

NEW TRENDS AFFECTING SWEDISH PATIENT DOSES FROM DIAGNOSTIC PROCEDURES

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SUMMARY

The number of medical X-ray examinations increased each year until around 1970, then decreased, but apparently increases again after 1980. The dose per examination has gone down since the early 1970ies, probably by around 50 %. In nuclear medicine, the number of examinations trebled from 1963 to 1983, when the trend changed to a decrease. The dose per examination declines, mainly due to substitution of Tc-99m for I-131. The number of dental X-ray films increased fivefold from 1963 to 1983, but the dose per examination has dropped perhaps even faster. The net effect of these trends is a reduction of the collective dose to patients from say 9 000 manSv in the early 1970ies, to say 5 000 manSv in the mid-1980ies.

The technical and medical changes behind these observations are bigger than the collective dose change. The results provide a platform for policy decisions: Is further dose reduction warranted? Does the examination serve its purpose? How do we optimize doses and image quality?

MEDICAL X-RAY EXAMINATIONS

Medical X-ray examinations contribute the biggest part by far of the collective dose from diagnostic procedures. Table 1 shows that after a steady increase, their number levelled off from around 1970. Statistics for the entire country (1) are not available after 1980, but data from the county of Stockholm (2) indicate that the number of examinations is now on the rise again. The fall-off during the 1970ies depends on the introduction of alternative modalities. The cause of the recent increase is not clear. In 1986, the National Board of Health and Welfare recommended mammography screening. Nationwide adoption of this will of course lead to many new examinations, but this could not affect statistics before 1986.

Table 1. Number of X-ray examinations, $\times 10^3$

Year:	1950	1960	1965	1971	1974	1977	1980	1983	1985
Entire country	950	2 266	2 908	3 884	3 904	3 684	3 576	?	?
County of Stockholm	?	?	?	914	955	892	896	941	1 022

While the number of examinations increased, doses per examination decreased. This is in part due to a changed selection of examinations. Discontinuance of routine lung photofluoroscopy, e.g., saves some 200 manSv per year. But probably, the most im-

portant change lies in better technique, in terms of more careful work as well as new methods such as faster film-screen combinations.

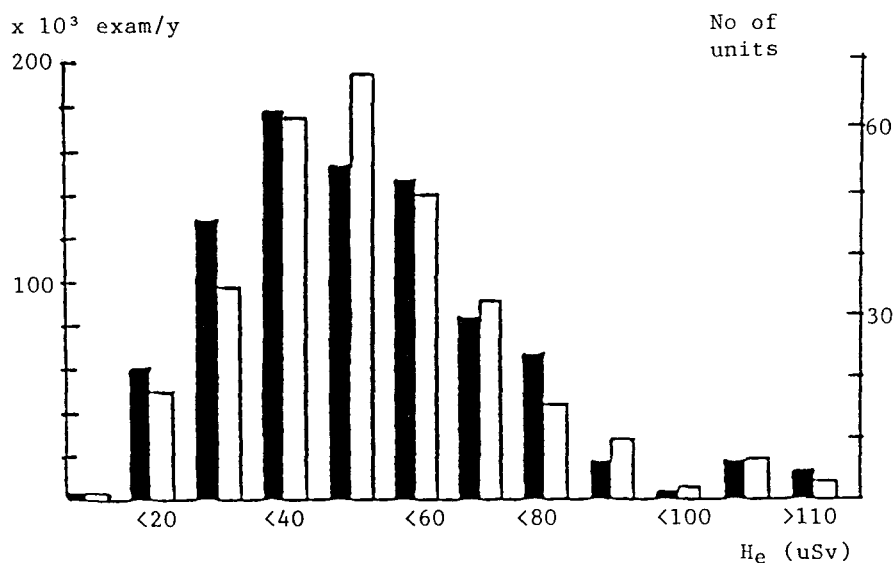
Table 2 compares the energy imparted in some X-ray examinations in Sweden 1974 (3), England 1984 (4) and a Swedish county 1986 (5). For full-size chest examinations, the energy imparted 1984/86 -and hence the dose- are about a quarter of the Swedish 1974 values. The same proportion applies to the other examinations in England, while the average appears to be say 40-50 % in Sweden.

