

## DOSES FROM NUCLEAR MEDICINE EXAMINATIONS: A 25-YEAR FOLLOW-UP STUDY



XA0101668

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### Abstract

New radiopharmaceuticals have been introduced in nuclear medicine examinations, and on the other hand, the amount of many routine nuclear medicine procedures have been replaced with clinical methods utilising non-ionising radiation (ultrasonography, MRI). To clarify the situation in Finland, a country wide survey on the use of radiopharmaceuticals in diagnostics and therapy was made in 1975, 1982, 1989, 1994, 1997 and will be made in 2000. A questionnaire was sent to all hospitals and institutes using unsealed sources in both diagnostic and therapeutic nuclear medicine procedures. For each procedure, the pharmaceutical used, the number of procedures and the typical administered activities were recorded. The collective effective doses from nuclear medicine examinations were calculated according to the ICRP formulae similarly for each survey. In Finland, in each of these years, more than 50 000 procedures in more than 30 different laboratories were performed. Significant changes in collective doses were observed: for example, the collective dose from I-131 was 350 manSv in 1975, and 20 manSv in 1997. In 1975, 68% (n=23967) of collective dose originated from I-131, whereas in 1997 the percentage of I-131 in collective dose was 10 % (n=1118). In 1994 and 1997, the use of the three radionuclides (Tc-99m, I-131 and Tl-201) accounted for 96 % and 95 %, of the collective effective dose.

Our results indicate that the collective effective dose from nuclear medicine examinations has decreased in last 25 years. National surveys form the basis when setting reference levels for typical nuclear medicine examinations. By introducing reference levels based on national practice it is possible to even decrease the collective effective dose.

### 1. Introduction

Currently more than 50 000 clinical nuclear medicine examinations in more than 30 different laboratories are performed in Finland. Exact data has to be reported regularly to the Radiation and Nuclear Safety Authority based on the implementation of MED-directive. Additionally, data on the frequency and collective effective dose of nuclear medicine examinations in Finland, were available in years 1994 [1] and 1997 [2]. Data was available in years 1975 [3] and 1982 [4] before that. However, the methods for evaluating collective effective dose have been changed. The aim of this study was to calculate collective effective doses from national surveys beginning 1975 in a similar manner, especially for iodine-131. Furthermore we wanted to find out how nuclear medicine procedures have been changed during 1975-2000.

### 2. Materials and methods

A country wide survey on the use of radiopharmaceuticals in diagnostics and therapy was made concerning the years 1975, 1982, 1989, 1994, 1997 and will be made concerning the year 2000. A questionnaire was sent to all hospitals and institutes using unsealed sources in both diagnostic and therapeutic nuclear medicine procedures. For each procedure, the pharmaceutical used, the number of procedures and the typical administered activities were recorded. The collective effective doses were calculated according to the ICRP formulae similarly for each survey. The dose factors (mSv/MBq) given in ICRP 62 [5] were used.

### 3. Results

Information was obtained from all hospitals and institutes. The major component of the collective dose was I-131. Table 1 demonstrates how the collective dose from I-131 has developed between 1975 and 1997.

**Table 1. The collective effective doses from the use of I-131 between 1975 and 1997**

Year	Total number of nuclear medicine examinations	Collective effective dose from I-131 (manSv)	Collective effective dose from I-131 (%)
1975	59350	350	75,9
1982	85340	303	56,6
1989	55730	124	-
1994	50900	33,0	14,9
1997	51730	19,8	9,6

The collective effective dose from I-131 was 350 manSv in 1975, and 20 manSv in 1997, respectively (Table 1). This means, that in 1975 68% (n=23967) of collective dose originated from I-131, whereas in 1997 the percentage of I-131 in collective dose was 10 % (n=1118). The following radionuclides in descending order, Tc-99m, Tl-201, Cr-51, I-131, In-111, I-123, F-18, O-15, C-11, Se-75, Xe-133, Co-57, were used in more than 100 different investigations in 1997. In 1997, the use of Tc-99m, I-131 and Tl-201 accounted for 95 %, of the effective collective dose.

Table 2 demonstrates how the use of bone scintigraphy using Tc-99m-labelled phosphates or diphosphonates has been changed between 1975 and 1997.

