC	MUGA	500-900
^{99m}Tc MAA	Lungs perfusion	80
	Venogram	200-350
^{67}Ga Citrate	Tumour imaging	200
^{131}I Hippuran	Renal imaging	55-75
^{201}Tl Chloride	Myocardial perfusion	50-100
^{131}I Sodium iodide	Thyroid uptake	0.50
	Thyroid imaging	2.0
^{99m}Tc MAG_3	Renal imaging	200-750
(normal kidney function)		
^{99m}Tc denatured RBC	Spleen imaging	200-350
^{99m}Tc MIBI	Myocardial perfusion	500-1000
^{99m}Tc IDA	Hepatobiliary system	150-350
^{51}Cr EDTA	Renal studies	2.0
^{75}Sc Methionine	Pancreas imaging	4.0

MUGA : Multigated Acquisition

Age dependent effective dose coefficients calculated by indigenously developed modified dosimetry approach for the radiopharmaceuticals of interest are presented in Table II. It shows that most of the nuclear medicine

investigations employing Tc-99m and Tc-99m based radiopharmaceuticals result in effective doses to patients of the order of millisievert or less. As different investigations employ different amounts of radioactivity, therefore, for calculating effective dose to the patient, these effective dose coefficients have to be multiplied by the actual amount of radioactivity (in MBq) used in the particular nuclear medicine investigation. The Table also shows that as the age of the patient increases, the effective dose coefficient decreases. This implies that for the same amount of administered activity, a one year old child may receive a higher effective dose (3 to 10 times) and therefore, may be at a higher risk of radiation detriment in comparison to an adult. The situation warrants greater care while carrying out nuclear medicine investigations in children.

A comparison has been made (Table III) of the effective dose coefficient values as calculated by the modified methodology and as given by ICRP[6] for adults for radiopharmaceuticals used in India. The Indian values of effective dose coefficients are higher by about 10% (5-20%) than the values given by ICRP[6]. One of the reasons for lower ICRP values may be the ambiguous manner in which the remainder of tissue weighting factor and doses to remainder tissues or organs are treated. The values based on the modified method are in closer agreement with the ICRP values of 1987[5] where the procedure for dose computation is more straight forward.

Each nuclear medicine diagnostic investigation results in different effective dose to patients. In general, investigations employing Tc-99m and Tc-99m based

Table II. Age dependent effective dose coefficients for some radiopharmaceuticals used in the country calculated by the modified approach[22].

Radiopharmaceutical	Effective dose coefficient (mSv / MBq)				
	Adult	15 year	10 year	5 year	1 year
^{99m}Tc Pertechnetate (no blocking agent)	14.77 E-03	18.74 E-03	30.50 E-03	49.20 E-03	89.41 E-03
^{99m}Tc DTPA	5.57 E-03	6.9 E-03	10.35 E-03	14.78 E-03	26.66 E-03
^{99m}Tc Gluconate Glucoheptonate	6.01 E-03	8.41 E-03	12.31 E-03	18.29 E-03	31.52 E-03
^{99m}Tc HMPAO	10.10 E-03	13.45 E-03	19.30 E-03	30.29 E-03	54.43 E-03
^{99m}Tc HSA	7.08 E-03	8.86 E-03	13.54 E-03	20.60 E-03	36.95 E-03
^{99m}Tc large colloid (Sulphur colloid)	10.16 E-03	16.21 E-03	24.49 E-03	37.37 E-03	66.65 E-03
^{99m}Tc DMSA	10.28 E-03	17.66 E-03	25.08 E-03	36.35 E-03	62.59 E-03
^{99m}Tc Phosphates Phosphonate	6.14 E-03	7.85 E-03	11.74 E-03	18.50 E-03	35.46 E-03
^{99m}Tc Erythrocytes	7.49 E-03	9.41 E-03	14.4 E-03	21.99 E-03	39.99 E-03
^{99m}Tc MAA	11.68 E-03	16.60 E-03	23.92 E-03	35.79 E-03	66.34 E-03
^{67}Ga Citrate	10.36 E-02	13.34 E-02	21.08 E-02	34.11 E-02	65.92 E-02
^{131}I Hippuran	55.33 E-03	69.08 E-03	103.43 E-03	160.12 E-03	304.68 E-03
^{201}Tl Cloride	24.74 E-02	41.0 E-02	22.23 E-01	26.95 E-01	39.52 E-01
^{131}I Sodium iodide (5% uptake)	37.34 E-01	56.66 E-01	87.55 E-01	18.91 E+00	34.80 E+00
^{131}I Sodium iodide (45% uptake)	32.15 E+00	50.20 E+00	75.30 E+00	16.6 E+01	30.60 E+01
^{99m}Tc labelled citrate complex	8.03 E-03	9.87 E-03	14.41 E-03	20.98 E-03	36.85 E-03
^{99m}Tc MAG_3 (normal kidney function)	7.37 E-03	9.38 E-03	11.66 E-03	12.34 E-03	21.12 E-03
^{99m}Tc denatured RBC	36.47 E-03	49.87 E-03	76.48 E-03	11.43 E-03	20.01 E-03
^{99m}Tc aerosol (DTPA)	6.49 E-03	8.59 E-03	12.4 E-03	18.14 E-03	33.05 E-03
^{99m}Tc MIBI	9.58 E-03	12.51 E-03	19.12 E-03	30.34 E-03	57.36 E-03
^{99m}Tc IDA	19.58 E-03	23.44 E-03	36.57 E-03	58.16 E-03	1.30 E-03
^{51}Cr EDTA	1.96 E-03	2.55 E-03	3.75 E-03	5.69 E-03	10.18 E-03
^{51}Cr Platelets	2.20 E-02	3.08 E-02	4.69 E-02	7.29 E-02	13.62 E-02
^{75}Se methionine	2.85 E+00	3.59 E+00	5.39 E+00	8.02 E+00	14.05 E+00

