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MEDICAL PHYSICS AND BIOMEDICAL ENGINEERING

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From the Editor:

In the present issue of the Bulletin you will find an ununsual item: a piece of poetry by W. Szymborska of Poland. I hope you will agree that her poem expresses well the feelings that many people may have at the end of the 20th century, especially those who are concerned with science.

Also you will find articles devoted to the effects of X-rays in diagnostic radiology, as well as some information on what is going on in medical physics and engineering in the world.

Since you will not hear from me before Autumn, I hope I shall see you all (or perhaps only some) at the NICE-97 Congress. For us, Europeans, the travel will not be difficult, but those of you who live in Asia or Australia or America it may not be so easy. Anyway, best of luck in obtaining adequate funds and good health from your Editor

Fin de siècle

It was to be better than the past centuries,
this twentieth century.
But it will not have time to prove it,
its years are numbered,
its step is unsteady, and
its breath is too short.
Too much has already happened
that was not to happen;
and what was to arrive
has not arrived.
Spring was to come,
and happiness, among other things.
Fear was to leave hills and valleys.
Truth was to arrive at the target
faster than lies.
A few misfortunes
like wars, famine,etc
were not to happen.
The helplessness of helpless people
was to be respected,
so was confidence and other things.
Those who wanted to enjoy the world
are facing a task
that cannot be performed.
Stupidity is not funny.
Wisdom is nor merry.
Hope is no more that young girl, etc.
unfortunately.
God was at last to put his faith in man
who is good and strong,
but good and strong are still two people.
How to live - I was asked in a letter,
but I was going to ask
the same question.
Again, and as always,
what can be seen from the above,
there are no more urgent questions
than naive questions.

WIS_AWA SZYMBORSKA
1996 Nobel Laureate from Literature
(translated from the Polish by OAC)

International Events

October 19 - 22, 997

Annual Meeting of American Society for Therapeutic Radiology and Oncology, ASTRO, at Orlando, Florida,USA.

For further information**: Vicky Caroll, ASTRO Office, 1891 Preston White Drive, Reston, VA 22091, USA.**

November 16-19, 1997

Euroson School on Vascular Ultrasound Echocardiography Course, at Monte Carlo, Monaco.

For further information: **The Conference Secretariat, Professor Allison's Office, Dept. of Imaging, Hammersmith Hospital, Du Cane Road, London, W12 0NN, Tel:(0181) 740 3132, Fax: (0181) 743 5409.**

November 30 - December 5, 1997

83rd Meeting of the Radiological Society of North America (RSNA), at Chicago, USA.

For further information: **Mr M.Hedland, Director of Scientific Meetings, 2021 Spring Road, s.600. IL 60521, Tower B, Oak Brook, USA.**

December 8-14, 1997

International Meeting on Medical Physics, Radiation Oncology Clinical Radiobiology,Medical Radiobiological Centre of Russian Academy of Sciences, at Obninsk, Russia.

For further information: **Jacek G.Wierzbicki,Radiation Oncology Center**, **Wayne State University, 3990 John R. Detroit, MI 48201; Tel:313 745 2191** ***or*** **Dr Oleg N.Denisienko, MRRC of RAMS,Koroliov 4, Obninsk 249020, Kaluga Region, Russia,Fax: 7 095 9561440.**

March 1998

49th Australian Annual Conference of the ISRRT, at Ayres Rock, Australia.

For further information: **Secretary of the Society, Mr.E.Hughes, PO Box 1169, Collingwood, Victoria 3066, Australia.**

March 30 - April 3, 1998

Society of Computed Body Tomography and Magnetic Resonance : Annual Meeting, at California, USA.

For further information: **Society of Computed Body Tomography and Magnetic Resonance (SCBT/MR) c/o Matrix Meetings Inc. PO Box 1026, Rochester ,MN 55903-1026, USA.**

May 13-17, 1998

6th International Meeting on Progress in Radio-Oncology, at Salzburg, Austria.

For further information: **Marleen Stevens, ISRO Office, Dept. of Radiotherapy, UH Gasthulsberg, Herestraat 49,3000 Leuven, Belgium, Tel: 3216347685, Fax: 32 34 76 81.**

Letters to the Editor

Thank you for your sending me such a nice and excellent Bulletin, especially the latest one. Because besides physics, I do research in philosophy. In my opinion, science is only one of the ways to study Nature...Sometimes the Quality character will be more important than the Quantity aspects... Maybe we need to go back to the very fundamental bases of physics to set up a new unified system of Mass, Charge, energy and Forces... In Belgium I have successfully done a lot of research on how to develop Electronic Portal Imaging Devices into an in vivo dosimetry system.

Prof.He Xiao dong*, Dept. of Radiation Therapy,Xin Hua Hospital, 1665 Kong Jiang Road, Shanghai 200092, P.R.C.*

Ed. Many thanks for your kind words and congratulations on your work. Perhaps some readers may be interested in your ideas and will write to you.

* * *

... You have been kind enough to send me the Bulletin regularly and I have found it to be quite useful and informative. At this part of the region, we have formed a small group of medical physicists 'UP-Delhi Chapter of AMPI (Association of Medical Physicists of India)...We have been meeting at least once a month for the last five years. We have started a Newsletter of our own...

Dr S.C.Jain, *Institute of Nuclear Medicine & Allied Sciences ,Lucknow Road, Delhi - 110 054, India.*

Ed. Thank you for the copies of your Newsletter. I hope we can cooperate in the future in exchanging information for the benefit of medical physicists and engineers.

* * *

...Thank you for sending me the Bulletin...I admire your stamina and activity... I believe the last time we met was in Bombay in September 1992.We shared a taxi to the museum. What a ride that was!...

Dr George Christoulides*, Nicosia, Cyprus.*

Ed. Unfortunately, my activity is somewhat restricted to the publication of the Bulletin, but anyway, thank for your nice words. How can people remember even small things (...taxi ride).

* * *

Best regards from a snow covered Russia!

Dr Irina M. Lebedenko,*CRC RAM Kashirskoye sh.24 Moscow,115478 Russia*

Ed. Here in Poland, perhaps this year we have been spared heavy snow, but the freezing temperatures were with us for over a month. It's good to live in Cyprus ...

Topical article

Safety Aspects in Medical X-rays

by Dr M.S.S. Murthy

Radiological Physics Division, Bhabha Atomic Centre
Trombay, Mumbai 400 085 India

In what follows you will find an adapted text taken from Dr Murthy's Book published in 1996 (by kind permission of the Publishers)

X -ray Dose and its Consequences

What are the units of X-ray dose?

The current SI unit of radiation dose is **gray** (Gy). It represents the energy absorption of 1 Joule in 1 Kg of tissue (milligray = 1/1000 gray). Older unit was **rad** which was energy absorption of 100 ergs per gram of tissue. 1 **Gy** = 100 **rad**.

Patient dose appears to be an important consideration in the selection and execution of an X-ray diagnostic test. How much dose does a patient receive during a typical examination?

