

Round table

## Medical imaging in the new millennium. How has worldwide health care benefited?

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Numerous papers have analysed the remarkable technical progress made in medical imaging over the past 50 years [1-5]. They have emphasized particularly the diversification of the imaging technologies now available to improve diagnostic and therapeutic decisions for a large number of diseases.

While it is true that the new techniques of medical imaging have contributed greatly to improvements in the quality of health care, it is probable that in much of the world the cost-benefits are not as high as claimed by some "enthusiasts". Regrettably, however, these new and usually expensive methods have not provided real solutions to the major health problems that afflict most of the world's population. How can this be?

There are many reasons. For example, many of the newer examinations take a considerable time to perform and require oral and/or intravascular administration of contrast material or other expensive drugs. Magnetic resonance imaging (MRI), single photon emission computed tomography (SPECT), positron emission tomography (PET), some sophisticated sonography and computed tomography (CT) are all high-cost low-utilization procedures. To the high initial costs of the machines and, often, new buildings, are added the high recurrent costs, complicated and expensive maintenance

and the need for skilled staff to operate the equipment and interpret the result. These factors have restricted the wide distribution of such sophisticated techniques and thus prevented general patient access. At the same time, the diseases for which these new techniques are most useful in diagnosing are not the most common disorders found among the human population. Many of the illnesses diagnosed by these techniques require specialist medical and nursing care, as well as expensive therapy. Equally important, many of these illnesses are due to tumours or chronic degenerative diseases for which there is no satisfactory treatment. To provide good health care, making an accurate diagnosis is but one part of the equation, good treatment must follow.

The World Health Organization (WHO), being very much aware of the discrepancies in the availability of good diagnostic imaging, has enlisted the help of many radiologists who have experience of the conditions in the developing countries. These consultants offer guidance and suggest solutions where there is poor or even no diagnostic imaging present. In addition, efforts have been made to persuade the major suppliers of imaging equipment not to neglect the common illnesses of most of the world's people. Because of the great need for X-ray and ultrasound equipment

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Table 1 Imaging equipment in different geographic areas per million population

Area	Population (millions)	X-ray generators		CT scanners		MRI scanners		PET total			
		Total	Min	Max	Total	Min	Max	Total	Min	Max	
North America	288	64 902	212	348	7 023	8.0	26.2	3 535	1.25	13.5	5
Japan, Australia, New Zealand	146	77 734	202	616	8 321	8.2	63.7	1 607	1.6	12.5	33
Western Europe	355	104 263	99	1 186	3 879	5.7	26.4	1 313	1.6	14.0	65
Eastern Europe	228	41 245	112	261	-	-	-	-	-	-	-
Asia <sup>a</sup>	320	-	-	-	725	1.3	7.1	163	0.04	1.26	2
Latin America	1 340	72 533	28	168	3 176	1.3	13.5	303	0.08	2.14	5
	438	41 972	16	336	-	-	-	-	-	-	-
	293	-	-	-	933	0.6	5.3	21	0.02	0.75	1
Africa <sup>b</sup>	122	4 466	4.4	123	-	-	-	-	-	-	-
	293	-	-	-	89	0.07	0.4	6	0	0.04	-

Source: adapted from [8].

<sup>a</sup>China, Taiwan, Malaysia, Philippines.<sup>b</sup>Including North Africa.

WHO, with the advice of the specialists advisers, has designed equipment suitable for use throughout the world in hospitals and clinics, both small and large. Such equipment has been thoroughly tested in developing world in small rural hospitals, as well as in urban clinics in Sweden, Iceland and other countries. Unfortunately, the price is quite beyond most of the countries where the need is greatest. As a result, the gap between the minority that has access to diagnostic imaging and the majority that does not continues to increase [6].

