Member's Paper

From IRPS Bulletin Vol 14 Nos 2/3 September, 2000

Contribution of Patient Dose from Computed Tomography to Human Background Radiation Levels

D. McLean

School of Medical Radiation Sciences, Faculty of the Sciences, University of Sydney
P.O. Box 170, Lidcombe, NSW 2141 Australia

Email : d.mclean@cchs.usyd.edu.au

The current trend in the medical use of diagnostic x-rays is towards the increasing use of digital format images. Computed tomography (CT), however, has been with us clinically for almost 30 years and has had a very significant impact on diagnosis. It is less well known, outside of the area of medical physics, that CT is the biggest contributor of radiation dose to the population from diagnostic radiology[1], which in itself far outstrips the contribution of other medical uses of radiation (such as radiation therapy) to background dose. Tables 1 and 2 show the magnitude and extent of effective doses in the UK, including CT. It is likely that data that are more current would show even higher doses attributable to CT.

The distribution of CT services is uneven as shown in Table 3 (the author would be grateful for any data from other countries) and suggests that clinical constraint may lead to a population reducing dose in some instances. The dose per CT slice could be shown to vary from machine to machine, however it has not reduced appreciably (if at all) over the last 30 years. The advent of continuous patient scanning (so called helical CT as opposed to discrete slice acquisition) has led to an increase in the number of slices per patient. The even more recent introduction of multi-slice (or volume) CT, delivering reduced patient scan time, has given mixed preliminary indications of patient dose when compared to similar previous machines[2].

If one looks at the detector efficiency, one sees that with detector quantum efficiency (DQEs) of >90% that the key to dose reduction is unlikely to lie in new detector efficiency. The high doses seem to be connected to attempts to reduce the image quantum noise levels, by increasing the photon flux at the detector, to allow better visualisation of small contrast structures.

While unnecessary high doses have been controlled in much film-based radiology, by regulatory standards relating to equipment performance and patient dose documentation, it is difficult to presently effect such controls in digitally based imaging equipment. Recent work has suggested that designs utilising feedback from detectors to the x-ray generator (as used in TV based x-ray fluorographic equipment) may have an impact inreducing dose[3]. However, the continued increase in the use of CT, and increasing newer available digital x-ray equipment in radiology poses a significant problem in terms of increasing population radiation levels. This is clearly highlighted in recent incidents of skin erythema doses from x-ray controlled cardiac catheter procedures[4]. It remains to be seen what attention is given this problem and how useful standards can be introduced and implemented to reverse the current trend of increasing population dose from medical diagnosis.

References

[1] J.S. Hughes and M.C. O'Riordan, Report No. NRPB-R263, "Radiation Exposure of the UK Population - 1993 Review", 1993.

2 C.H. McCollough and F. E. Zink, "Performance evaluation of a multi-slice CT system," Medical Physics **26** (11), 2223-2230 (1999).

[3] W.Huda, E. M. Scalzetti, and M. Robskopf, "Effective doses to patients undergoing thoracic computed tomography examinations," Medical Physics **27** (5), 838- 844 (2000).

4 T.B. Shope, "Radiation-induced Skin Injuries from Fluoroscopy," (Office of Science and

Table 1 : Typical patient effective dose for diagnostic procedures in UK (1995)[1]

Examination	mSv
Chest PA	0.017
Abdomen AP	0.7
Skull AP	0.03
Ba Enema	7.2
CT Head	3.5*
CT Abdomen	8.8*

* 1993

Table 2 : Contributions to the annual collective dose from medical X-ray examinations in the UK[1]

Examination	% frequency	% collective dose
Computed tomography	2.4	22
Lumbar spine	3.3	15
Barium enema	0.9	14
Barium meal	1.6	12
Intravenous urography	1.3	11
Abdomen	2.9	8
Pelvis	2.9	6
Chest	24.0	2
Limbs and joints	25.0	1.5
Skull	5.6	1.5
Thoracic spine	0.9	1
Dental	25.0	1
Others	4.2	5
Total	100	100
Annual collective dose from all procedures		20,000 man Sv

Table 3 : CT utilisation in the world

Country	scanners per 10^6 people	exams per 10^3 people
Australia	16-19 ('94)*	60 ('94)
Japan	69 ('95)	97 ('89)
USA	18 ('90)	52 ('90)
NZ	7 ('92)	21 ('92)
UK	6 ('93)	22 ('93)
Norway	16 ('93)	-
Italy	13 ('91)	-

* date of publication