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MEDICAL TECHNOLOGY AND HEALTH

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Abstract. Health Technology (HT) or Medical Technology is at present one of the important reasons of inequity in Health Care visible in our world as demonstrated very clearly by the UNSCEAR 2000. Data of this document demonstrate that less than 25% of the world population has reasonable access to diagnostic radiology and that situation is not improving but on the contrary, deteriorating. The main reason are the high cost of Health Devices which are not designed with the view to serve the world at large. The solution to this situation is to change the actual policy imposed by the industry and to adopt the approach used in the field of "essential drugs", which means to design appropriate HT devices responding to the following criteria: 1- scientifically and technically valid-producing better outcome; 2-reliable and reproducible; 3- affordable by those who need the HT; 4-clear, unambiguous in functions; 5-multidisciplinary in concept, maintenance and utilization; 6-periodically revised and improved; 7- adequately documented and certified. With such approach supported by the users and producers of HT it will be possible to offer to the majority of those deprived today the opportunity to see the improvement of the health status they deserve.
Key words: radiological equipment, diagnostic radiology, QA programmes

Rezumat. Tehnologia medicală este în prezent una din cauzele principale ale inechității existente în domeniul îngrijirilor de sănătate, fapt demonstrat foarte clar în raportul Comitetului Ştiinţific al Organizației Națiunilor Unite privind Efectele Radiațiilor Atomice (UNSCEAR) din 2000. Datele acestui document demonstrează că mai puțin de 25% din populația lumii are acces în condiții satisfăcătoare la radiologia diagnostică şi această situație nu pare să se îmbunătățească, dimpotrivă. Principalul impediment îl constituie costul ridicat al tehnologiilor în domeniul sănătății care nu sunt concepute pentru a deservi întreaga populație a lumii. Soluția acestei situații este schimbarea politicii actuale impusă de industria producătoare şi adoptarea uneia asemănătoare cu cea utilizată în domeniul ”medicamentelor esențiale ”, ceea ce ar însemna utilizarea de tehnologii adecvate care să răspundă unor criterii ştiinţifice şi tehnice bine precizate. Doar aşa s-ar putea oferi majorității celor care în prezent nu pot utiliza aparatura medicală modernă posibilitatea îmbunătățirii stării de sănătate pe care o merită.
Cuvinte cheie: echipament radiologic, radiologie diagnostică, programe de asigurare a calității

Medical technology (MT) or in a broader sense of the word Health Technology (HT) includes the equipments and technologies (hard and soft) aimed to both diseases prevention, diagnosis and treatment and patients rehabilitation.

The very fast integration of scientific and technological developments occurred during the last decades of 20th century allowed a quickly progress of HT in

some fields. Diagnostic imaging is a perfect example as analysed by the amount of papers published in Radiology by reputed professionals (1÷3).
Today, the health care disposes of technologies to prevent many communicable diseases or to early detection of some malignancies such as cervix and breast cancer.
The diagnosis and staging of diseases have been highly improved by this imaging development. Laboratory technologies and surgery progressed not only in widening the field but developing the minimal invasive techniques.
Rehabilitation has become a reality and outcome of all these acquisitions become visible on population lifespan, particularly in the countries where the overwhelming majority had access to HT.
It is this particular aspect of the access to HT which I want to discuss as one of the causes of inequity in health domain, so obvious in our world with deep social, political even religious consequences.
The radiological diagnostic examinations data published by UNSCEAR-2000 Report have been used as a HT example (4). Although the document covers the period between 1991 and 1996 very likely, no major changes occurred during the last years. An indicator used by UNSCEAR to stratifies the world countries in four levels of health care (HCL) is the number of physicians per million population.

Table 1. Number of physicians and radiologists per million population

HCL	Physicians (no)			Radiologists (no)			Population	
	min.	max.	aver.	min.	max.	aver.	million	%
I	1282	4750	2874	3	405	106	1,510	26
II	390	1540	695	0	222	76	3,070	53
III	130	409	208	0	14	5	640	11
IV	30	80	45	0	0.4	0.1	580	10

As table 1 data demonstrates only 26 p. cent of world population has access more or less reasonable to health care. When HT is expressed as radiological examinations the inequity become more evident, even among the countries of HCL I, considered as a most advantaged category.
Tables 2 presents a worldwide picture of the diagnostic and therapy equipments using ionizing radiations and magnetic resonance imaging (MRI).