The need for imaging can be estimated in many ways, at its simplest by observing the ever growing demand for the WHO manuals on radiological interpretation, radiographic techniques, darkroom techniques and ultrasound. Together they have sold over 100 000 copies and have been translated into many languages (for example the Manual of diagnostic ultrasound is now available in at least 14 languages). But there are many practical difficulties in gathering accurate information; as an editorial in the British medical journal noted, "many governments have only the vaguest idea how many people live in their territory" [7]. Nevertheless, sources of data can be found to indicate the need and to show the type of imaging that is required; for example data published by the United Nations Scientific Committee on the Effects of Atomic Radiations (UNSCEAR-2000) [8] and by the Centre de recherche, d'étude et de documentation en économie de la santé (CREDES) [9]. Table 1 shows the number of X-ray generators for medical use, and the number of CT, MRI and PET units in various geographic regions of the world. This table

shows that North America, Western Europe and Japan, Australia and New Zealand, with a total population of less than 800 million people, had over 70% of the X-ray generators, 90% of the CT scanners and 90% of MRI units installed at the time of the report [8]. While the total numbers are undoubtedly increasing, it is certain that there are still great discrepancies in the distribution of imaging equipment, even amongst populations within the same geographical area.

The discrepancies do not occur only in the developing world; in one Western European country there are only 99 X-ray generators for every million people, while another has nearly 1200. The distribution of CT and MRI scanners is also very uneven, even in industrialized countries, which results in a large variation in the use of such techniques. Data from one country in Eastern Europe (Table 2) show that a large number of machines presently in use are more than 20 years old and were produced either locally or by manufacturers in the former communist block.

It is well known that poor radiographic quality can lead to erroneous interpretation which, in turn, affects general health care. As the design of X-ray machines has evolved considerably in the last 15 or 16

years, it is easy to deduce that many X-ray examinations were and still are performed with machines that do not meet the current standards of radiation safety and film quality. This is confirmed by the fact that, in the same Eastern European country, the number of machines acquired from major international manufacturers in the last 10 years has suddenly increased, and many of the previous types of equipment are no longer available. This purchase of expensive capital equipment has occurred despite the economic difficulties the country is facing, demonstrating the role of raising the standard of diagnostic imaging in the improvement of health care.

In spite of the advancements, X-ray machines with the technology of 50 years ago are still produced in a number of countries and sold at competitive prices on the world market. Their purchase allows health authorities the satisfaction of claiming that radiological examinations have been made available to populations previously deprived of this benefit. However, independent review of such equipment by WHO advisers in the past few years has shown that the use of such outdated design results in radiographic quality which is far below acceptable modern standards and that the exposure to radiation is too high. It

Table 2 Age and producers of X-ray machines in one Eastern European country (2000)

Age of equipment (years)	Number of machines per given type of producer			Total no.	%
	Locally produced	Other Eastern European producer	Internationally recognized producer		
Over 20	312	264	30	606	65.6
11-20	109	45	32	186	20.1
Under 10	12	6	114	132	14.3
Total no.	433	316	176	924	100.0
%	46.9	34.1	19.0	100.0	

should be added that such equipment is usually durable and in many small hospitals will last 10-20 years. When eventually replaced, the equipment will be at least 60-70 years out of date. Whole generations of patients will therefore receive substandard care and unnecessary irradiation.

The picture with sonography is a little different and reliable figures are even more difficult to obtain. Ultrasound does not use ionizing radiation and therefore is not so carefully regulated. There has been a tremendous growth in number and use of ultrasound units, with little or no attempt to insist that the users, either physicians (sonologists) or technicians (sonographers) are properly trained. Many of the ultrasound units currently in use do not meet the minimum standards set by WHO. The WHO response to the problem has been to publish the very popular Manual of diagnostic ultrasound, which includes minimum specifications for the general purpose ultrasound unit (WHIS-U/S) and to issue international standards for training [10]. But ultrasound equipment is cheap compared with X-ray machines, is safe, requires no radiation protection and can be used almost anywhere. Already sonography is widely used in some countries to choose the sex of a child; some clinics offer abortion as well as the sonographic examination. The danger of unregulated sonography lies in the large number of diagnostic errors that are made, together with the often high fees paid by the trusting patient. The problems are ethical rather than physical, which does not make them any easier to rectify.