Typical dose per examination ranges from a fraction of a milligray in some routine radiographic examinations to a fraction of a gray in some special fluoroscopic procedures. Majority of the examinations deliver doses well below 10 milligray. With gradual improvement in the quality of X-ray tubes, detection systems and the techniques in radiology, the X-ray doses delivered to the patient for many diagnostic procedures have been reduced drastically. There is wide range in the doses received by the patients for a given examination in different clinics and even from different machines in the same hospital. For example, in a UK survey, doses from a few selected examinations in 20 hospitals were investigated. The investigators were surprised to find that the entrance skin dose for a given type of examination ranged over factors of 20 to 100 for individual patients and between 5 and 20 in the mean value for all the 20 hospitals. Some of this data are shown in Table 1. Similar was the situation for fluoroscopic examinations.

All those examinations must be yielding clinically useful results. Then, how is it that some of the clinics can achieve their goal at doses 50 to 100 times lower than others?

That was the interesting outcome of this study. Bulk of the variation was due to differences in the sensitivity and reliability of the imaging equipment, filtration and the operational factors such as anode voltage (kV) and tube current (mA). This was what worried investigators and the participating radiologists. It also gave hope that corrective measures can be taken to harmonize the situation towards lower doses. It is important to standardize the procedures and develop reference dose values under optimized conditions against which every clinic can compare its own performance.

TABLE I. Distribution of Individual Entrance Surface Dose in Some Radiographic Examinations of Adult Patients at a Random Sample of 20 English Hospitals [3].

Examination	Entrance surface dose (mGy)		
Lumbar spine	Minimum	Maximum	Median
AP	0.83	59.1	7.68
Lat	2.38	108	19.70
LSJ	7.40	131	34.50
Abdomen			
AP	0.71	62.40	6.68
Pelvis			
AP	0.85	31.60	5.67
Chest			
PA	0.03	1.43	0.18
Lat	0.14	10.60	0.99
Skull			
AP	0.73	13.90	4.02
PA	1.82	13.10	4.25
Lat	0.36	9.09	2.19

AP: Anterior Posterior; Lat:Lateral; PA: Posterior Anterior; LSJ: Lumber Sacral Joint

What are the frequencies of various examinations and which of these result in higher doses to the patient?

It is estimated that about 150 X-ray examinations (excluding dental) are carried out for every 1000 persons in our country. This is much less than the number of examinations conducted in developed countries (an average of 887 per 1000). The average entrance skin doses for these examinations are given in Table I. It may be noted that while examinations involving chest and extremities result in comparatively smaller doses, those of spine and hips are at the other end of the scale.

TABLE II. Entrance Skin Dose for Some Radiographic Examinations [4].

SITE	Dose per examination (mGy)
Chest	0.20
Extremities	0.19
Skull	9.50
Lumbosacral spine	50.00
Pelvis/hips	50.00
Abdomen	5.50
GI tract-upper	34.00
GI tract-lower	25.00
Urography	29.00

How much is the cancer risk due to different diagnostic examinations?

The probability of fatal cancer being induced in an individual patient from a single X-ray examination is extremely small. It depends upon the age of the patient, the type of examination, the number of views taken, the dose, and other population parameters such as the average life span and the rate of incidence of cancer in the population. The National Radiological Protection Board in the UK has carried out some detailed estimates for their population. Life-time risks of fatal cancers per million patients from various X-ray examinations are shown in Table III. These values are calculated on the basis of a model that the risk of radiation induced cancer follows a constant multiple of the age related cancers occurring in an unexposed population and continue throughout the life-span. It can easily be seen that the risk varies from as low as 2 per million to as high as 350 million depending on the examination. **Compared with the natural incidence of cancer (approximately one in four in UK) the above numbers are small.** However, it should be remembered that a person may undergo many X-ray examinations in his or her lifetime and risks are cumulative .

TABLE III. Risk of fatal Cancer Due to Radiation Dose Received during an X-ray Examination (data for UK population) [5].

SITE	Lifetime fatal cancer[a] (per million persons)
Skull	7
Chest	2
Thoracic spine	40
Lumbar spine	100
Abdomen	60
Pelvis	55
Intravenous urography	100
Barium meal	170
Barium enema	350

[a] Average for all ages

Can we assume that similar risk applies to the Indian patients?

The answer is both yes and no, because of the large number of factors on which it depends and also the uncertainty in quantitating these factors. However, while extending these risk values to Indian population (*or perhaps to any population in Developing Countries* **Ed.**), we have to keep in mind a few points. Because of the lower life span of that population and lower incidence of cancer (*as compared with the incidence of infectious and/or parasitic diseases* **Ed.**), the risk can be lower: may be half as great. However, this can be readily offset by the higher doses that an individual patient may receive during an examination because of the older equipment and non-availability of sophisticated dose-reducing gadgets. As mentioned earlier, the dose for a given examination varies over a wide range from hospital to hospital. Therefore, the risk is proportionately higher in those clinics where the dose are higher than the dose per examination used in these calculations.

Another important factor is the age of the patient. Younger patients have higher risks. If the patient is under the age of ten, the risk may be twice as high as that for the adults.

What about fluoroscopy? Will the patient dose be much higher?

It is generally so, since fluoroscopic examinations expose the patient for much longer time, particularly in some invasive procedures listed in Table IV. Normal fluoroscopy is performed with a table top dose of 0.02 to 0.05 Gy/min. Even under good working practice, a procedure such as insertion of a pacemaker may result in the entrance skin dose in the range of 0.5 to 3 Gy, depending on the thickness of the patient. Scientists from the Bhabha Atomic Research Centre have investigated two cases of severe skin injury to patients during pacemaker insertion under fluoroscopy [6]. The estimated doses to skin were 58 and 22 Gy, respectively. This high dose was due to a combination of bad work practice (fluoroscopy was performed without image intensifier), ill maintained equipment (missing beam limiting diaphragm and filters) and lack of awareness on the part of the attending radiologist and the cardiologist. The staff also received excessive exposures during these procedures.

In the high dose-rate fluoroscopy, the table top dose can be as high as 0.2 Gy/min (20 rad/min). Hence, in such a system, the threshold dose for various skin injuries can be exceeded in a short period. For example, Table V shows the hours of fluoroscopic 'on time' to deliver the threshold dose for various skin injuries under both normal and high-dose rate conditions. It can be seen that under high-dose conditions a fluoroscopic "on time' as low as 10 minutes can deliver enough dose to the skin to cause early transient erythema (appearing within hours). Some of the other forms of skin injuries may not appear until weeks after exposure, making the assessment of the problem more complicated. In fact, the Food and Drug Administration of the USA has warned the physicians performing such procedures of the potential radiation risks to the patient and has issued a set o guidelines to prevent such injuries.

TABLE 5. Procedures typically involving extended fluoroscopic exposure time [7].