Table 2. Diagnostic and therapy equipment per million population (1991-96)

HCL	X-ray generators general use			CT scanners			MRI			Teletherapy highvoltage		
	min.	max.	aver.	min.	max.	aver.	min.	max.	aver.	min.	max.	aver.
I	48	1186	293	0.3	63.7	17.4	0	18.5	5.7	0	9.22	4.60
II	12	201	58	0	7.1	2.4	0	0.5	0.14	0	3.54	0.78
III	4.7	123	38	0	1.1	0.44	0	0.26	0.13	0	1.01	0.21
IV	-	-	4.4	0	0.14	0.11	0	0.07	0.04	0	0.45	0.07

Table 3 indicates the annual number of X-ray exams per 1000 population and the resulted collective dose (4).

The lowest number of 48 X-ray generators (table 2) for all purposes use cannot cover the diagnostic needs of any million population.

Table 3. Number of X-ray examinations for 1000 population/year

HCL	X-ray examinations			CT examinations			Annual collective effective dose (man Sv)
	min.	max.	aver.	min.	max.	aver.	
I	180	1477	920	0.02	91	48	1,875,000
II	45	306	154	0	13	6.7	425,000
III+IV	7	37	18.4	0	0.21	0.13	27,000

The consequences are in the delay of an accurate diagnosis and appropriate treatments of simple and highly curable pathology as trauma or some acute conditions of respiratory tract.

The situation becomes really inconceivable for countries where a million of people is sharing 12 or less X-ray machines. If are considerate all factors involved: geographical distribution of X-ray departments; transport facilities; climatic conditions; the supply with films and chemicals; machines time down related to obsolescence as well as the availability of personnel operating the machines it is very clear that many people who could benefit from a timely performed X-ray are not doing it.

Analysing the temporal trend of annually X-ray diagnostic examinations and teleradiotherapy treatments made available by UNSCEAR-2000 Report (table 4 and 5), resulted that about 20% of world population benefits of the advances of medical technology in a more or less “free way” while for 50% of population the use of diagnostic radiology is heavily restricted and for remaining people, almost inexistent.

Table 4. Temporal trend of annual X-ray examinations per 1000 population

HCL	1970-79	1980-84	1985-90	1991-96
I	820	810	890	920
II	-	140	120	154
III+IV	35	-	64	40

Table 5. Temporal trends in teleradiotherapy treatments per 1000 population/year

HCL	1970-79	1980-84	1985-90	1991-96		
	average	average	average	min.	max.	average
I	1.0	2.4	1.2	0.23	3.65	1.50
II	0.1	-	0.2	0	3.12	0.65
III	-	-	0.1	0	2.06	0.46
IV	-	-	-	-	-	0.05

It is difficult to believe that other health technologies such as: clinical laboratory, endoscopy, surgery and especially the "minimal invasive" one, are in better situation in countries where the per capita health expenditure is very low and health care facilities unevenly distributed.

Among the factors influencing the usage HT I have mentioned the "obsolescence" of devices. It is known that the technically complex and costly medical devices are more quickly outdated and replaced by a new generation, which usually is labeled as real "improvement". The new machine is praised of solving the deficiencies of previous generation, which were never acknowledged during the advertising period for clinical use.

Even HT which are less fashionable and therefore not so rapidly "outdated" such as an X-ray machine, has a "life time". The progress of the radiological techniques have imposed new requirements and the advent of new generators, X-ray tubes, image treatment modalities, have offered the possibility to produce equipment with real improved performances. Due to the lack of adequate information and understanding of the stringent needs of the majority of the world population the producers of X-ray machines have not facilitated the diffusion of the newly designed equipment. The principal obstacle is an economical one, the cost of the new machines was almost inaccessible to a greater part of the world and as an alternative, machines with an obsolete technology or with very limited performances, have been purchased. The poor quality of the examinations and high patient exposure are the main consequences of this unfortunate decision taken by many countries. Quantitative information from one country in Europe about the X-ray machines age and producer (table 6) demonstrate that in countries belonging to Level I the situation of HT is far from expectations and that the process of "aging" is a real factor which hinders the efficacy of the radiological diagnostic (5).

Table 6. Age and manufacturer origin of X-ray machines in a Eastern European country

Age (years)	Number of machines installed according to manufacturer origin				
	Local	Eastern Europe	Western Europe	Total	%
> 20	312	264	30	606	65.6
11-20	109	45	32	186	20.1
≤ 10	12	6	114	132	14.3
Total	433	315	176	924	100.0
%	46.8	34.0	19.2	100.0	

Table 6 shows the tendency to replace the machines with outdated technological performances with ones more suitable for high diagnostic quality examination. The poor financial resources and the high prices maintained by internationally

recognized manufacturers have prevented replacing the old equipment as it should have been done. Low quality examinations are the main consequence and the health of the given population is not improving, neither health expenditure nor expectations.