**Table 2. The collective doses from the use of Tc-99m-phosphates between 1975 and 1997**

Year	Number of bone scintigraphies	Collective effective dose from Tc-99m (manSv)	Collective effective dose from Tc-99m (%)
1975	2761	8,7	1,8
1982	15266	44,6	8,3
1989	19689	62,2	-
1994	20912	62,6	28,5
1997	21845	71,0	34,3

The total amount of nuclear medicine procedures was higher in the 80's than in the 90's (Table 1). In 1975 there were 42 laboratories and also 42 different diagnostic procedures and a total of 59350 investigations were performed. Nuclear medicine procedures were carried out in 33 laboratories in 1997, and more than 150 different diagnostic procedures were carried

out, even though the total number of investigations was 51730. The amount of bone scintigraphies has stabilized during the last 10 years. The amount of collective effective dose derived from Tc-99m in bone scintigraphy has increased gradually. Figure 1. demonstrates the current practice of bone scintigraphy in different laboratories.

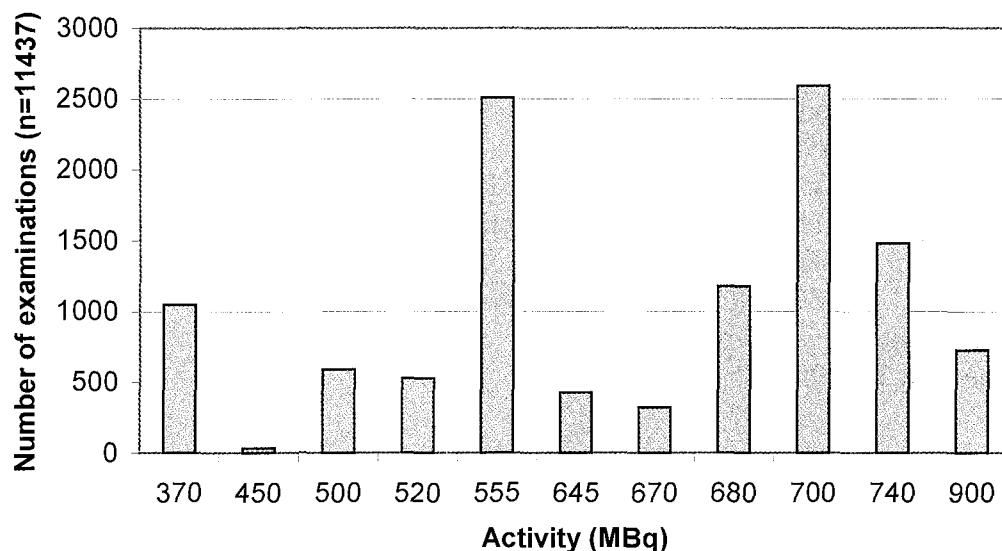


Figure 1. Injected mean activities in bone scintigraphy in Finland in 1997.

#### 4. Discussion

Our results indicate that the collective effective dose from nuclear medicine examinations has decreased in last 25 years. Our results also demonstrate that the total amount of nuclear medicine procedures is nowadays lower than in the 80's. The major constituent of the collective dose has been I-131 (Table 1). Its use has been decreased in a greater extent than those of other radionuclides in diagnostic nuclear medicine.

The influence of Tc-99m on the collective dose derived from bone scintigraphy has increased (Table 2). There is still a great variability in the administered activities between laboratories (Figure 1). Therefore, reference levels are needed. National surveys form the basis for reference levels for administered activities in nuclear medicine examinations. By introducing reference levels based on national practice make it possible to even decrease the collective dose. The reference level planned for bone scintigraphy is 600 MBq and, if SPECT is performed 800 MBq. For comparison, in German national survey [6], in 1992, the mean effective dose from bone scintigraphy was 4.8 mSv per examination whereas our mean effective dose was 3.2 mSv in 1989 and 3.0 mSv in 1994, respectively. In Germany in 1992 [6], the bone scintigraphy was responsible for 38.8 % of the collective effective dose whereas the collective effective dose was in Finland in 1994 28.5%.

In general, the nuclear medicine has developed into right direction during the last 25 years in Finland, i.e. the collective effective dose has decreased and the diversity of nuclear medicine procedures has increased. Also, most of the collective dose originates nowadays from Tc-99m, which is an optimal solution from the radiation protection point of view.

## References

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