In spite of the low cost and apparent ease of use of sonography, the first choice of imaging equipment is for general radiography, except perhaps in a maternity hospital where ultrasound is routinely needed. Therefore, WHO sought to improve the

standard and availability of general radiography by designing an improved and easy to use X-ray unit, initially named BRS (basic radiological system). When numerous trials and wide experience showed that there was nothing "basic" in the design or image quality obtained with the BRS, the name was changed in 1992 to "WHIS" (WHO Imaging System). The new naming also recognized that imaging is more than radiography and must include general sonography. WHIS-RAD, the designation of the radiographic component of the system, is an X-ray machine designed to consistently produce high quality radiographs even when used by inexperienced operators. Furthermore, it allows minimum exposure to patients and maximum safety for both operators and patients. At the same time, it is easy to install, maintain and operate even in the conditions common in developing countries. It is not affected by fluctuating electrical supply and it has been shown to continue to produce diagnostic quality images even when there has been no electrical input for several days. WHIS-RAD uses a high frequency generator, a design which became available at about the time WHO initiated the project (1978-81). Other advantages over the older equipment include: ease of installation, much lighter weight, more powerful and simpler maintenance. If it were produced in large numbers, it could also be reasonably priced.

The WHIS-RAD machine was only part of the WHO aim. To facilitate the training of the users, WHO headquarters asked their consultants to prepare a set of manuals for radiographic techniques, film processing and film interpretation [11-13]. These were published by WHO during 1985-86 and since then more than 40 different translations have been printed by health authorities or commercial publishers

throughout the world. Recently, after review consultations and in light of practical experience, the specifications of WHIS were updated and the Consumer guide for the purchase of X-ray equipment was published [14] in order to help and guide health care providers when X-ray departments need general radiographic equipment.

In spite of these considerable efforts, the situation of radiological services in the developing world has changed very little and sometimes even deteriorated, as demonstrated in the UNSCEAR-2000 report [8]. The reasons for this lack of success are probable multiple and none will be easy to correct [15]. They include the following.

- The cost of the WHIS has been and still is the major factor preventing its worldwide distribution. The main manufacturers consider that WHO should purchase or mediate the purchase of a large number of machines before a real production line can be started, but such action is not permitted by the laws of the Organization.
- There is also the problem described by the late Professor WP Cockshott as the "capital city syndrome". Many national health authorities are advised by senior radiologists who are based in large cities. This results in imaging equipment being concentrated in large towns, leaving the rural population with very few machines, radiographers and radiologists. Good practice indicates that every imaging unit, even those in small rural hospitals, should be regarded as part of the nearest large radiology department and be supervised by the trained staff of the given department. In this way, standards of imaging and diagnosis could be maintained.

- There is a reluctance of manufacturers to advertise and sell the WHIS-RAD type of machine in industrialized countries, perhaps because it produces films of the same or higher quality than the equipment which is presently sold for general radiography at much higher prices. This refusal to market WHIS-RAD in the industrialized world is not because there are shortcomings in the design. WHIS has been used for many years with great success in suburban clinics in Lund, Sweden, in Iceland and other such countries. An image quality comparison test evaluating in parallel WHIS and other X-ray machines has shown the advantage of the WHO-recommended equipment in an objective way. Yet no major X-ray manufacturer has run an advertising campaign or exhibited and promoted WHIS at any major radiological congress. In fact, the majority of the sales staff appear to be unaware that their companies even make such units. This lack of advertising is a "backhanded" compliment to WHIS. It is too good to put on the market in industrialized countries because it will upset the sales of the more costly equipment marketed to do the same work. Unfortunately this fact prevents the large-scale production of WHIS which would reduce the cost and facilitate the distribution of the machine both in developing and industrialized countries.

There can be no denying good contemporary medical care requires diagnostic imaging in order to provide the best treatment and to avoid complications which may lead to permanent disability. The lack of good imaging facilities for more than three-quarters of the world's population should be a matter of real concern for WHO and

health care providers at the national level. Table 3 gives data on the variation in the use of radiological procedures in a number of countries expressed as number of examinations per 1000 population per year. To facilitate the comparison, the number and percentage of CT scans as well as the number of CT machines per million population are given.

