1. RADIATION RISKS OF DEXA TOTAL BODY SCANS

a. What are the risks

Studies of the radiation dose to patients from DEXA scans have confirmed that patient exposure is small compared to many other sources of exposure including most radiological investigations involving ionizing radiation (Huda and Morin, 1996; Njeh et al. 1997; Njej et al. 1999). The radiation hazard to the patient is often expressed in terms of the effective dose (ED). This is defined as the sum of the absorbed doses to each irradiated organ weighted for the radiation type and the radio-sensitivity of that organ (ICRP, 1991). The ED is equivalent to the uniform whole body dose that will put the patient at equivalent risk from the carcinogenesis and genetic effects (ICRP, 1991). For low doses, as encountered in DEXA, the principal risks to patients are the stochastic process of carcinogenesis and genetic effects (Njeh et al. 1999). The dose associated with DEXA BMD measurement (lumbar spine and femur) was described as low or even insignificant in comparison with natural background radiation levels, well below the background value of about 7µSv per day (Njeh et al. 1999). Similarly, Roux (2003) examined non-invasive methods of bone mineral density measurement and found DEXA measures of 0.1-0.4µSv, which was described as having no observable radiological or biological effect and was the same as natural background levels of radiation in France. The radiation dose for total body scans is lower than that of the lumbar spine and proximal femur scans for three reasons:

- Total body scans use a lower x-ray current setting
- The transverse passes of the scan arm do not overlap
- The scan arm moves more quickly down the length of the scan table.

Albanese et al. (2003) recently published the most comprehensive review of body composition measurement using DEXA. There are two main types of image geometry (pencil- and fan-beam) available in DXA units today. Albanese et al. (2003) in their review stated that the radiation exposure from whole body DEXA is relatively low (Table 1). Another interesting finding from the literature was that the dose rate from scanning was found to be so low that:

- multiple scans were used to increase the radiation flux above the detection limit; and
- for the total body fast scan mode, the patient's average skin entrance dose was 0.2µSv (Bezakova et al. 1997; Njeh et al. 1997).

Table 1: Comparison of radiation doses (Albabese et al. 2003)

Type	Model	Patient Dose (μSv)
Body CT scan		5,000-15,000
Head CT scan		2,000-4,000
Lumbar Spine X-ray		600-1,700
Lateral spine X-ray		820
Dental Bitewing		60
Chest X-ray		50
DEXA Total body	Lunar Prodigy	0.37
DEXA Total body	Lunar DPX-L	0.20

Dose limits for occupational exposures are expressed in equivalent doses for deterministic effects in specific tissues and expressed at effective dose for stochastic effects throughout the body. In 1990 the ICRP recommended an annual dose limit of 1mSv for members of the public and below 20mSv per year over 5 year period in the workplace. For pencil-beam systems (Lunar DPX-L), a time-averaged dose to staff from scatter is very low (<1μSv h^{-1}) even with the operator sitting as close as 1m from the patient without shielding during the scanning (Njeh et al. 1997). The annual dose to the operator at 1m would therefore be less than 0.4mSv per year given a typical maximum workload of 16 patients per day. However, these figures are based on two scans per person (spine and femur) for osteoporosis assessment, whereas a total body scan requires only one scan per person, which conceivably halves this figure. Figure 1 provides a guide to the effective dose to patients following different x-ray procedures and dose to the operator at 1 metre.

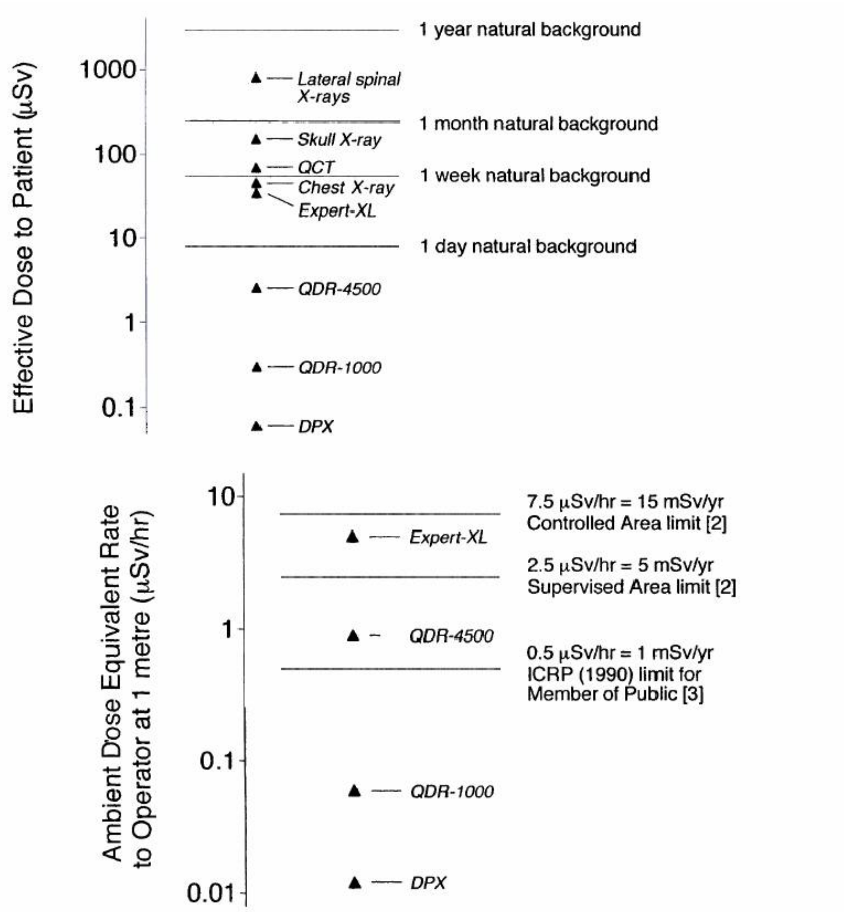

Figure 1: Effective dose to patients and ambient dose equivalent rate to the operator (Njeh et al. 1999). DPX in this figure is the DEXA machine used in this study.

b. Comparing the risks to day-to-day living

In 1990, scientists from the Australian Radiation Laboratory (now part of the Australian Radiation Protection and Nuclear Safety Agency) conducted a nationwide survey of Australian homes to determine the average annual radiation dose to the Australian population from exposure to natural background radiation. They found that the annual average radiation dose to the Australian population from natural background is relatively low, at 2.3mSv (ARPANSA). The prevailing assumption is that any dose of radiation, no matter how small, involves a possibility of risk to human health. However there is no scientific evidence of risk at doses below about 50μSv in a short time or about 100μSv per year. At lower doses and dose rates, up to at least 10μSv per year, the evidence suggests that beneficial effects are as likely as adverse ones (Hall, 1984). The Australian Radiation Protection and Nuclear Safety Agency provides a list of exposure values for natural radiation (Table 2) and we have added to the table the value from exposure to one total body scan from a Lunar DPX-L densitometer.

Table 2: Common values from exposure to radiation in Australia.

Man's Exposure To Ionizing Radiation **Source Of Exposure**	**Exposure**
Natural Radiation (Terrestrial and Airborne)	1.2 mSv per year
Natural Radiation (Cosmic radiation at sea level)	0.3 mSv per year
Total Natural Radiation	**2.3 mSv per year**
Seven Hour Aeroplane Flight	0.05 mSv
Chest X-Ray	0.04 mSv
Cosmic Radiation Exposure of Domestic Airline Pilot	2 mSv per year
DEXA Lunar DPX-L	0.002 mSv

2. REFERENCES

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