



## EDITORIAL

# Radiology for the People: A Basic Radiological System for Health Care in Developing Nations

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**DOI:** 10.7191/jgr.2019.1083

**Published:** 11/5/2019

**Citation:** Watnick M. Radiology for the people: A basic radiological system for health care in developing nations. *J Glob Radiol.* 2019;5(1):Article 4.

**Keywords:** Basic radiographic system, diagnostic imaging, developing nations, World Health Imaging System-Radiology (WHIS-RAD)

**Word count:** 1,409

In the first decade of the 21st century, highly developed technology has become commonplace and is accepted without reservation as progressive and essential to modern life in the developed world. This has become especially apparent in the field of medicine and diagnostic imaging with modalities such as ultrasound (US), computed tomography (CT), magnetic resonance imaging (MRI) and nuclear molecular imaging becoming rather routine in the diagnostic armamentarium. While considered routine and accessible in developed nations, unfortunately for the greater part of the world's population, these incredible technological break-throughs have virtually no meaning. For approximately 3.6 billion people, or about 60% of the world's population, there is little or not access to the simplest examination such as a chest or extremity radiograph (2). For example, if x-ray capability is available in Guatemala City, patients may have to travel for several days by foot to reach the city where the machine is located. Once they reach the site, lines and wait times may be long, causing significant delay in diagnosis and treatment. This delay in diagnosis and treatment has effects at the individual level with increase in morbidity and mortality, but also at the public health level, as seen with pulmonary tuberculosis, a disease that causes approximately 1.6 million deaths a year throughout the world and about 400,000 in India alone (7). Additionally, tuberculosis has become a very important complication for AIDS patients around the world.

Even if imaging equipment is available in underserved areas, it may not be functional. Generally, due to lack of resources and second-hand donations, there are no service contracts with the manufacturers for maintenance or service for non or malfunctioning equipment. At any point in time up to 60% of the x-ray machines may not be operating due to factors such as broken or missing parts (2). Another 20% may be operating suboptimally (2). Other reasons for this unfortunate state of affairs include limited health care budgets, war time conditions, including embargoes, personnel with little or no training, fluctuating electrical power sources, unfavorable climate conditions, and oppressive non-caring health care systems. Additionally, availability of equipment may be inappropriate for the specific site. For example, a positron emission tomography (PET) scanner would be of little use at a site with no cancer care but requires basic radiography to meet their baseline needs. The vast majority of medical problems in the developing world center around infection, trauma and pregnancy (2). Efforts should be focused on basic radiography, ultrasound and possibly CT. High costs of technology are also a significant barrier. The cost of a single MRI scanner could exhaust the entire health care budget of a small developing nation. It is clear that the basic diagnostic needs of most of humanity are not being satisfied by the current arrangement.

In current times, more sophisticated imaging technologies have been cast aside in favor of more appropriate modalities. For example, during the conflict in the Iraqi desert, air-cooled 2-slice CT units and not water-cooled 16-slice CT units were used in field hospitals, water being a scarce resource. On the navy hospital ship "The Comfort" a single-slice CT unit was installed because of the difficulty in installing the much larger and heavier multi-slice unit.

On the battlefield, hand-held portable ultrasound machines are used in the early diagnosis of battle injuries, in contrast to hospital-based units which are more cumbersome and complicated. These are a few examples of the use of appropriate technology.

Despite this bleak picture of global diagnostic imaging, there is a ray of hope. The basic radiographic system (BRS) as proposed by the World Health Organization is designed to address these issues and work towards providing appropriate imaging resources in the developing world (1). The BRS, first developed by Dr. Richard Chamberlain at the University of Pennsylvania in the 1960s, was known as the Technomatic Unit, and later advanced by the advising group to the World Health Organization in the mid 1970s after careful analysis of the problem. This group, led by Drs. Thune Holm, Philip Palmer, and Gerald Hanson, decided that for the most part, non-operating, non-adaptable donated equipment by well-meaning individuals and groups looking for tax credits was not needed. Expensive high-tech equipment located in large centers in large cities is not widely accessible and will not satisfy the basic diagnostic needs of the great majority of the population. Properly designed equipment should meet the following criteria: (2,5,6)

1. Scientifically valid
2. Adapted to real needs, mainly infection and trauma
3. Acceptable to populations serviced
4. Affordable, simple utilization and maintenance
5. Acceptable to health care providers
6. Must comply with international standards
7. No compromise with image quality

In 1974, after long consultation with engineers, physicists, radiologists, technologists and administrators, the World Health Organization decided on an acceptable design (8). The machine should be simple to operate with a brief training period of approximately eight days for the operator. It should be able to function under extreme climactic conditions and cope with large power fluctuations, operating off a battery or a main-connected rectifier with a storage capacitor. There should be easy installation, usually needing one day, with simple maintenance and repair. The techniques must be standardized with repeats seldom required. In essence, an "instamatic camera" approach was required. The machine was to be stationary, with fixed geometry at 140 cm and simple controls producing plain films only with no fluoroscopy. Although the approach is essentially low-tech, the design specifications would be relatively high-tech but inexpensive. Radiation exposure had to be within acceptable limits. Three manuals were to be published on techniques, dark room processing (not needed with digital application) and interpretation (3,4). The last manual is controversial in that non-radiologists are to be trained in simple interpretation. The paucity of trained diagnostic radiologists in developing nations necessitated

this decision. In 1993, the designation BRS was changed to WHIS-RAD (World Health Imaging System – Radiology).

After observing the use of this system in hospitals in Nicaragua and Costa Rica, I am firmly convinced of the great applicability of this design. The equipment appears to perform well and easily satisfies the requirements of the original design (1). Over the past two decades, approximately 1,500 units have been installed all over the world, mainly in Asia and Africa. The number installed in our hemisphere has been far fewer. The reason for this is open to conjecture. Dr. Chamberlain found that the units he helped to install in Saigon, Vietnam were thought to be too simple and inexpensive to have any prestige. The projects in that country then failed. The impetus for demand must spring from highly motivated health care providers (radiology and primary care). Case in point is the large number of units in Africa, due largely to the efforts of Dr. Palmer and WHO in that region. General Electric, Philips and Siemens no longer manufacture these units, possibly due to low demand and low profit margins. One unit costs \$45,000-\$50,000 USD. Dr. Palmer at the University of California estimated that one unit would be able to service 50,000-100,000 people, with the potential market at about 80,000 units. The only company now manufacturing the unit is Sedecal, a Spanish company. Lack of awareness of the incredible benefits of these units on the part of medical personnel may be another factor for low demand. The simplicity of the unit without "bells and whistles" and the necessity for some interpretations by non-radiologists may be other factors.

Fortunately, a current effort in Guatemala provides a model for other nations around the world. The digital age, and its ability to transmit images over great distances, have the ability to change everything. Twenty-nine units will be installed in remote clinics in Guatemala with transmission of images via the internet to regional health facilities for interpretation. Ten units are already in place. Close cooperation between various partners has made this possible. Rotary District 6440, Illinois, USA, has taken the leadership role; the groups include the Pan American Health Organization (PAHO) which is a part of WHO, other Rotary districts in US and Guatemala, and Guatemala's Ministry of Public Health. Medical schools have also participated. The estimated cost of the project is \$2.5 million (9).

Radiology will be a critical component for the future of a revitalized health care system for the world's population. Hopefully, WHO and PAHO, cooperating with Rotary International, governments, medical schools, and major manufacturers, will make the globalization of basic diagnostic imaging a reality.

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