by Madan M. Rehani

Smart Protection

A 'smart card' that contains patients' information including radiation dose data would help protect them from radiation effects.

Until a decade ago, radiation protection programmes in the world were largely dominated by actions that concerned protection of the staff at the medical facility. Patient protection was felt to be not as important, as it was assumed that a patient undergoes examination with ionizing radiation once or only a few times in his or her lifetime.

When I entered the medical radiological profession in 1972, I was informed that my protection, as a member of staff, was more important than protection of the patient. Most countries of the world had adopted a system whereby it was mandatory to monitor radiation dose to the staff and keep lifetime records of it, while annual dose limits for staff as well as for members of the public were set. It was always felt that the concept of "dose limit" should not apply to patients, because of the associated medical benefits of exposure to radiation.

Further, if you asked the representative of a manufacturer of imaging equipment about the radiation dose to the patient, he would hardly have a clue as no buyer would normally ask such a thing. The image quality and the speed of the examination were the main focus of buyers rather than the radiation dose for patients. Take the example of computed tomography (CT). Every year the manufacturers of CT scanners would announce an improvement in scanning time from the previous year while there would be no mention of radiation dose. Faster scanners are what users want. In fact, most professionals would still instinctively associate lower radiation dose with a quicker scan.

The early emphasis on staff protection did pay rich dividends in terms of making staff safer. Currently, most (nearly 98%) of those who work with ionizing radiation in any area of medical practice receive a radiation dose that is lower than what they get from natural radiation sources — the so-called background radiation, e.g., cosmic radiation, radon, radiation from building material, earth, food, etc. Background radiation depends on the place you live, but typically is 1 mSv to 3 mSv per year, although in some places can be up to 10 mSv. The dose limit for staff currently recommended by the International Commission on Radiological Protection (ICRP), and adopted by the IAEA and most countries with few exceptions, is 20 mSv/year, expressed as 100mSv over a period of five years. Such has been the success of occupational radiation protection programmes that not even 0.5% of staff members who work in medical facilities (or in any nuclear facility) reach or exceed the dose limit.

Since there are no dose limits for patients, many may incorrectly assume that there are no controls on patient exposure. The 1996 International Basic Safety Standards (BSS), developed by the IAEA in cooperation with Food and Agriculture Organization (FAO), International Labour Organization (ILO), Organisation for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA), Pan American Health Organization (PAHO) and World Health Organization (WHO), clearly

Smart Card: This image is not actual and only a representation of what the Smart Card could look like.

stipulates requirements on patient protection that involve the need to justify and optimize radiation doses. Although no dose limits are propagated, the concept of diagnostic reference levels or guidance levels (DRL or GL) has been proposed. This concept has been included in the European BSS and in most national regulations. Thus there are requirements to keep radiation dose for the patient as low as possible without hampering the diagnostic or intended clinical purpose.

Many countries have estimated DRLs based on large scale surveys and have used these to demonstrate a reduction in patient doses with time, say over 10 years. But such reductions have been observed only for simple radiographic examinations such as chest X-rays or X-rays of other parts of the body. The effective dose to the patient from any of these radiographic examinations is typically in the range of 0.02mSv to 2mSv. During the last 100 years, improvements in technology have resulted in dose reduction for single radiographic examinations by a factor of few tens.

However, these are low dose examinations, whereas a single CT scan can impart a dose of 5 mSv to 20 mSv to a patient. On average, a CT scan with 10 mSv effective dose is equivalent to 500 chest X-rays, each with 0.02 mSv. Yet, patients nowadays are not getting lower doses compared to two decades ago. While technology has improved substantially, making it possible to obtain a CT scan with a lower radiation dose than in the past, the usage pattern has been changing. Much better clinical information is obtained, but generally there is no reduction in dose per examination.