It is a common fact that trained staff of a radiology department have an understandable fascination with the latest imaging technologies, such as CT and MRI. In the right setting, for example a large hospital with diversified clinical services, such equipment maybe appropriate, provided the

major needs of patients have been met. This means that everyone anywhere in the country is able to have a limb or a chest X-rayed not far from their home and without undue delay. A minority of patients will then have to be referred for further examination by specialists with more sophisticated equipment. The economic implications are important, and balancing the needs of different patient populations is far from easy. The purchase and installation of one CT-unit will cost more than 10-12 WHIS units, even at the present excessive prices. On a busy day, the CT may scan 10-15 patients, many with incurable diseases. WHIS will provide information essential for the immediate treatment of 40 or more patients of all ages, many of whom will go back to work or to their families after straightforward treatment. The running and maintenance costs for WHIS are only a minute proportion of those of a CT unit, and more sophisticated imaging such as MRI and PET are even more costly.

Looking at Table 3, the following observations can be made.

- Radiography remains the most frequently needed diagnostic imaging tool throughout the world.
- The number of X-ray investigations per 1000 population per year shows very large variations from 7 to 1284. These differences are due to a number of factors such as:
  - population access to radiological facilities;
  - the availability of equipment and qualified personnel;
  - financial resources for imaging equipment and supplies;
  - diseases patterns (types and prevalence of diseases);
  - age structure of the population, and sociocultural and religious patterns;

Table 3 X-ray and CT scanner use in various populations

Country	Number <sup>a</sup>		CT % <sup>b</sup>	CT <sup>c</sup>
	X-ray	CT scans		
United States of America	962	91	9.5	26.2
Greece	?	87		14.3
Cyprus	937	69	7.3	12.3
Germany	1284	64	5.1	17.2
Slovakia	800	54	6.8	5.8
Australia	565	52	9.2	18.8
Norway	708	48	6.7	17.3
Hungary	475	43	9.0	5.2
Switzerland	750	43	5.7	26.4
Canada	892	41	4.3	8.0
Sweden	668	35	6.8	13.1
Netherlands	600	32	5.3	8.0
Poland	641	4.4	0.7	1.9
Ghana	7	0.08	1.2	0.17

Source: adapted from [8].

<sup>a</sup>Number examinations per 1000 population per year.

<sup>b</sup>CT scans as % of annual total numbers of diagnostic medical imaging examinations.

<sup>c</sup>CT scanners per million population.

- extent of industrialization and urbanization, traffic, trauma;
- education of staff and patients, traditions in local health care, etc.
- The workload of the imaging equipment also varies considerably: X-ray units perform from 632 to 19 125 examinations per year and CT scanners from 470 to 8269 examinations per year. This suggests that in some countries there is an excess of equipment beyond the present needs, while a large part of the world's population lacks reliable X-ray machines for the most basic and essential investigations.
- From these data it is possible to derive figures for average use which can be used for planning for imaging equipment. For a large number of countries, rational planning figures seem to be:
  - between 3000 and 6000 examinations per X-ray machine per year;
  - between 100 to 600 X-ray examinations per 1000 persons per year.
- Comparing the present situation with the figures suggested above and with the previous UNSCEAR data it is clear that the situation of diagnostic radiology has not improved but instead has deteriorated.
- The number of CT scanners has continued to rise, even in countries with very low health expenditure per inhabitant despite the high initial and recurrent costs, the skill required to use such scanners and to treat the diseases diagnosed. The workload of CT scanners and their use varies greatly, from 0.08 to 91 examinations per 1000 persons per year representing between 0.8% and 9.5% of the total number of radiological examinations.

It is not easy to explain why in some countries where radiological facilities are

not highly developed, there are a significant number of CT examinations and a very high workload per machine. It would be very helpful to know if so many scans are justified and if the therapeutic measures which were indicated by the CT findings were available and effectively applied. If there are no satisfactory answers to these questions, it becomes difficult to justify the decision to purchase such expensive equipment, particularly if the X-ray facilities are still lacking. It would seem that improving general X-ray facilities is for more justified in the present circumstances of radiology for more than three-quarters of the world.