Radiofrequency cardiac catheter ablation
Percutaneous transluminal angioplasty (coronary and other vessels)
Vascular embolization
Stent and filter placement
Thrombolytic and fibrinolytic procedures
Percutaneous transhepatic cholangiography
Transjugular intrahepatic portosystemic shunt
Percutaneous nephrostomy, biliary drainage or urinary-/biliary stone removal

What about the latent period for the cancer to appear and the age of the patients? Many of our patients are old. Hence does it not make the concern about long-term effects irrelevant?

To some extent, yes. The risk factors given in Table IV are obtained by averaging over all ages. There is a latent period between exposure to radiation and appearance of cancer. Hence one can say that older patients may not survive long enough to develop radiation-induced cancer. However, the length of the latent period varies with the type of cancer and also the age of the person at exposure. For leukemia it is only about 2 years and peak incidence occurs within 5 years after exposure, which is not too long. For other cancers, the time at which they appear after exposure follows the pattern of natural incidence with age. Hence the latent period is expected to be shorter for older people than for younger ones. Furthermore, it is also not correct to say that majority of the persons who undergo X-ray examinations are elderly. Given the age structure of Indian population (where the younger people outnumber the elderly ones), nearly 66% of all X-ray examinations are

No, not really. Pregnancy is an important factor. In fact, a detailed study of the teratogenic effects of radiation among pregnant women who were exposed to the

done on persons under the age of 40 years and a good fraction of this is in the age group of below 15 years. In addition, some persons undergo several X-ray examinations during their lifetime. Since the cancer risk at low levels of radiation is assumed to be cumulative,the concern is not really irrelevant .

X-ray Examination in Pregnant Women

What about the X-ray examination of pregnant women?

During pregnancy the self regulatory nature of the growth and development process of the foetus tends to favour either the normal birth or termination of a highly abnormal foetus. Having said that, it would however be prudent to assume that radiation can interfere with the complicated process of cell division and cause some disruption in foetal development. Hence, special precautions are needed in dealing with pregnant women and women of child bearing age. The birth of a monster following an X-ray examination of a pregnant woman is a myth.

Can* you *elaborate on the present status of ten-day rule ?

In the early '70s, the *International Commission on Radiological Protection (ICRP)* had recommended the so-called "ten-day rule", as a means of protecting the foetus. This rule states that women of child bearing age may be subjected to X-ray (or nuclear medicine) examinations involving pelvis or lower abdomen only during the first "ten days" after the start of menstruation cycle. During this period it is reasonably certain that she cannot be pregnant and, therefore, there is no risk to the conceptus. The rule could be waived only if postponement of the examination was detrimental to the health of the woman. However, it is now realized that the risk of foetal malformation due to irradiation is very small during the 4 weeks after the last menstrual period, and the irradiated foetus, if interrupted in the developmental process, may simply be aborted (which will go unnoticed during this period). Thus, a malformed survivor is very unlikely. Hence, in 1985, the ICRP relaxed its recommendation so that so special limitation on exposure during the four weeks following menstruation is required.

During the first 10 days following the onset of the menstrual period, there is no radiation risk to the conceptus since no conception will have occurred. The radiation risk to a foetus which had been irradiated *in utero* during the remainder of the first month following the onset of menstruation (ie approximately the first 2 weeks after conception) is likely to be so small that no special limitation on X-ray examination during that period is required.

Does it mean that pregnancy status is not a factor in subjecting women to X-ray diagnosis?

atobomb explosions in Japan revealed that the most

TABLE VI. Radiation-induced skin injuries [7]

Effect	Typical threshold dose (Gy)	Hours of Fluoroscopic "on time" to reach threshold[a] at		Time to onset of effect[b]
		Usual fluoroscopic doserate of 0.02 Gy/m	High level dose-rate of 0.2 Gy/m	
Early transient erythema	2	1.7	0.17	hours
Temporary epilation	3	2.5	0.25	3 weeks
Main erythema	6	5.0	0.50	10 days
Permanent epilation	7	5.8	0.58	3 weeks
Dry desquamation	10	8.3	0.83	4 weeks
Invasive fibrosis	10	8.3	0.83	
Dermal atrophy	11	9.2	0.92	>>14 weeks
Telangiectasis	12	10.0	1.00	>>52 weeks
Moist desquamation	15	12.5	1.25	4 weeks
Late erythema	15	12.5	1.25	6-10 weeks
Dermal necrosis	18	15.0	1.50	>>10 weeks
Secondary ulceration	20	16.7	1.67	>>6 weeks

[a] Time required to deliver the typical threshold dose at the specified dose rate
[b] Time after single irradiation to observation of effect

mportant period in foetal development from the point of view of radiation effects is the 8 to 15 weeks after conception. During this period forebrain development will be in progress and any damage to these cells may lead to mental retardation. It has been estimated that the risk of mental retardation during this period is 1 in 2500 per mGy. Since pelvic examination results in a dose of 2 to 10 mGy to the foetus, the risk cannot be ignored. The risk can be even higher - 1 in 140 - if the foetus is exposed inadvertently while the mother is having a barium enema examination. However the risk falls off to one fourth during 16 to 25 weeks and to almost zero thereafter.

In addition, a detailed study conducted at Oxford, UK, has revealed that children who were exposed *in utero* (ie their mothers were subjected to X-ray examination during pregnancy) had a higher risk of childhood cancers which appear in the first ten years. The excess risk is estimated to be about 1 in 5000 per mGy.

Mental retardation, childhood cancer,etc can occur even in unirradiated children. How can we firmly ascribe these to radiation exposure?

It is not possible to ascribe these firmly to radiation. This is because a number of other factors such as malnutrition, drugs,etc can also lead to these complications. Statistically it has not been possible to ascribe any cases to the radiation over and above the cases due to conventional factors. Further, there is uncertainty in the dose-effect relationship, particularly with respect to the induction of mental retardation. The available data suggest that there may be a threshold dose of about 250 mGy below which mental retardation will not be induced. Even in the case of childhood cancer, the frequency may be as low as 1 in 40,000 per mGy. The exact numerical values of the risks are debatable. Nevertheless, the possibility that such effects can occur cannot be ruled out , particularly at higher doses. Hence there is a need to avoid radiation exposure to the foetus, or at least to keep the dose to a minimum. These considerations are summarized in Table VI.

Table VI. Nominal risks of irradiation *in utero* for absorbed doses in the embryo or foetus [8]

Time after conception	Nominal risk per mGy
First two weeks	minimal
3rd to 8th week	potential for malformation of organs
8th to 15th week	severe mental retardation 1 in 2,500[a]
16th to 25th week	severe mental retardation 1 in 10,000[a]
Throughout pregnancy	childhood cancer 1 in 50,000

[a] These minimal risks do not take into account the possible presence of a threshold dose below which severe mental retardation would not occur.

What are the other precautions to be taken in dealing with pregnant women?