This apparent paradox could be better understood by comparing CT scans to personal computers (PCs) and the evolution they have gone through. The price of PCs has changed relatively little over the years, but their performance has improved many fold. Similarly, the diagnostic benefits of CT scans have been increasing over time, as has patient friendliness thanks to shorter scanning times, making it very convenient for patients — unlike MRI scans, which still remain relatively unfriendly for the patient. For a CT scan, you just hold your breath for a few seconds and your whole chest is scanned with CT, or your whole body (head to pelvis) is scanned in about a minute. As for MRI, the patient has to lie in an inconvenient tunnel with the unpleasant noise of gradient coils for almost 40 minutes for each scan. The convenience of CT with the added advantage of increased information has resulted in increased usage to the point that there are instances of patients getting tens of CT scans in a year, which may not be justified, or getting CT scans when it is not indicated. An increasing number of infants and children are also getting CT scans.

A Growing Problem

It is the alarming increase in use of high radiation dose examinations such as CT that is creating a need for cumulative records of patient dose, somewhat similar to the practice adopted for medical staff all these years. Of course, this would be a voluntary system for patient dose records rather than a mandatory system.

It may be argued that in no other practice in the world is a human being exposed to so much radiation as in medical examinations. According to the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), there are over 4 billion medical radiation imaging procedures done annually. Other than natural background radiation, medical uses constitute the next largest source of ionizing radiation to the world's population.

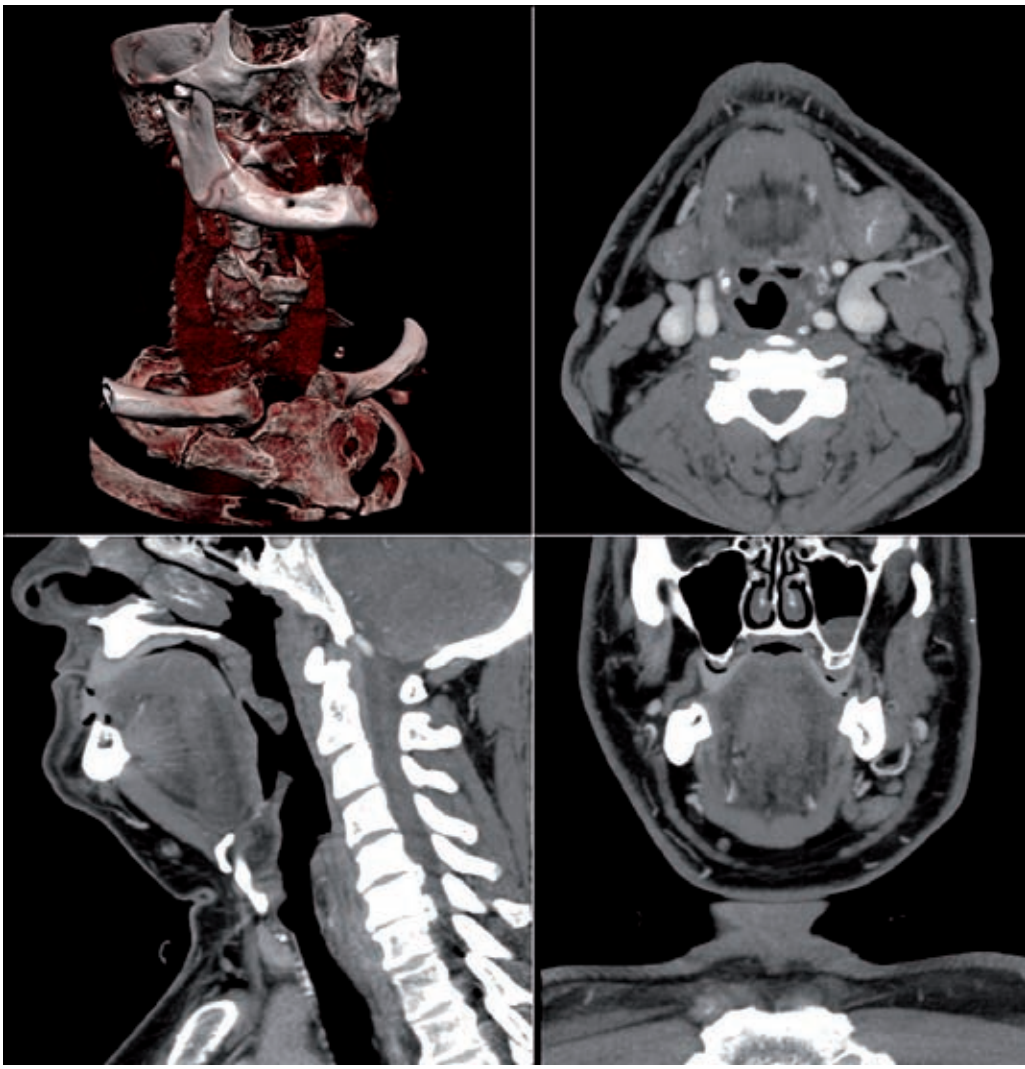
There has been an increased use of X-rays to guide interventions so as to replace surgical procedures. A typical example is angioplasty, which has reduced the need for coronary bypass surgery in many situations. But the patient exposure to radiation is quite large (no less than CT) and there have been a number of reports of radiation-induced skin injuries to patients.