Another factor related to the use of obsolete technologies is the "die hard" techniques which in spite of all data and facts demonstrating the inefficacy or the lack of justification of given procedures are still used sometime on a large scale as screening techniques. Massminiature chest photofluorography and chest fluoroscopy are very pertinent examples of such HT.

It is almost incredible that after more 25 years the WHO had fully documented the mass miniature chest fluorography's lack of efficacy, high costs and risks for patients, in some European countries, the procedure is still performed with annual frequencies between 23 and 60% of total examinations (4).

Chest fluoroscopy is another examination with very limited clinical indications and high patient exposure, especially when no image amplification is used. Despite all warnings concerning these facts the use of this procedure still remained very frequently (up to 60% in China) indicating that the "die hard" techniques are an alarming reality of present health care.

Other investigations in the some category are those clinically unjustified such as chest radiography for employment, administrative, reasons, preoperative routine or radiographies in minor trauma cases (6,7).

All above data tried to justify the idea this paper intended to demonstrate that HT progress is far from being usefully to the worlds' population at large and to have a real impact on the World Health Status at the level which is possible at present. This situation is partially due on the way health technologies were developed and made available to populations. To change this picture it is necessary to review the concept of "Appropriate Health Technology" to redesign the essential equipment for health care according the mentioned concept. As an example for such approach will be described the project developed by WHO for Radiological services WHIS (WHO Imaging System), formerly known as WHO-BRS (Basic Radiographic System) (8).

First a brief review of "appropriateness" of HT, in an already old WHO concept. Four criteria were requested for a technology to be "appropriate": 1-scientific and technologic valid; 2-economically affordable; 3-maintained with the resources and know-how existent locally and 4-accepted by those who are using the technology (health personnel) and those on which is used (patients). To the above four criteria some other three were added by the American College of Radiology (9) and an improved "validity" criteria was defined. A HT is therefore appropriate if answers the following:

1-is scientifically and technically valid, produces better health outcome,

2-is reliable and reproducible, 3-is affordable world wide or as large as the health problem concerned is

spread, 4-is clear and unambiguous in design and utilization, 5-has a multi-disciplinary concept for maintenance and utilization, 6-is periodically reviewed and improved, 7-is adequately documented and certified.

With this updated view on "appropriateness" HT will stand a better chance to serve the world population and improve the World Health Status.

WHIS or BRS was designed with many of the criteria for appropriateness in view and an objective evaluation will found that the mentioned technology fulfill the additional criteria not envisaged at the time when the project was formulated. The hardware of WHIS is an X-ray machine for general radiographic examinations which constitute more than 85-90% of the demands in small hospitals or remote Health Centres. A number of essential parameters have been considered in the technical specifications of the WHIS machine with the aim to obtain a device which will be responding to the criteria of "appropriateness" (6). The examinations which are critical for an X-ray machine as WHIS are chest and lumbar spine lateral. Chest requires a focus-film distance of at least 135-140 cm, a very short exposure and at least 125 kV, while the lumbar spine imposes that during an exposure time not so long (2-4 second) enough radiation to penetrate the body and produce the image in a heavy build person is delivered. The above factors have imposed the minimal power which the generator of WHIS should have and the distance focus-film.

When the machine was under study a new type of generator for X-ray machines was developed- the convertor or high-frequency generator. It was logically to choose the convertor generator, particularly as this was also easy to be used with other sources of electrical power than the main, which is unavailable or of very poor quality in most of the developing world. A rational calculation shows that 15 kV were enough to produce the chest and lumbar spine lateral images with a film-screen system current in use, blue sensitive film and calcium-tungstate screens. But, without special reasons the manufacturers twiced this value and offered 30 kV generators. An anecdotal story with the convertor generator demonstrate how difficult is to get new ideea accepted by the specialists. To prepare the radiologists and the X-ray engineers for the new generator an editorial paper was send to a major radiological journal during the first years of 80. The paper was returned with the comment that the editorial board was not aware of this new device. Few years later it was almost impossible to sell a new X-ray machine in US if it was not having a convertor generator.

The focus-film distance has been fixed at 135-140 cm. which permit a chest image without significant magnification, at the same time the fixed geometry has a number of advantages such as:i-facilitate the patient positioning, ii-exposure variations due to variable focus.film distance are avoided, iii-the lines of the focussed grid are not

visible at 30 cm distance for film viewing.