Superscript no. refers to the serial no. in the reference list.

Table III. Comparison of effective dose coefficient values as calculated by modified methodology[22] and as given by ICRP (ICRP 1992)[6] for adults for radiopharmaceuticals used in India.

Radiopharmaceutical	Effective dose coefficient mSv/MBq		$\frac{B-A}{B} \times 100$
	ICRP (A)	Indian values (B)	
^{99m}Tc Pertechnetate (no blocking agent)	1.4 E-02	14.77 E-03	5.2
^{99m}Tc DTPA	5.2 E-03	5.57 E-03	6.6
^{99m}Tc Gluconate	5.4 E-03	6.01 E-03	10.1
Glucoheptonate			
^{99m}Tc HMPAO	9.3 E-03	10.10 E-03	7.9
^{99m}Tc HSA	6.1 E-03	7.08 E-03	13.8
^{99m}Tc large colloid (Sulphur colloid)	9.2 E-03	10.16 E-03	9.4
^{99m}Tc DMSA	8.7 E-03	10.28 E-03	15.4
^{99m}Tc Phosphates	5.8 E-03	6.14 E-03	5.5
Phosphonate			
^{99m}Tc Erythrocytes	6.6 E-03	7.49 E-03	11.9
^{99m}Tc MAA	1.1 E-02	11.68 E-03	5.8
^{67}Ga Citrate	1.1 E-01	10.36 E-02	6.1
^{131}I Hippuran	5.3 E-02	55.33 E-03	4.2
^{201}Tl Chloride	2.3 E-01	24.74 E-02	7.0
^{131}I Sodium iodide (5% uptake)	6.1 E-02 (0% uptake)	37.34 E-01	?
^{131}I Sodium iodide (45% uptake)	2.4 E+01 (35% uptake)	32.15 E+00	?
^{99m}Tc labelled citrate complex		8.03 E-03	11.6
^{99m}Tc MAG_3	7.1 E-03	7.37 E-03	<1
(normal kidney function)	7.3 E-03		
^{99m}Tc denatured RBC		36.47 E-03	20.5
^{99m}Tc aerosol (DTPA)	2.9 E-02	6.49 E-03	6
^{99m}Tc MIBI	6.1 E-03	9.58 E-03	11
^{99m}Tc IDA	8.5 E-03	19.58 E-03	21
^{51}Cr EDTA	1.5 E-02	1.96 E-03	7.1
^{51}Cr Platelets	2.1 E-03	2.20 E-01	18.2
^{75}Se methionine	1.8 E-01	2.85 E+00	12
	2.5 E+00		

No comparison could be made for ^{131}I as the values of effective dose coefficients were given for 0 and 35% uptake while Indian values were for 5 and 45% uptake.