Table 2. Energy imparted to the patient in four routine types of X-ray examination, in mJ

Examination	Sweden, 1974	England, 1984	County of Halland, Sweden 1986
Thoracic spine	210	55	58
Abdomen	200	57	145
Lumbar spine	410	124	167
Chest	21	4.4	7.4

We have also made a survey of all full-size chest units in Sweden. This was designed in collaboration with the US Center for Devices and Radiological Health on basis of their NEXT programme, and CDRH kindly lent us advanced phantoms and other measuring equipment. We do not only look at doses: image quality is tested, individual units are optimized, recurrent problems are attacked in dedicated projects, and the relevance of the use of the unit is considered. Many parameters are registered, among them dose, the distribution of which is shown in Figure 1.

Figure 1. Distribution of effective dose equivalent in full-size chest examinations (black = no. of examinations, white = no. of units), posterior-anterior view



The mean dose is 0.05 mSv, i.e. about a quarter of the 1974 mean of 0.22 mSv. Thus, the Halland data in Table 2 appear representative. If this is true for all four examinations, an average dose reduction by $\frac{1}{2}$ could perhaps be assumed. The 1974 collective dose was c 8 000 manSv (3). With provision for the recently increased number of examinations (Table 1) and discontinued lung photofluoroscopy, the collective dose would now be c 4 500 manSv. Nationwide mammography screening will add perhaps 200 manSv.

EXAMINATIONS IN NUCLEAR MEDICINE

In Sweden, radiopharmaceuticals are only used in public health care. The number of examinations and activities used must be reported to us. Table 3 shows that the number of examinations rose steadily until 1983 and then fell off slightly. The biggest increase concerned Tc-99m in various kinds of scintigraphy. The Tc-99m trends are not monotonical. Bone scintigraphy no longer increases since 1984, liver scintigraphy (where Tc-99m supplanted Au-198 in the early 1970ies) is now replaced by ultrasound, brain examinations are now made with CT scans, and so on. I-131 decreases strongly, which reduces the collective dose. It is still used for function studies, but for thyroid scintigraphy and renography it is replaced by Tc-99m and in recent years I-123. Ultrasound tends to replace I-125 for renal localization. In renal clearance studies Cr-51 finds increasing use. Tl-201 is increasingly used in heart scintigraphy.

Table 3. Number of examinations in nuclear medicine, and proportions used of important nuclides

Year	No of exam:s x 10 ³	Per cent of examinations done with						
		Tc-99m	I-131	I-125	I-123	Au-198	Cr-51	Tl-201
1968	48	5	59	10	-	6	0.4	-
1971	67	20	56	11	-	2	1	-
1974	96	38	38	10	-	0.3	3	-
1977	114	50	28	8	-	0.2	5	0.7
1980	125	59	20	8	0.2	-	6	0.8
1983	132	64	14	6	0.5	-	8	1.6
1986	120	64	13	3	0.9	-	10	3.2

The radiological impact of these examinations is still dominated by I-131, which contributed 51 % to the collective dose. Tc-99m contributed 38 %, Tl-201 6 % and all other nuclides together contributed 5 %. The total collective dose was 720 manSv in 1973 (including I-131 profiles), but in spite of the much bigger number of examinations it was only 420 manSv in 1986 (excluding profiles).

DENTAL X-RAY EXAMINATIONS

A Dental Health Insurance Act introduced in 1974 stipulated X-ray examinations before all expensive treatments. This and other causes have dramatically increased the number of exposed intraoral

films, from 3 million per year in the early 1960ies to 15.7 million 1983 (6). But vast technical improvements and more stringent radiation protection have led to even more marked dose reductions. Here, the collective dose in the early 1970ies is rather loosely estimated as 300 manSv. A thorough estimation for 1983, based on our data from 400 randomly chosen dental offices, shows a collective dose of about 80 manSv (7).

TOTAL IMPACT OF DIAGNOSTIC PROCEDURES

Table 4 summarizes these results, and shows that we believe the collective dose to patients to have decreased by 40-50 % in c 15 years. Now, we find it more and more important to take all factors such as image quality, not only dose, into account. Our aspiration is not to minimize doses, but to optimize processes where radiation is involved.

Table 4. Collective effective dose equivalent in manSv to patients and average per caput dose in mSv from diagnostic procedures in Sweden

Source	Early 1970ies	Middle 1980ies
Medical X-ray examinations	8 000	4 500
Nuclear medicine examinations	700	420
Dental X-ray examinations	<u>300</u>	<u>80</u>
Total, manSv	c 9 000	c 5 000
Average dose per caput, mSv	1.1	0.6

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