Only four settings for the kV are used and a rotating collimator with fixed apertures limits the useful beam at the size of the film. A lead shield at the back of the cassette holder absorbs the emerging radiation and permit the installation of the machine in rooms without too complicated protection of walls, particularly in institutions where the workload is relatively low.

WHIS is designed to be operated with different options of power supply such as: a grounded 50/60 Hz power source which can deliver 2.3 kV within 10% disposing of a slow fuse either 10A at 230V or 20 A at 115 V; a lead-acid maintenance free battery pack, rechargeable from the main or from solar cells or a large capacitor discharge. The integrated energy storage system avoid the effect on the exposure of a poor power supply, often encountered in developing world a common factor of poor image quality. The critical choice of technical parameters of WHIS could serve as example in the development of other devices for HT according to the mentioned concept of appropriateness. At the same time it must be mentioned that the WHIS could be also made in an advanced type to be used by fully qualified operator- as radiographers- and the use of light-beam collimators, of posibilities for beam angulation and modern digital image receivers is within the concept of flexibility the given system was ready to include in situations which request such additional improvments. Health Authorities, other providers of health care were aided to get a rational decision in purchasing radiological equipment by a recent WHO publication (10) where all informations on WHIS are given with the relevant technical details.

To complete the hardware described WHIS offers a software consisting of three manuals (7,8).

The above manuals have become a true bestseller of WHO and have been translated in more than 40 different languages and largely distributed worldwide, fact which confirms the real place the WHIS project has in the context of improving health care and diminishing the existant inequity in this field.

However, it is difficult to find a pertinent explanation of the reasons which have contributed to the lack of interest of the major producers of X-ray machines for the project offered by WHO. One reason was the fact that the WHIS solution was contemporary with a number of more « prestigious » imaging devices in full develpoment such as: CT scanner, MRI, digital imaging, a.s.o. much more attractive for the large multinational companies that the product proposed by WHO, an Organization with not very high credit among the decision makers of the X-ray industry. Another reason which has probably its value was the fact that the market for WHIS was not really ready as many of those who needed this type of HT were not aware of its advantages and continued to be mislead in the process of equipment selection. In most countries of the world the meager health care resources were

in good part devoted to expensive HT without too much concern that such technologies have not only a high initial cost but also a very important recurrent one and the effect on the health status of the population is limited, in comparison with the one of WHIS.

I have examined only some of the causes of WHIS very limited distribution worlwide, but we should not disregard the fact that the industry was reluctant to the ideea to promote a HT conceived by specialists which were not within the usual developers of such technologies, the so-called "technology enthusiasts" which are unfortunately sometime misleading not only the producers of HT but also the end users.

The positive experience obtained with WHIS in places where the project was applied and the large distribution of the WHIS Manuals worldwide permit the conclusion that despite the reluctance of the producers of X-ray machines to support and develop the described project, this should not be discarded and new efforts to revive-it appears justified. These efforts could be on a much wider basis extending the ideea to the other areas of HT, which are as much unequally distributed in the contemporary world as X-ray machines.

WHO has already made similar eforts in the field of diagnostic ultrasound for which a Manual was published in 1995 (11) and recommendations for the appropriate devices and a Quality Assurance Programme were made available to providers of health care. As for the previous manuals the one mentioned here was also a real success and was spreaded in a large number of countries.

These facts as well as the data contained in the present paper permit the conclusion that the HT is today in great shortage on a world basis and the care of patients is greatly hindered by this situation. The main factor generating this situation is the "inappropriateness" of many of the existing devices that the manufacturers are offering at very high initial and recurrent costs. A similar situation was in the field of medicines which were kept at very high prices even after the period when the "patent" was running-out and most of the world population didn't have access to the most basic drugs. WHO has initiated in early 70 the concept of "essential drugs" which today has become the real solution to limit the cost of health care even in countries where the mentioned concept was considered totally unrealistic at its inception. In many countries the essential drugs are produced in special premises or in local drug factories and patients are able to benefit fully of the availability of such products. It seems logic to adapt the success of this approach to HT and offer to HT a solution to become accessible to those who at present are unable to use the devices of modern medicine. Borrowing from the success obtained by "essential drugs" it is possible to initiate a similar approach in the field of "Appropriate Health Technology" and concentrate efforts to review, redesign and produce at realistic costs and with

adequate technical parameters the types of medical devices which could really serve the purposes to improve health care worldwide in a significative way.

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