For a pregnant woman it is necessary to know, before the start of an examination, the position in which the uterus may lie with respect to the useful beam. Irradiation of the foetus during the critical period of 8-15 weeks should be avoided as far as possible. Any woman who had a missed or overdue period or in the response to the question " are you or might you be pregnant?" cannot answer with a definite "NO", should be considered to be pregnant. If foetus is known to exist and the examination cannot be postponed, then efforts should be made to minimize the number of exposures and the dose to the foetus. Other X-ray procedures of chest, scull and extremities can be performed at any time during pregnancy, if the foetus is properly shielded and the X-ray beam suitably collimated.

Another important question we sometimes face is about termination of pregnancy in case of an unavoidable high foetal exposure. At what dose levels should it be recommended? Are there any guidelines?

It is not possible to give specific guidelines, since the situation varies from patient to patient. It should depend upon how important the pregnancy is and the stage of pregnancy. The *International Commission on Radiological Protection (ICRP)* has recommended [9] that the pregnancy should be allowed to proceed if the embryo was exposed to less than 100 mGy. Termination must be considered only if the dose is much higher than this, especially as there is a relatively higher risk from factors other than irradiation, which necessitates the X-ray examination. Many diagnostic procedures rarely justify terminating a pregnancy. When such a concern arises, an estimate of the absorbed dose and the associated risk to the foetus should be made by a qualified expert. With that advice the patient should be in a position to take a decision regarding the termination of pregnancy . ☐

(*To be continued in the next issue of the Bulletin)*

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CALRAD Programme

A New Approach to Teaching the Core Knowledge for the Use of Ionising Radiation

This programme, called CALRAD(Computer Assisted Learning of Radiation) and intended for use by junior doctors and medical students, has been written by the Medical Physics Consortium with funding from the Teaching and Learning Technology Programme jointly funded by the four UK higher education funding bodies.

It consists not only of the basic radiation physics knowledge, which should be known to physicians and medical physicists professionally employed in applications of ionising radiation in diagnosis and therapy, but it also makes it possible to introduce a Logging System to record in a special file the data bases related to the learning progress of students using the System.

The CALRAD System was developed taking account of the radiation protection regulations in force in the European Union. It consists of eight interactive Books covering the following topics: (1) Basic Physics of Radiation, (2) Definitions of Ionising Radiation Units, (3) Biological Effects and Risks, (4) Aims of Radiation Protection, (5) Safe Use of X-radiation, (6) Safe Use of Radionuclides, (7) Radiation and Pregnancy, and (8) Rules and Regulations. Each Book includes two levels of knowledge: (a) "basic" and (b) optional.

The Programme requires a PC equipped with a minimum 33Mb hard disk, 486 or Pentium processor, 4 Mb RAM, the graphic card and monitor 640x480 with 256 colours, software Microsoft Windows 3.1 or higher, and MS-DOS 5.0 or higher.

To contact the authors: **Dr.R.A. Lerski, Director, University of Dundee, Medical Physics Dept. Ninewells Hospital and Medical School, DUNDEE DD1 9SY (UK), Fax: (01382) 640177, E-mail: R.A.Lerski@dundee.ac.uk.**

Reference doses for diagnostic medical exposures

B.F.Wall

National Radiological Protection Board, Chilton, Didcot, Oxon, UK

The article describes the development of the idea of reference ionization doses established in the UK and in the EU with respect to common X-ray examinations and computed tomography.

The need for guidance on appropriate levels of patient exposure for diagnostic X-ray examinations has long been felt since it has been shown that there is a wide variation in performance between various hospitals.

The total dose, and therefore the radiation risk, to the patient from an X-ray examination (*see the article by M.S.S.Murthy on p.3*) depends not only on the sensitivity of the imaging system, but also on other factors such as how well the X-ray beam is collimated to the area of interest in the patient and how many radiographs or how much fluoroscopy is needed to complete the examination. Practice regarding these factors is well known to be diverse. Observed variations in the typical dose-area product values for complete examinations, a measurement that essentially includes the effect of all these factors, are also very high. For example, these values may vary in a particular examination by up to factor of 20 between hospitals according to the NRPB (U.K.) national patient dose database [1].

An area of radiology of particular radiation protection concern is computed tomography (CT) in view of the relatively large individual and collective doses to patients. The effective dose for individual CT examinations often exceeds 20 mSv, ie 1,000 times the dose for a conventional chest X-ray and the collective dose for CT probably now exceeds one third of the total from all diagnostic radiology in the UK. A survey of CT practice in the UK [2] showed that even seven years ago the typical dose for a given type of CT examination varied by a factor of up to 40, mainly due to the adoption of different technique protocols.

One of the main reasons why such wide variability in patient doses exists is the fact the X-ray department staffs have not until recently had the means of knowing precisely what are the doses that they are delivering to patients. The first requirement to reduce this wide variability is to provide X-ray departments with a method for monitoring their performance.A set of reference or guidance dose levels for common diagnostic procedures, expressed in a simple manner, would fulfill this requirement. In the U.K. such guideline doses were first suggested in a paper from NRPB in 1989 [3] and then recommended in a joint report between NRPB and the Royal College of Radiologists on patient dose reduction in diagnostic radiology published in 1990 [4]. The idea was further developed in a U.K. National Protocol for Patient Dose Measurements in Diagnostic Radiology [5].

The protocol describes methods for monitoring patient doses from routine X-ray examinations that can be easily carried out by radiographers with advice and assistance from medical physicists. The recommended dose quantities, Entrance Surface (ESD) for individual radiographs and Dose-Area Product (DAP) for complete examinations, can be directly measured with readily available dosemeters or estimated from measurements made during routine quality assurance tests. Since doses are critically dependent on patient size, it is recommended that measurements be made on a representative sample of about 10 patients with mean weight close to 70 kg. The average dose for this sample for particular types of radiograph or examination should provide a good indication of typical clinical practice in each room of an X-ray department. The average doses can then be compared with national reference doses to assess local performance. The reference doses are currently based on the third quartile values observed in a national survey of 20 randomly selected English hospitals in 1983-85. They are expressed in terms of ESDs for 10 common types of radiographs (Table I) and DAPs for six common types of complete X-ray examination (Table II).

The reference doses are intended to act as investigation levels triggering an internal investigation by a department if the typical dose for a specific type of diagnostic procedure is found to exceed the relevant reference level. Unless this can be justified by sound clinical judgement, appropriate action should be taken to improve practice; this involves changes in technique or equipment to reduce doses to below the reference level without compromising the quality of the diagnostic information. With this function in mind, the reference dose should ideally be set at the somewhat

Table I.Reference values of entrance surface dose (ESD) per radiograph

Radiograph		**Reference entrance surface dose (mGy)**
Lumbar spine	APL	10
	LAt	30
	LSJ	40
Abdomen	AP	10
Pelvis	AP	10
Chest	PA	0.3
	Lat	1.5
Skull	AP	5
	PA	5
	Lat	3

Table II. Reference values of dose-area product (DAP) per examination

Examination	**Reference dose-area product ($Gycm^2$)**
Lumbar spine	15
Barium enema	60
Barium meal	25
Intravenous urography	40
Abdomen	8
Pelvis	5

indeterminate borderline between acceptable and un- acceptable practice. A pragmatic way of setting this level is to use the third quartile values observed in wide-scale surveys of typical doses for common procedures.