Superscript nos. refer to the serial nos. in the reference list.

radiopharmaceuticals result in lower effective dose to patients (unless the investigation demands very high activity) and those examination requiring I-131 and I-131 based radiodiagnostic agents with higher doses to patients. Some investigations that result in high effective doses to patients are shown in Table IV. A few of these investigations are performed frequently, specially involving I-131 at clinics/centres in smaller cities.

Conclusions

A new methodology was developed for effective dose estimation. Employing MIRD scheme and ICRP reference man data, age-dependent effective dose coefficients were calculated for all the radiopharmaceuticals used frequently in the country. The values arrived at by the new methodology were higher by 10% (5-20%) than the ones given in ICRP[6]. While employment of Tc-99m and Tc-

Table IV. Some nuclear medicine investigations resulting in high effective doses to adult patients.

Investigation	Radio-pharmaceutical used	Activity normally employed (MBq)	Effective dose (mSv)
Tumour imaging	^{67}Ga citrate	200	21
Myocardial perfusion	^{201}Tl chloride	50-100	12-25
Thyroid uptake (45% uptake)	^{131}I - Sodium iodide	0.5	16
Thyroid scanning (45% uptake)	^{131}I - Sodium iodide	2.0	64
Brain scanning	^{99m}Tc pertechnetate	500-1200	7-18
Pancreas scanning	^{75}Sc-methionine	4.0	11

99m based radiopharmaceuticals resulted in low radiation doses, other radiodiagnostic agents specially I-131 and I-131 based agents imparted significant radiation doses to patients . At most centres, the amount of radioactivity administered to a patient, was adjusted to his/her age and weight. In a significant number of cliffics/centres particularly those located in comparatively smaller cities, investigations were being still carried out using I-131 and I-131 based radiopharmaceuticals resulting in unwarranted high radiation doses to patients.

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(To be concluded)

APPENDIX

Absorbed dose (D) : The basic physical quantity used in nuclear medicine dosimetry is the absorbed dose. For all types of radiation, the absorbed dose is a measure of the amount of energy from the radiation field which is deposited in unit mass of an organ or tissue. The SI unit of absorbed dose is joule per kilogram and is called gray (Gy). The method of calculating absorbed dose in nuclear medicine has been developed over many years by the Medical Internal Radiation Dose (MIRD) Committee of the American Society of Nuclear Medicine. In the MIRD scheme, a body is considered to consist of source organs (*ie* those with significant uptake of radiopharmaceuticals) and the target organs (*ie* those being irradiated by the source organs). For each pair of source and target organs, the following equation is used to calculate the absorbed dose D (T←S) in Gy to a target organ 'T' from the activity in the source organ 'S'.

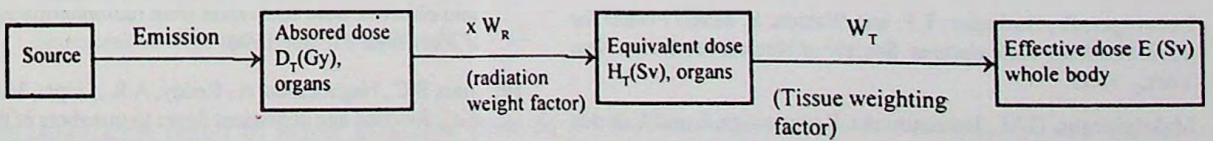
$$D(T \leftarrow S) = A_s \times S \quad (T \leftarrow S)$$

A_s is the time-integrated, or cumulated activity, and is equal to the total number of nuclear transformations in S; and S (T←S) is the absorbed dose in T per unit cumulated activity in S and is referred as the S-factor which is the absorbed dose coefficient for that organ. Numerical values of S (T←S) or simply 'S' have been tabulated for large number of organs and tissues in both standard man and children for a variety of radionuclides and radiopharmaceuticals. Age dependent 'S' values are given in ICRP publication 53 (ICRP 1987) and later in one of its addendum (ICRP 1992).