The commonest imaging examinations worldwide, including countries in Western Europe, are the chest (lungs) and the skeleton (usually for trauma, especially the limbs). The increased use of sonography has not altered this pattern in any significant way. CT is not indicated as the first examination for the chest or skeleton, except for the skull. It must be recognized that CT and MRI are of major importance for intracranial and many soft-tissue diagnoses. However, these are not the major reasons for imaging, and sonography could provide vital information for most intra-abdominal diseases. Purchasing decisions must be based on the most efficient use of the available funds to serve the needs of the majority of patients.

The UNSCEAR report covers only the imaging techniques using ionizing radiation. To get a more complete picture other sources of data are needed. CREDES in France published data on imaging investigations in hospitalized patients for the years 1991-92 [9]. Most hospitalized patients are more severely ill and in need of a greater number and variety of imaging procedures, and the CREDES data show the following: 80.6% all imaging was radiography; 13.7% was ultrasound; 4.8% was CT and MRI;

0.9% was imaging by nuclear medicine. It is highly likely that a mix of out- and inpatients, as found in any patient population, will require far less use of sophisticated techniques (CT, MRI) than shown by the CREDES report. Therefore WHIS-RAD could satisfy a very important part of the diagnostic imaging needs of the world's population.

Finally, it is necessary to look at the appropriateness of the imaging, rather than at the figures showing the actual use. Are all the examinations really needed? The American College of Radiology Project on Appropriateness Criteria [16] was intended to increase the efficient use of diagnostic imaging and followed an earlier study named Efficacy-Efficiency in Radiology. WHO, inspired by this project and its equivalent from the Royal College of Radiology in the United Kingdom, organized international study groups, which resulted in the publication of four technical reports [17-20]. All provided guidelines for the appropriate choice of imaging technique best suited to the clinical problem of the patient, with the aim of improving the end results of imaging procedures and reducing the number of unjustified and unnecessary examinations. The notion of "appropriateness" includes the following attributes: validity, reliability/reproducibility, clinical applicability and flexibility, clarity, multi-disciplinary process, scheduled review and documentation. To simplify the understanding of appropriateness a scale from 1 to 9 was chosen, with one as the least appropriate and nine the most. Using this scale, if one considers 22 clinical conditions, each with a number of variants (a total of 132 pathological conditions) from the viewpoint of the imaging technology radiographic examination (plain and contrast) is most appropriate for 58 conditions; CT (plain or contrast) for 22; MRI (with or

without contrast) for 21; dual scan absorptiometry for 12; and bone scans (nuclear medicine) for 6.

It is important to remember that the conclusions of the American College of Radiology and the Royal College of Radiology refer to the pattern of diseases which are common in the respective countries. They are not representative or even always appropriate for the type of disease patterns most commonly found in other parts of the world, where the role of radiography is probably much higher. The WHO technical reports are more international as the expertise used comes from many different parts of the world.

The WHO initiative to improve the world coverage of radiological services has had a low profile since 1988. This has encouraged the industry to go ahead with the production of high-cost, low-use machines, for which a lucrative market exists in the industrialized world. The virtues of these scanners are extolled in journals and congresses devoted to radiology, further convincing the health authorities in developing world that this is the type of equipment which must be purchased. It is understandable therefore that the real needs of most of the world's people have not been satisfied.

It is necessary to consider a new approach to remedy the situation. The WHO concept that has been applied to improve pharmaceutical-drug coverage could be copied in the field of medical imaging and also in other domains of medical equipment. International cooperation, with the support of major producers of medical equipment, should be pursued and would, one hopes, lead to an adequate supply of affordable medical devices to cover the needs of the majority of the world's population. This would result in a real improvement in world health.



WHO should give due consideration to this idea and initiate negotiations with the producers of medical equipment. It will be a hard and long task but the success of such an endeavour would result in enormous benefits to the people of the world.

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### Commentary

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It is quite obvious that Dr Racouveau is an expert in the subject of medical imaging and its influence on health care, simply because in his paper he has dealt with this problem from all aspects. He has analysed the existing situation and given a short historical background of the development of the basic radiological system (BRS) and WHIS-RAD.