In Europe, similar reference dose values have been incorporated into *European Guidelines on Quality Criteria for Diagnostic Radiographic* Images, by a study group supported by the European Commission, to be published as a EURATOM report later this year. The use of such reference levels is also being promoted in the latest draft of the revised EC Patient Protection Directive. Internationally, the recently published interim edition of the IAEA Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources [6], not only promotes their use in those countries where wide-scale surveys have not yet been performed to establish national norms. Most of these Guidance Levels, both for X-ray examinations and for nucledicine procedures, are based on UK data.

Back in the UK, there is an urgent need to extend the idea of reference doses to CTconsider the use of reference levels for nuclear medicine procedures and also possibly updating those for conventional X-ray examinations in the light of the more extensive and current information available in the NRPB national patient dose database. Reference doses for CT are being developed by an EC study group, with a majonput from NRPB, and should appear in an EC working document on *Quality Criteria for Computed Tomography* by the end of 1996. NRPB has recommended [7] that appropriate professional bodies, together with the Department of Health's Administration of Radioactive Substances Advisory Committee (ARSAC) should advise on national reference levels for nuclear medicine. These should be expressed in terms of administered activities for common procedures and might be related to, although not necessarily coincident with, the "maximum usual activities" already quoted by ARSAC [8].

The 1995 review of the national patient dose database [1] revealed that only about 10% of hospitals were now exceeding the reference doses for common conventional X-ray examinations and that the mean and third quartile values of the dose distributions had dropped by about 30% since the 1983-85 national survey. This could be regarded as clear evidence of the successful implementation of recommendations on patient dose reduction over the past few years, encouraged by the heightened awareness of patient doses through widespread periodic dose monitoring and comparison with national reference levels. However, although the distributions of typical doses have shifted downwards, the variability between hospitals remains as high, if not higher, than before, indicating a continuing need for (perhaps lower) reference doses to help identify and bring more into line those hospitals at the top end of the dose range.☐

(Adapted from RAD Magazine, October)

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Research Information

The Estimation of the Effect of Therapy using Physical and Analytical Methods

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A group of physicists and mathematicians in Moscow have developed a new method for the estimation of the effect of therapy using physical and analytical methods

While applying various protocols in radiation therapy of cancer, the disease itself undergoes gradual transformation depending on the type and dose of the radiation. The information about this transformation is necessary during therapy so that any correction and/or modification of the radiation protocol can be made to intensify the effect of therapy. Until now the information of this kind has usually been obtained by analysing the X-ray image of the irradiated tumour and by following the change in the size of the tumour with time. Clearly such data are selective and insufficient since the transformation may proceed inside the tumour structures leading to the elimination of the malignant tissue without any change in the external size of the target area.

To obtain more exhaustive data on the reorganization of the tumour the authors have developed a new method that makes it possible not only to estimate the changes in the size of the tumour, but also those in its density ρ (g/cm^3), from mammographs, computed tomogrames, etc. Because of the mathematical processing of such X-ray pictures obtained before and during therapy, for each 10-15 Gray of the radiation dose, the following parameter can be used in following-up the effect of therapy

$$K = f(S, V, r),$$

where S is the area, V is the volume and r is the density of the tumour. Similar data can be obtained for the healthy tissue in the target area using the following equation

$$K_T = \_\ (S_T ,V_T , r_T).$$

Thus the relative effect of the radiation on the malignant and healthy tissue can be estimated by the formula

$$\delta = K / K_T.$$

In the presence of a disease, changes in the peripheral blood cannot be easily followed by means of standard methods. In this respect, a mathematical technique using nonstandard determinations of images, based on calculation algorithms (nonstatistical processing) applied to small size samples, plays an important role. Several coefficients serve as a source of information on the peripheral blood: haemoglobin, erythrocytes, colour index, reticulocytes, trombocytes, leukocytes, eosinophiles, basophiles, myelocytes, lymphocytes, etc. It is possible to determine mathematically all shifts in the values of the above coefficients. In practice, this is done using a cluster analysis and taking account of the quantitative estimation of the class of the object investigated. For example, for a division into only two classes ("healthy" and "unhealthy") during treatment procedures one can determine the shift in the value of the class coefficient in the patient's condition towards the first class ("improvement") or the second class ("deterioration"). In other words, periodical analysis of the peripheral blood makes it possible to follow-up the patient's condition and, consequently, to introduce necessary changes in the treatment. For example, having analyzed a group of 17 women-patients, who had a combined treatment for the breast cancer, it was found that: (1) In four patients the treatment lead to a real improvement, (2) in seven patients there was no change observed, and (3) in six patients their condition deteriorated.

By carrying out additional treatment procedures, such as modification or supplementation of chemotherapy, introduction of new drugs, enhancement of the immunological system and/or modification of the radiation therapy by fractionation, etc., this coefficient of the patient's condition could sometimes be improved. In this way, the physical and analytical methods of estimating the pathological condition of the tumour and the whole body throughout the course of treatment make it possible not only to estimate the effect of treatment, but also to introduce changes with the view of improving the therapy.

The above analytical method may be applied to various treatment procedures. Its utility has been proved at the Central Clinical Hospital of the Ministry of Health of the Russian Federation in the therapy of cardiovascular, pulmonary, gastrointestinal and urinary diseases.

(*Translated from the Russian by OAC)*

Medical Physics in the World

The Medical Physicist in Japan Today and Tomorrow

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Medical physics is still a developing profession in Japan (ie about 1991). The status of a medical physicist does not formally exist in Japanese hospitals. However, technical innovations in medical physics have been intensively introduced to hospitals in recent years.

There are two associations in Japan: "*The Japanese Association of Radiological Physicists (JARP)"* and *"The Japanese Association of Medical Physics (JAMP)."* In 1941, the "*Japan Radiological Society (JRS)"* was founded. This is the parent body of JARP. "*Nippon Acta Radiological"* was started as the official journal of the new society. In 1953, a small body of physicists and radiobiologists, called "Physics Commission," was formed as a subgroup of JRS. This small group with 15 members grew to present JARP.In 1961, a new association "Professional Commission of Physics" started that was a beginning of the present JARP with some 40 members.

In 1980, another society, the "Japanese Association of Medical Physics" (JAMP), was formed and it joined the International Organization for Medical Physics (IOMP). The number of JARP members was 6560 and that of JAMP was 50. In 1981, JARP's official journal "Japan Radiological Physics" was started and in 1987 the bylaw of accreditation of a "Certified Medical Physicist" came into effect. JAMP was established by the members of JARP with the purpose of making possible the affiliation to the IOMP and with the view of encouraging scientists and engineers from other fields to work in medicine. JAMP has annual scientific meetings and has currently (1991) 157 members, whereas JARP has 695 members and 10 committees, holds biannual meetings and publishes the "Japan Radiological Physics."