Equivalent dose (H) : Even when the energy is equal at a macroscopic level (*ie*, the absorbed dose is the same) different types and energies of radiation will produce different amounts of biological damage. To allow for this, a further quantity has been introduced. This is called the equivalent dose, H , which is the average absorbed dose in an organ or tissue multiplied by a dimensionless radiation weighting factor, W_R that is a function of linear energy transfer (LET) of the radiation. Radiation weighting factor of 1 is assigned to low LET radiation, including X-rays and gamma-rays of all energies. The SI unit of equivalent dose is joule per kilogram and is called sievert (Sv). Smaller unit of equivalent doses are millisievert (mSv) and microsievert (μSv) that are one thousandh and one millionth of a sievert respectively. For almost all the radiation used in medical imaging, radiation-weighting factor is unity, so the absorbed dose and equivalent dose are numerically equal.

Effective dose : Effective dose equivalent is the risk related parameter to describe the overall effect of non homogeneous dose distribution (as takes place in nuclear medicine imaging), taking into account the relative radiosensitivity of each organ and tissue and is similar, in terms of overall risks , to a uniform whole body exposure in which each organ receives an equivalent dose equal to effective dose. The Effective dose $E = \Sigma W_T H_T$ is obtained by calculating a weighted average of the equivalent doses received by each organ or tissue in the body which has been irradiated (where W_T is the tissue weighting factor for organ T, H_T is the equivalent dose received by organ or tissue T and $\Sigma W_T = 1$).

The relationship between the different dosimetric quantities are illustrated in the flow chart.



Organs or tissues which are at higher risk (or are more sensitive to radiation detriment) are given higher tissue weighting factor. The values of tissue weighting factor are given in Table A. The different dosimetric quantities used in nuclear medicine and their conversion from one unit system to another is given in Table B. Effective dose is also expressed in sieverts (Sv), millisieverts (mSv) and microsieverts (μSv). Effective dose as defined by the International Commission on Radiological Protection[11], provides a possibility of expressing the radiation risk to patients undergoing different radiodiagnostic procedures by means of a single figure.

Table A. Tissue and organ weighting factor values (W_T) as given by ICRP 1990 for estimating effective dose.

Organ or tissue	W_T	ΣW_T
Bone surface and skin	0.01	0.02
Bladder, Breast, Liver Oesophagus, Thyroid and remainder	0.05	0.30
Bone marrow, Colon, Lung and Stomach	0.12	0.48
Gonads	0.20	0.20

Table B. Conversion between various units used in nuclear medicine dosimetry

Physical quantity	SI unit	Non SI unit	Relationship
Activity	Becqueral(Bq)	Curie(Ci)	$1Bq = 2.7X10^{-11}$ Ci $1 Ci = 3.7X10^{10}$ Bq
Absorbed dose	Gray(Gy)	Rad	1 Gy = 100 rad 1 rad = 10 mGy
Equivalent dose	Sievert(Sv)	Rem	1 Sv = 100 rem 1 rem = 10 mSv
Effective dose	Sievert (Sv)	Rem	1 Sv = 100 rem 1 rem = 10 mSv

ABSTRACTS

Some Research Projects Completed Recently

Action of cisplatinum on some unicellular organisms.

A study was conducted to investigate the mode of action of cisplatinum on unicellular ciliate species in order to understand the action of this drug on eukaryotic cells and some aspects of its metabolism. Several different species of genus *Stylonchia* collected from wild habitat were treated with anticancer drug, cisplatinum in the dose of 150 µg/ml for 2 h. Studies on macronucleus and micronucleus were carried out to study the mechanism of action of the drug. Different species of the unicellular ciliate protozoa *viz* isolated from wild habitats exhibited variable sensitivity towards the antitumour drug cisplatinum. Intracellular quantitative measurements of platinum in post-treatment resistant cells showed that higher resistance was not due to poor metal uptake; these cells showed comparatively higher uptake. Likewise, the germ line micronucleus of these cells was highly vulnerable to genetic damage in comparison to the somatic nuclei. The germ line nuclei bound at least 3 times more of platinum when cells were treated *in situ*.The DNA lesions in the micronucleus caused by extremely low platinum dosages were detrimental to the completion of meiosis and formation of a new functional somatic macronucleus. DNA characterization of platinum damaged micronuclei showed unusual fragmentation to low mol. wt. components. Such damage was irreversible leading to the loss of micronuclei and production of amicronucleate strains. It appeared that micronuclear components like non histone chromosomal proteins facilitate higher platinum binding leading to fragmentation of high mol. wt. micronuclear DNA.

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Evaluation of the effectiveness of brief in-patient family intervention vs. out-patient intervention for mentally retarded children.