Dr Racouveau has discussed the various reasons why the World Health Organization's (WHO's) aim to provide good radiological services has still not been fully achieved in spite of the continuous and great efforts being made by the Organization in the form of provision of manuals and consumer guides on different aspects of imaging, particularly X-ray, ultrasound and dark room techniques. Dr Racouveau attributes this lack of success mainly to the high cost of the machine and pharmaceutical agents used in different examinations, a lack of proper advertising by the manu-

facturers, the absence of a proper production line because of a lack of guaranteed purchase demands. "Capital city syndrome" which results in a concentration of imaging equipment in cities is another important reason given.

In his conclusion Dr Racouveau highlights how to rectify this imbalance in the availability of good basic diagnostic imaging techniques for adequate health care. He emphasizes that WHO may benefit from its previous experience with the pharmaceutical industry in the field of pharmaceuticals production and apply this to the field of medical imaging. Dr Racouveau believes that WHO should start negotiations with the medical equipment producers in order to ensure that affordable and satisfactory medical equipment can be made available in all countries and to all people.

In my opinion Dr Racouveau should have obtained more recent data than those he presents here, which go back some

time. In addition, Dr Racoveanu did not emphasize the importance of utilizing the expertise in different parts of the world by persuading experts in the field to participate actively in solving the problem of the provision of adequate medical imaging in health care in order to help fulfill WHO goals in this area. In this context, from my long experience (over 37 years) in the field of radiology and medical imaging, I would recommend that WHO recruit small groups of eminent experts (say two or three) in the

field of medical imaging to visit the different countries exploring if and how far the WIIS-RAD system is applied. These groups could discuss with the local authorities the introduction and use of such a system. Financing these projects could come mainly from the medical equipment manufacturers. Reappraisal of the specifications of each technique could also be carried out by experts in the field with the aim of lowering the costs.

#### *Commentary*

#### **Dr Philip F.S. Palmer**

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Dr Racoveanu has written an important review article on the difficulties that face many countries when trying to provide diagnostic imaging equipment, particularly to meet the needs of the majority of the population.

First, why should we listen to Dr Racoveanu of Hanover? Because he writes with considerable knowledge, gained first as a physician with special training in nuclear medicine, and in the public health services of his native Romania. He then brought his skills to the problems of radiation medicine in the World Health Organization (WHO) Regional Office for the Eastern Mediterranean Region and, appropriately, was subsequently appointed Chief of Radiation Medicine at WHO headquarters in Geneva, Switzerland. His article reflects the wide experience he has gained in a very difficult and sometimes controversial subject.

Dr Racoveanu has gathered data to confirm the widely held belief that more than half the population of the world does not have access to diagnostic imaging. Yet ev-

eryone and their doctors need X-ray or ultrasound images to diagnose and treat almost all the common causes of significant ill health. Dr Racoveanu also describes the radiographic unit specified by WHO, the "WHIS", as the minimum acceptable quality for good health care anywhere, recognizing that the same standards must apply for patients in the developing world as are expected in the more advanced countries. WHIS has been thoroughly tested in all levels of health facility, probably more thoroughly and independently tested than any other piece of imaging equipment; there is no doubt that it has met expectations and is exactly what is needed. It works extremely well in a variety of hospitals, small and large, urban and rural. It is not universally available because the price is too high.

It is here that Dr Racoveanu's conclusions become so very important. There is a conflict in the acquisition of every item of health care equipment, from bandages, to drugs, to equipment: the conflict between

what is desirable and the reality of what can be afforded. It is surely not the right solution to lower our standards and believe we can then serve more patients. There must be a minimum level, judged only by the errors and failures that result when standards are not kept. This has nothing to do with complex or advanced health care, although these must have high standards also. The principle (of a minimum quality) applies to all that is done for every patient: the water must be clean, the food should be adequate and nutritious and the essential drugs must be available. Equally, satisfactory imaging must be available to provide the images needed to show clearly the underlying pathology and allow the correct treatment of a patient.