Accreditation of a "Certified Radiologist" started in 1969. The number of certified radiologists has been increasing along with the number of JRS members. JARP consists of 40% of physicists, 20% of physicians and 32% of technologists. Among the ten Committees there are the Publication Committee, Education Committee, Radiation Dosimetry Committee, Professional Qualification Committee and others. The JARP and JAMP members have been playing important roles in other organizations, such as the Japanese Society for Therapeutic Radiation and Oncology, Japanese Society of Nuclear Medicine, Japanese Society of Medical Imaging Technology, Japanese Health Physics Society and many others. Presentations at JARP meetings dealt mostly (60%) with radiation dosimetry and physics in diagnosis.

The aim and purpose of the accreditation in medical physics was to establish the status and high standard of competence. The certificate is given to an accredited physicist who has a bachelor's degree in physics (or equivalent) and a minimum in-service training of 2-4 years in a medical establishment depending on his or her postgraduate education.Evaluation of "Individual Achievements" is mandatory. The Japan Radiological Society makes periodical evaluation of certified medical physicists to promote continuous improvement of their competence. Seventy JARP members passed the first qualifying examination held in 1987, and were accredited as Certified Medical Physicists. As a result of four such examinations, a total of 90 JARP members has been accredited. Out of the present (1991) 89 certified medical physicists 29 belong to the Departments of Radiology in Medical Schools as members of the teaching staff,

whereas 19 physicists are also on the teaching staff in Health Science Schools for radiology technicians. These are truly medical physicists according to the Japanese standard. According to the "Annual Report for Pharmaceutical Substances," published by the Japanese Ministry of Health and Welfare, in 1989 pharmaceuticals valued at about 5.5×10^{12}¥ (ie 4×10^{10} US dollars) were produced, which was about five times as much as the value of the production of medical equipment and supplies. X-ray film maintains its overwhelming position, the next positions are taken by diagnostic X-ray units, CT machines, ultrasound, endoscopes and dialyzers. For therapy, about 40 accelerators are produced every year, whereas the annual production of SPECT units is about 200. At present (1991) 6,000 X-ray CTs are in operation Japan.In conclusion, it should be stated that in Japan the most important role of a medical physicist is in research, especially in radiology. Medical physicists are also responsible for supporting a high standard of medical services, they are engaged in the safety analysis of newly developed methods, and they work in health physics and education.
(*Adapted from "Japan Radiol. Physics"No.2, 1991)*.

The EFOMP Education, Training and Professional Committee

The Need for Continuing Education for the Medical Physicist

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1. Introduction

One of the objectives of the European Federation of Organisations for Medical Physics (EFOMP) is to formulate recommendations for education and training in medical physics. The first two policy statements were published in 1984, "The Roles, Responsibilities and Status of the Clinical Medical Physicist" [1], mentioning the important professional aspects of education and training, and "Medical Physics Education and Training: The Present European Level and Recommendations for its Future Development" [2].

In the latter document [2] it is recommended in short that *"the education of the clinical medical physicist is divided into three stages. After the first step of bringing the physicist up to a basic standard (B.Sc.) in Physics, Mathematics and other relevant topics in Natural Sciences, the second step is to introduce Medical Physics in postgraduate education. The third step is in-service training in hospitals. After finishing this the physicist can be recognized as a medical physicist at an appropriate level. It should also be possible to reach a senior level by further education and training, and to get a higher academic degree, i.e., M.Sc., Ph.D. or equivalent in Medical Physics."*

Also, in 1984, the Council of the European Community presented a directive laying down the basic measures for the radiation protection of persons undergoing medical examination or treatment. This directive, 84/466/ EURATOM of 3 September 1984, contains in Article 5 the statement: *"A Qualified Expert in radiophysics shall be available to sophisticated department of radiotherapy and nuclear medicine."* EFOMP was invited to help the CE in the definition of the QE(r), assessing existing education and training schemes, making recommendations for competency requirements etc. Thus, the policy statement "Radiation Protection of the Patient in Europe: The Training of the Medical Physicist as a Qualified Expert in Radiophysics." [3] was published in 1988. EFOMP identifies the QE(r) and his/her role and recommends a training programme consisting of (1) fundamental principles, (2) special courses in the main fields of application, and (3) practical experience

"working in a clinical environment under the professional supervision of a qualified medical physicist who is an expert in radiophysics." Communications between CEC and EFOMP have been successful and are continuing. Of special interest are the amendments to this directive now being considered (1996), where explicit requirements are expected to be set out on theoretical and practical training for medical physicists as experts in radiation physics, including requirements on continuing education and training after qualification.

The EFOMP view on harmonisation of standards in training is to concentrate on what the trained medical physicist must be competent to do. In 1993, EFOMP presented guidelines on competency-based training schemes for diagnostic radiology, radiation therapy and nuclear medicine, to be carried out by the National Medical Physics Organisations. Five levels of competency have been assigned to the full career development, related to the roles and responsibilities of the medical physicist.

2. Knowledge, Education and Competence

To acquire and maintain sufficient knowledge and a certain level of competence, both initial and continuing education and training as well as "individual learning" are necessary. To stay professional in a specific area, increasing demands will be made on the individual. The [policy statements mentioned above are mainly concerned with the initial education and training of the medical physicist. Here, aspects of maintaining a certain level of knowledge and competence after qualification are addressed.

Society will have a continually growing need of experts, such as the medical physicist acting as an expert in radiation physics. These experts must have the competence not only to participate statically in their fields of competence, but also to participate actively in changes and developments. Furthermore, society is expecting the experts in radiation physics to promote and stimulate research in their fields of competence for optimising present techniques and methods,
ie minimising risks, increasing quality of medical results and decreasing health system costs. Basic education, as well as further and advanced education and training, must aim at this and provide the conditions required for becoming, and continue being a specialist.

Knowledge is commonly used to mean all that can be or is known; it is more than many facts, and includes also the contributions of the mind, such as understanding concepts, making evaluations, etc.

Four (operational) types of knowledge could be defined in medical physics:

(1)*Common basic knowledge*: speaking, reading, writing and arithmetic. It also includes a knowledge of history, philosophy, civics, etc. - to have profited by ones cultural heritage and to have a moral ethical platform to act on. Other types of common basic knowledge, as defined here, are knowledge of foreign languages, basic computer knowledge, report writing...(provided by family, society, school, university).

(2)*Subject knowledge*: the basis of our professional identity (academic education and training). This means knowledge of relevant topics in natural sciences, mathematics and physics in particular, up to at least a basic standard. Knowledge of medical physics, ie the application of physics in health care, is also included. Other subjects, both within and outside the natural sciences, are often included in both the basic university education and also later. They are, without doubt, of great value to the medical physicist. In this context, however, they should be regarded as "common basic knowledge" or " profession-specific knowledge".

