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Dosimetric data on radiation workers in Switzerland: Availability and limitations for epidemiological research

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According to the statistical data for the year 1989, there were about 55000 occupationally radiation-exposed persons (radiation workers) in Switzerland (6,6 million inhabitants). The definition of radiation workers, the regulations regarding the control of their radiation exposures, and other related subjects are covered by the Swiss Radiation Protection Regulations of 30.6.1976 (currently in revision)[1]. According to these regulations, individual monitoring of radiation exposure is required. This is currently performed by 10 approved dosimetry services, which are responsible for the regular issue of dosimeters, the dose assessments and the dose record-keeping. The dosimeters, mostly of the TLD type, are issued on a monthly basis. Each radiation worker has to undergo a medical check-up before starting to work. Further medical check-ups follow periodically or when a certain dose limit is exceeded.
Three main national authorities ensure supervision and compliance with the regulations:

- the Federal Office of Public Health (Bundesamt für Gesundheitswesen – BAG) provides supervision for about 86% of all radiation workers.
- The National Accident Insurance Fund (Schweizerische Unfallversicherungsanstalt – SUVA) provides supervision for radiation workers in industry and medical surveillance of all radiation workers.
- the Nuclear Safety Inspectorate (Hauptabteilung für die Sicherheit der Kernanlagen – HSK) provides supervision for radiation workers in nuclear power installations.

The statistical information on radiation exposure of the radiation workers is published in the Annual Report on Occupational Radiation Exposure in Switzerland issued every year, starting in 1975, by the Swiss Federal Commission on Radiological Protection.
Table 1, taken from the Report for 1989[2], shows the main categories of radiation workers and their annual dose distributions. Unlike those of many other countries, Swiss regulations include among radiation workers the work force in dentistry. These workers contribute to the population with the lowest dose exposure. On the other side, the small group of workers in the nuclear power industry, accounting for only 7% of all radiation workers, carries about 75% of the total accumulated dose. Their dose distribution extends towards higher doses and their average annual dose is ten times higher than the overall average.

Dosimetric data on occupational radiation exposure in Switzerland

A definition of radiation workers appeared for the first time in Switzerland in the first Radiation Protection Regulations from April 1963. In 1964 the first dosimetry service (BAG) came into operation, marking the beginning of regular personal dosimetry in Switzerland. There are no official documents on individual radiation exposures before 1964. This means that a radiation worker who started his job before that time cannot have a complete dose history.
Later on, other dosimetry services followed, also private ones. Between 1969 and 1984, the 5 Swiss nuclear power plants were built. From the very beginning they have been providing personal dosimetry for their personnel and for "contract workers" (persons working in the power plants only temporarily, mainly during the maintenance period). All the dosimetry services still have the data which have been collected since they came into operation. Unfortunately, these data often suffer from a lack of complete personal information, which is a result of the regulations which oblige a dosimetry service to send the dosimeters and the assessed dose values to the employer and not to the radiation worker himself. The information collected by the dosimetry service was therefore "dose-oriented", and the connection with the radiation workers was officially made through the employer. However, the dosimetry services did in fact put a lot of effort into gathering personal information even before they were obliged to do so by the new "statements on the approval of dosimetry services".
In the first radiation protection regulations "Radiation Booklets" were introduced, and these are still obligatory. The booklet is a kind of personal radiation passport that every radiation worker should possess, containing personal, employment and dosimetric information. The responsibility for keeping and updating the Radiation Booklet lies with the employer. The Radiation Booklet gives the most complete information on an individual's history of radiation exposure, and the accumulated

Tab. 1. Whole-body external exposures: Number of persons exposed, average doses and employing organisations.

Dosisintervall (mSv) Dose-interval (mSv) Intervalle de dose (mSv)	Spitäler Hospitals Hôpitaux	Arztpraxen Medical practices Cabinets médicaux	Radiologische Arztpraxen Radiological practices Cabinets de médecins radiologues	Zahnärztliche Praxen Dentistry Cabinets dentaires	Universitäten Forschung Universities, research Universités, recherche	Kernkraftwerke Nuclear power stations Centrales nucléaires	Industrie, Handel Trade and Industry Industrie, commerce	Öffentl. Dienste Public services Services publics	Verschiedenes Various Divers	Total Total Total
0.0– 1.0	12053	13754	375	11042	8778	1861	2988	713	1187	52751
1.1– 2.0	130	16	6	14	224	472	32	5	11	910
2.1– 5.0	94	17	6	9	160	578	29	4	2	899
5.1– 10.0	22	3	1	3	54	427	12		1	523
10.1–15.0	2	2			15	185	1			205
15.1–20.0	1				1	119	1			122
20.1–25.0	1					46	4			51
25.1–30.0						23				23
30.1–35.0						6				6
35.1–40.0										
40.1–45.0										
45.1–50.0										
> 50.0										
Personen Persons Personnes	12303	13792	388	11068	9232	3717	3067	722	1201	55490
Mittlere Jahresdosis (mSv) Mean average dose (mSv) Dose annuelle moyenne (mSv)	0.08	0.02	0.15	0.02	0.26	3.31	0.12	0.08	0.05	0.30

dose. The problem is that the booklets are kept by the employers, of whom there are about 15000 in Switzerland, and are therefore not easily accessible. However, the most exposed groups of radiation workers are concentrated in the nuclear power plants, big industrial enterprises, universities and hospitals.