The need for WHIS is enormous. The data in Dr Racoveanu's report show that many thousands of units are required yet the manufacturers have suggested that a bulk order from WHO is needed to bring the price down. This is clearly ridiculous. Every company in the world follows the production of a new idea with intense advertising; why should WHO do this for them? Simply, because the companies do not want WHIS widely marketed because it would compete with more expensive units and do the job much better. The work in Lund mentioned by Dr Racoveanu has clearly shown that the standard of radiographs produced by WHIS equals or exceeds that from much larger and far more expensive equipment in a big university hospital, as judged by the same academic radiologists.

The sale of drugs faces the same hurdles. The market for drugs to treat many common tropical and sub-tropical diseases is huge but the profit margins will be low. Pharmaceutical companies claim that they cannot afford to produce the drugs at a lower price, yet supermarkets operate

worldwide on a large turnover of low-cost items. It has even proved impossible to get WHIS manufactured in low-cost countries because, as with drugs, a generic WHIS would ruin the market for the artificially high priced versions produced in the Western world. Because some components, such as the X-ray tubes and parts of the high frequency generators, might have to be imported (at least at the start) the major companies are in the position to prevent their subsidiaries from making the WHIS where labour costs are low, or they charge excessive prices for the specialized items. They prefer their subsidiaries to make the outdated equipment described by Dr Racoveanu because it is no threat to their own markets. The fact that these units produce sub-standard radiographs, which will result in clinically important errors, is not allowed to interfere with these companies' decisions. No manufacturer of X-ray equipment has a patent on the design of the WHIS; it was designed by WHO advisers and is available to anyone, provided the completed equipment meets all WHO specifications.

Dr Racoveanu suggests one solution and, while this is feasible, there is another way to influence the market place. WHO must embark on an education programme to show how important it is to have high quality images and to illustrate the benefits of the WHO specifications for all essential diagnostic imaging. Such a programme must also clearly demonstrate the dangers of low-standard, outdated equipment. For example the high radiation dosage for patients and staff, and the high error rate when poor quality images are interpreted, especially by non-radiologists. Non-radiologist interpretation is usual in the vast majority of small hospitals and, in some countries, in large hospitals as well: the error rate has been shown to reach 30%-

50% [1]. Nor should capital cost be the only consideration. Studies carried out for WHO have documented decreased film and processing costs when using the WHIS design. Over the 10–20 year life of the equipment, it will not prove very expensive to run.

It is also important to educate many of the senior radiologists who advise health service administrators. Dr Racoveanu mentions the “capital city syndrome”, which is only too common. Many senior and highly expert radiologists who advise ministries of health do not know about WHIS; the manufacturing companies have been careful not to advertise the product! This is where independent WHO-advisers may be very helpful.

The next push to increase equipment sales will extol the wonders of digital imaging and teleradiology. Both are indeed major advances but currently any digital X-ray unit costs more than three times a WHIS unit and will not improve the diagnostic results for the commonest examinations. Moreover, there are many extra costs to transmit the images and maintain such equipment. For example: while an X-ray film can be carried immediately to any part of a hospital or clinic, digital images must be viewed on very high-resolution

monitors if the images are to be correctly interpreted. It will be very expensive to have multiple interconnected monitors so that the doctors, without walking to the X-ray department, can see the patient's images whenever necessary, in the emergency room, clinic, ward or operating room. It is wise, however, to require (in writing) that any new X-ray equipment be so designed that it can later be easily adapted for digital techniques; the WHIS design already allows a simple conversion at any time, should the cost of the digital accessories become more accessible.

The majority of the common health complaints of patients all around the world are because of coughs and fractures. I sometimes dream (quite wrongly) that the choice between high- and low-technology imaging equipment will be made by an official who has broken a leg or developed a bad cough and needs immediate treatment somewhere in a remote part of the country. The correct choice would be made at once! But, WHIS is not a dream: it exists now to help patients whoever they are and wherever they may be.

Dr Racoveanu has delivered a message that needs to be heard and must then be followed up by action.

### References

- 1 Palmer PE. The challenge of international radiological education. The First Antoine Beclere Lecture of the International Society of Radiology, Beijing, China, 1996. *Radiology*, 1997, 202(3): 643–9.