(3)*Profession-specific knowledge:* the necessary complement to "subject knowledge", specifically directed towards a certain profession. The profession-specific theoretical and practical knowledge is just as essential in clinical environment as the subject and basic knowledge. The theoretical part of the profession-specific knowledge covers detailed subject knowledge and also subject knowledge outside the natural sciences, eg. knowledge of medicine, laws and regulations, administration, etc. The clinical practical part is acquired by supervised on-the-job training and by continued clinical experience. The profession-specific training should be organised through national training schemes, where well established larger medical physics departments cooperate with academic education and training centres. Further profession-specific knowledge is provided on the international level; examples are the EFOMP summer schools, the German speaking Medical Physics courses, the Nordic postgraduate Radiation Physics courses, open also for clinical hospital physicists, and the Greek postgraduate courses with English as the official language. It is to be noted that academic education and training to a higher academic level cannot replace the practical experience of on-the-job training.

(4) *Knowledge of the scientific method:* Perhaps the most difficult type of knowledge to acquire (and to teach). This is not the knowledge of facts, but rather proficiency at scientific thinking - tacit knowledge. To be able to think scientifically implies the ability to collect and structure information, to critically review material and to analyse and draw conclusions. The "Scientific Method" is of the utmost importance to the medical physicist in applying "subject knowledge" to the problems of professional life. Furthermore, this is a type of general knowledge of great value in any field. To teach the scientific method is perhaps the most important task in academic education.

3. Professional Life and Continuing Education

According to EFOMP recommendations**,** the physicist can be recognized as a medical physicist at an appropriate level after finishing (1) the basic university education and training in physical sciences, (b) a period of basic medical physics education followed by (3) an appropriate time of on-the-job training. These recommendations are generally accepted as desirable, even if the "trainee problem" has not been solved satisfactorily everywhere (cf. the organisation of practical training for physicians).

Much less accepted, however is the requirement that for everyone with a high level of knowledge, education and competence, a continuing education and training at a correspondingly high level should be available during the whole professional life. The higher the level, the more education and training are needed to maintain the relative level of competence.

The clinically working medical physicist is a member of a team responsible for diagnosis and treatment of patients. He/she is responsible in his/her area of competence for equipment, techniques and methods used in the clinical routine, for introducing and adapting new methods etc., and he/she also often has a responsibility in research and development. The competence of the qualified medical physicist is unique: he/she is a specialist in his/her own right. Scientific and technical developments happen more and more quickly, and it is vital to follow these developments to preserve this specific competence. Many methods used routinely today could just be discerned 15-20 years ago, and the tremendous development of information technology is continually making new and different information, programming and systems strategies available.

EFOMP believes a continuing education and training in the relevant subjects are necessary to maintain the appropriate competence level of a medical physicist.

To illustrate the situation, some examples of areas, where medical physicists have to keep up to date with developments, are given below (mainly from medical radiation physics).

3.1 Radiation protection

The clinical medical physicist working in diagnostic radiology, radiotherapy or nuclear medicine, could generally speaking be said to do radiation protection work. The specific radiation protection tasks require

With the introduction of new types of gamma cameras, such as multihead cameras, ring cameras and PET scanners, and new methods of reconstruction, scatter correction etc. in SPECT, there is a continuous and fast evolution in this specialty. The physicist must have knowledge about developments of new of new pharmaceuticals and techniques for dose calculations. Thus continuing education is necessary for radiation protection of the patient.

3.4. Radiotherapy

In external beam radiotherapy, 3-D treatment planning, using 3D patient models based on 3D CT-imaging with 3D radiation beam data and true 3D dose calculation models, is today available owing to the continuing development of smaller and faster workstations with larger memory capacity. The developments of computer controlled megavoltage treatment units, with multi-leaf collimators and on-line portal imaging systems, allow for more complex treatment techniques together with their verification - "conformal radiotherapy." The developments of computer controlled high-dose-rate afterloading equipment for brachytherapy and of new brachytherapy sources open up new possibilities for individualised treatments. Continuing updates on basic, subject and profession-specific knowledge is necessary to fully utilise the existing facilities and to develop new techniques.

3.5. Other fields of medical physics

- laser applications in medical optics, surgery, etc.
- ultraviolet radiation,
- receptor-targeted radionuclides,
- biomagnetism,
- physical measurements in physiology, neurology, audiology, ophthalmology,
- biomaterials in dentistry, surgery, orthopedics, etc.
- biosensors, etc.

In all these areas where new methods constantly are introduced, the need for continuing education is immediately apparent.

3.6. Management in medical physics

The need for effective management is just as

skills and experience to practise and give advice. Some aspects require several years of experience and continuing education, including for example

#assessing risks-identifying sources or potential sources of radiation exposure,
#updating radiation safety policies,
establishing radiation controls,
#contributing to advances in safety and evaluating advances in radiation safety practice,
updating legislation and its interpretations.

3.2 Imaging

Since the introduction in the 70s of computed X-ray transmission tomography (CT), computers have been introduced with increasing acceleration. Continuing updates on both basic, subject and profession specific knowledge is necessary in the clinical environment, where digital radiology, dynamic CT, fast imaging and spectroscopy in MRI, flow Doppler, PET scanners etc. are introduced.

3.3. Nuclear medicine

important in medical physics as in other aspects of health care. The EFOMP view on organisation has been presented in the 1993 policy statement "Departments of Medical Physics - Advantages, Organisation and Management" [5]. Some management issues are rather specific to the provision of scientific services, and some relevant examples are:

Service provision and finance, e.g., service specifications, work load measures, budget and overheads, contracts and service level agreements.
Quality management and audit skills, see also below.
Man management, e.g., job analysis, personnel specification, interviewing skills, labour planning, staff motivation.
Organisational and departmental issues, e.g., case presentation, assessing priorities, commissioning buildings, selection and tendering for expensive equipment.
Biomedical equipment management.

The need to continually update the specific technical knowledge is immediately apparent.

3.7. Quality assurance in medical physics

Quality Assurance (ISO 9000) is defined as all the planned and systematic actions necessary to provide adequate confidence that a product or a service will satisfy given requirements for quality. In health care the quality systems are by default interdisciplinary, and all aspects, medical, physical and technical, have to be included. Medical physicists have always been heavily involved in what is today called quality control work, such as

- establishing quality standards,
- doing quality measurements,
- setting-up quality control systems with feedback to improve certain chains of action,
- practical QA manual writing,
- defining comprehensive quality assurance programmes.

The quality control work generally covers all types of medical physics activities, thus the necessity of continuing education is indisputable.

4. Conclusions

For most medical physicists, the continuing education mainly consists of individual studies of scientific journals and books (sadly becoming less available due to economic reasons) and to some degree of participation in congresses, symposia, etc. The employer should make means and time available for participation in scientific meetings and symposia as well as for individual studies, the latter also an indispensable part of the normal professional duties, requiring access to adequate literature.