In the early part of twentieth century, when radiation protection measures were not yet established, skin injuries to the hands of those working with X-rays were often observed. Then, for almost 70 years (from the 1920s to 1980s) such injuries largely disappeared. It was in the 1990s that a number of skin injuries in patients undergoing interventional procedures started to be observed. Thus we are now in an era when patient exposure has increased tremendously, is increasing and will continue to increase. Overall, this may not be a bad thing as the medical benefits still outweigh the harm. But there is growing concern about increased cumulative doses to patients. For example, an estimate based on UNSCEAR data indicates that the average life time dose to the patient is almost 200 times higher than the average life time dose to the staff. This means that the conventional dictum that staff protection is more important than patient protection is no longer valid. This calls for action and thinking about the future.

The IAEA is the first UN organization to take a lead in this area, in a clear sign of its commitment to the radiation protection of patients. In fact the IAEA was the first organization to create a separate unit dedicated to the "Radiological protection of patients" in 2001.

An international action plan on radiation protection of patients has been developed involving a number of international organizations such as WHO, PAHO, UNSCEAR, ICRP, European Commission (EC), International Electrotechnical Commission (IEC), International Organization for Standardization (ISO) and professional societies in the field of radiology (ISR), medical physics (IOMP), nuclear medicine (WFNMB), radiographers (ISRRT) and radiation oncology (ESTRO).

The risk of cancer from radiation doses imparted through a number of CT scans is not insignificant. Most other radiation effects (such as skin injury, just to name one) can be avoided rather effectively, but this is not true for the risk of cancer. There are estimates of few millions excess cancers in US over the next two to three decades from about 60 million CT scans done annually.



A Smart Plan

So, what needs to be done? The situation demands records of patient doses such that there is a lifetime record of how much radiation an individual has received. This is a highly ambitious plan full of ifs and buts, but developments in information technology in health care show promise.

One idea is to have a 'smart card' that contains a patient's information including radiation dose data. This is something that is already in sight in several countries, at least for medical records, and if works starts right now it is possible to imagine that it will be possible to add radiation dose information to the smart card. However, more important than that is the electronic health record systems that many countries are aiming at. Imagine a situation where the health records of a patient in a European country (say A) are available on a server in his country. He goes to another doctor in another country (say B) and gives permission for this doctor to access his records. Thus doctor B does not need to repeat many radiological examinations that were already done. Again, this will result in avoidance of additional radiation exposure to millions and millions of patients. This is something that is not a distant dream but could fast become reality.

The IAEA has launched a smart card project that covers both of the above options. The first meeting dedicated to the smart card project is being held in Vienna on 27-29 April 2009. It is anticipated that much of the framework will be decided and partially implemented within 3 to 5 years. The manufacturers of the imaging equipment and those dealing with issues of standards for inter-connectivity and inter-operability will also be involved. After all, it has taken decades to develop occupational dosimetry and still its outreach is far from 100 percent.

It is hoped that despite increasing use of radiation which is for the benefit of patients, it will be possible to keep radiation risks to a level that are acceptable.

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