A prospective study was carried out on mentally retarded children to evaluate the effectiveness of brief in-patient and out-patient family focussed interventions (developed in-house) in terms of their impact on the child's development and behaviour, and family adaptation (perceived stress and coping). The components of the intervention included medical measures, family orientation, general parenting measures, and parent training. Outcome variables studied included child variables (intellectual/adaptive functioning and presence and severity of problem behaviour) and family variables (self report and observer rated stress in families and level of family adaptation).

A total of 157 mentally retarded children of either sex (75 in the in-patient group and 82 in the out-patient group) from low socio-economic group (both rural and urban) and

with moderate to profound degree of mental retardation were recruited for the study. Children who had already undergone major intervention, those with severe hearing or vision impairment which was more disabling than the mental retardation and children with progressive neurologic disorders were excluded from the study. Thirty three (44%) children/families is the in-patient and 47 (57%) in the out-patient group could complete one year of follow up.

Improvements or gains were noted on all outcome measures to a varying extent in both the groups. The gain in the child adaptive functioning was more pronounced in the in-patient group (10 points) as compared to the out-patient group (4 points). Problem behaviour came down by 55-60%, family stress reduced by 27-35% and family adaptation was improved by 30% in both the groups. Maximum gains occurred during the first 3-6 months of follow up and subsequently remained stable over the remainder of the follow up period. There were no major effects of age, sex, and residence on outcome.

It is therefore concluded that it is possible to formulate and test effective family focussed interventions in mental retardation which are suited for Indian conditions and such inerventions will produce long-lasting and significant improvements in both children and their families.

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Publication

Girimaji, S.C.R. Family intervention in mental retardation : An overview. *NIMHANS J 11* : 21, 1993.

ICMR NEWS

Meetings of the Project Review Committee (PRC)/Task Forces (TFs) and other meetings held:

PRC for proposals in Non-Communicable Diseases	July 17, 1998 (at New Delhi)
Meetings of the Investigators of of the district nutrition project	July 23-24, 1998 (at Mumbai)
Annual Review meeting of the Human Reproduction Research Centres	August 10-11, 1998 (at Mumbai)
Meeting of the Investigators of the project on mobile unit approach to meet reproductive health needs of women	August 13-14, 1998 (at New Delhi)

Participation of ICMR Scientists in Scientific Events:

Dr. B. Shiv Kumar, Dy. Director (Sr.Grade), National Institute of Nutrition, Hyderabad, participated in a conference on Iron Deficiency Anaemia at Colombo (July 19, 1998).

Exhibition:

As part of the commemoration of the 50th Anniversary of India's Independence the Department of Science & Technology, New Delhi, organised an exhibition at the lawns of India Gate during August 3-16, 1998 on the achievements of India in the field of Science & Technology during the last 50 years. The ICMR Hqs, in collaboration with its Delhi based Institutes/Centres and the National Institute of Nutrition, Hyderabad, participated in this exhibition depicting the achievements in the field of malaria, nutrition, cancer research, *etc.* This exhibition attracted a very large number of visitors daily including students and the general public.

ICMR AIDED SYMPOSIA/SEMINARS/WORKSHOPS/COURSES/CONFERENCES

Symposium/Seminar/Workshop/ Course/Conference	Date & Place	Contact Address
Workshop on Environmental Impact on Health	August 16-18, 1998; (at New Delhi)	Dr. T.R.C. Sinha, General-Secretary, National Environmental Science Academy, 206, Raj Tower-I, Alaknanada Community Centre, New Delhi-110019.
XIV International Conference on Alzheimer's Disease	September 24-27, 1998; (at Mangalore)	Dr. K. Jacob Roy, Organising Secretary, ADI 98, P.O.Box NO.53, Kunnamkulam-680503.

Symposium/Seminar/Workshop/ Course/Conference	Date & Place	Contact Address
Symposium on Alzheimer's Disease and Neurocognitive Disorders	October 3-4, 1998; (at Delhi)	Col. D.S. Goel, Senior Advisor (Psychiatry), Base Hospital, Delhi Cantt-110010.
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.
XXXI Annual Conference of the Indian Pharmacological Society	December 17-20, 1998; (at Lucknow)	Dr. V.N. Puri, Organisng Secretary of the Conference, Division of Pharmacology, Central Drug Research Institute, Lucknow-226001.

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).

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 Medical Officers (November 30-December 6, 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 Indians – 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

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