It should be of interest to society, employer and the individual medical physicist that he/she has the opportunity to participate in "refresher courses," where subject experts supply information about scientific developments (subject knowledge). Universities/ equivalent should be responsible for, but necessarily finance, these courses. Universities should have a continuing responsibility for scientists they have produced and examined, and universities are probably the most qualified organisers of such educational programmes. In the same way that software companies send out new version of their software, universities ought to be responsible for a continuing updating of their education and training of old students.

Of equal interest is the updating of profession-specific knowledge; new techniques and methods are introduced and old ones are developed and improved or dropped. These update courses, both theoretical and practical, could be organised through the same channels as those mentioned above in section II.

The employer who invests in knowledge, education and competence by employing scientists, should be interested in keeping an eye on these investments and in discover that the scientist's ability to acquire and use new knowledge is actually utilised. [...]

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MEDICAL PHYSICS - 97

8-12 DECEMBER 1997

The Third International Scientific Conference of the Association of Medical Physicists of Russia

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The deadline for the abstracts of lectures and papers in a computer-ready format
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(also *see* p.2 **International Events**)

GENERAL INFORMATION

√ MEDICAL PHYSICS BOOKS and JOURNALS are available on the Internet everyday. More medical physicists are obtaining e-mail service and more "home pages' are being established . For those not familiar with internet terminology, a "home page" is much more than a "page ." It can contain a great deal of useful information. For example, a new home page at the University of Wisconsin-Madison is " *Medical Physics Books and Journals* ". Its address is **http://www.biostat.wisc.edu/medphys/mpbj.html**. It is a Bibliography of Books and Journals in Print in Medical Physics and Related Fields. It is an electronic successor to the bibliography published by Medical Physics Publishing (MPP) for some years. The new version is much less expensive to produce and maintain. At present it will only be available electronically, but anyone with internet service can download and print any or all of the bibliography. This service will be maintained with donated funds at the University of Wisconsin Dept. of Medical Physics. The "Page MAnagers" are Prof. John Cameron of the University of Wisconsin (e-mail: jrcamero@facstaff.wisc.edu) and Ass.Prof. Kwan-Hoong Ng from the University of Malaya, currently at the University of Wisconsin (e-mail: kngl@facstaff.wisc.edu.

√IUPESM also has a "home page" on Internet**http://minf.vub.ac.be/~ifmbe/iupesm.html** Those of you who have not yet made use of the Internet service are welcome to do so. This Bulletin has also been published on Internet and is accessible at the above address. **IF YOU HAVE AN ACCESS TO INTERNET PLEASE LET ME KNOW AND I WILL STOP SENDING YOU COPIES OF THE PRESENT BULLETIN !**

√A NEWSLETTER of the UP-Delhi Chapter of the ASSOCIATION OF MEDICAL PHYSICISTS OF INDIA have been published for some time now. The Editor is Dr M.M.Rehani and the address of the Editorial Office is : Medical Physics Unit, Institute Rotary Cancer Hospital, A.I.I.M.S., Ansari Nagar, New Delhi-110029. You can obtain copies free of charge.

√ THE GREATPOLAND Cancer Centre organizes International Annual Seminars on "Treatment Planning in Radiotherapy" in Poznan, Poland . The forthcoming 3rd Seminar will be held May 19-20, 1997. The registration fee is 25.00 new Polish zloty ($10.00), which includes materials, lunches, tea and coffee and a social event, should be transferred to the account: PBI S.A. O/Poznan 19801300-592-3700-1 (3rd Spring Seminar-registration).

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√ THE FOLLOWING CONFERENCES are forthcoming(details available on Internet):

☞ 2nd Okayama International Medical Engineering Forum

☞ The 20th Annual International Conference of the IEEE Engineering in Medicine and Biology Society

☞ APCMBE 99

NEWS IN BRIEF

√ **The National** Radiological Protection Board (NRPB) has published a review of information for assessing the deterministic effects on human health likely to arise from exposure to relatively high doses of ionising radiation. It applies advances in techniques for data analysis to the well established clinical and experimental information on such harmful effects.

√ **Interventional MR (fMR)** is a new concept still in the early stages of development. By combining MR and X-ray, clinicians can explore procedures which are not as yet possible using the individual modalities. Initial results indicate that, for certain procedures, fMR may provide a viable alternative.

√ **Varian Associates Inc** announce that its health care subsidiary, Varian Biosynergy Inc., has entered agreement with the University of Arizona to jointly pursue new cancer cures by combining targeted energy with gene therapy.

√ **Hewlett**-Packard has introduced a high-performance, digital, multispecialty imaging solution for the general purpose ultrasound market. The HP Image Point system's standard configuration is said to provide high-quality images across the full range of ultrasound applications, including abdominal, obstetrical, gynaecological, vascular small parts and cardiac.

√ **Research** into brain perfusion imaging with MRI by Philips is currently being carried out in close collaboration with a number of clinical partners.It is a technique that provides functional information about the human brain, beyond morphology.

√ **Strong growth** of ultrasound in developing countries is due to health care cost-cutting and economic boom. The market for this modality has increased by 6.6% since 1992 and is now etimated at US$ 603 million.

Sales of Ultrasound Developing Regions 1992-1995

US$ Mill	**Lat. America**	**Asia & Far East**	**Central E-.Europe**	**Total**
	234.2			
1992	238.6	236.2	96.0	566.4
1993	239.3	250.3	102.9	591.8
1994	135.3	265.0	97.9	602.2
1995	216.7	278.6	98.0	611.9
1996e		297.3	89.6	603.6

NEW BOOKS

An Electron Accelerator Accident in Hanoi, Vietnam, published by IAEA, Vienna

Safety Series 115-International Basic Safety Standards. Sponsored by FAO,IAEA,ILO etc. and WHO, published by IAEA, Vienna

Physics for Medical Imaging, by R.F.Farr and P.J.Allisy-Roberts, published by Sanders via Harcourt Brace & Co, price: US$36.00

Measurement of the Performance Characteristics of X-ray Systems; Part VI: X-ray image intensifier fluorography systems, by J.Robertson, Report No.32 IPEMB.

Measurement of the Performance Characteristics of X-ray Systems used in Medicine. Report No.32, Part II, by Hiles and Starritt, published by IPEMB.

Health Effects of Exposure to Low-Level Ionising Radiation, ed. by W.R.Hendee, published by the Institute of Physics (USA) ,price US$250.00

Medical Radiation Detectors, ed. by N.F.Kember, published by the Institute of Physics (USA), price:US$105.00

A Century of X-rays and Radioactivity in Medicine, by R.F.Mould, published by the Institute of Physics (USA) ,price:US$ 90.00.

Mould's Medical Anecdotes by R.F.Mould, published by Institute of Physics (USA), rice:US$25.00