In order to obtain better coordination and to achieve a better overview and control of occupational radiation exposure in Switzerland, the three national authorities agreed to build the national dose registry.

The Swiss National Dose Registry

According to the definition, the Swiss National Dose Registry (SNDR) is a database containing personal, dosimetric and employment information for all radiation workers in Switzerland. The SNDR is maintained by the BAG. The database for the SNDR is based on the commercial MIMER database management system and is installed on a VAX 8650 computer.

Table 2 shows the main personal, employment and dosimetric information included in the Registry. Personal identification is possible through the National Identification Number. This number may also be very useful as a link to some other related databases, like the one containing all the reports on medical check-ups for the radiation workers (by the SUVA) or the cancer registries. At present, the SNDR contains only dosimetric data on external exposures. Work is in progress to include in the Registry also the data on nuclide incorporation.

Tab. 2. Summary of the data included in the Swiss National Dose Registry.

Personal information:
Surname
First name
Previous surname
Date of birth
National Insurance Number
Sex
Nationality
Title
Job identification
Position held
Employment information:
Current employer
Address
Licence number
Type of employing organisation
Previous employers
Dosimetric information:
Dosimetry service
Types of dosimeters
Date and time of exposures
Effective dose equivalent values (H_p, H_s)
Codes to dose values (missing value etc.)

Tab. 3a. Job classification used in the Swiss National Dose Registry.

Medical doctor
Dentist
Veterinarian
Chiropractor
Radiologist
X-ray technician
Other medical personnel
University graduate
Technician
Industrial radiographer
Administrator

Tab. 3b. Classification of employing organisations used in the Swiss National Dose Registry.

Medicine
Radiation therapy
Nuclear medicine
Radiology (diagnostic)
Dermatology
Gynecology
Chiropractic
Other medicine (diagnostic)
Dentistry
Veterinary
Others
University and research
Paul Scherrer Institut
European Organisation for Nuclear Research
Nuclear power research installation
Universities and engineering schools
Nuclear power installations
Beznau I + II
Leibstadt
Goesgen
Muehlenberg
Nuclear waste management
Industry
Luminous paint manufacture
Service industry
Other industry

In order that statistical studies can be carried out, some codes are built into the Registry. Some of them are already completed (the ones shown in Table 2), others, like those in Tables 3 a and 3 b, are planned for the future. The first report produced on the basis of the Registry will be the annual report for 1990, replacing the former manually-produced reports as quoted in Table 1.

The dosimetric data for the Registry are sent monthly by the approved dosimetry services to the BAG. Here the different types of data are translated into a standard format and processed to update the Registry.

The SNDR contains full dosimetric information back to 1989. Special efforts have been made to collect the "older" information as well. During the "first processing", in Dezember 1989, all the computerised data that the dosimetry services had at that time were processed (also the data for retired radiation workers, or those who had left their jobs). In this way very different amounts of data from different dosimetry services were obtained. Most of the dosimetery services have sent the following data:

- monthly doses for the year 1989,
- total accumulated dose assessed by the dosimetry service,
- "previous exposure" (accumulated dose before starting dosimetry by the dosimetry service, obtained from the application form).

In the "first processing" the exposure data of about 100 000 persons were processed. The data differ with regard to the completeness and reliability of the dose histories. In particular the "previous exposures" are questionable because the values from the application form often proved to be wrong and there is no way to distinguish between a zero value and a missing value. In order to distinguish between "complete", "reliable", "not reliable", "not known" etc. dose histories, special codes are introduced into the Registry.

Three of the dosimetry services, two services of the nuclear power plants and the service of the SUVA, checked the "previous exposures" from the Radiation Booklets. For their radiation workers (about half of the personnel of the nuclear power plants and the workers in industry) the whole dose history (for external exposure) is known and reliable. Additional work has to be done to calculate correctly the fraction of radiation workers who have complete dose histories.

Availability and limitations of the dosimetric data for radioepidemiological studies

There are two main points which have to be clarified when evaluating the feasibility of radioepidemiological studies. The first one is the definition of the cohort of interest, and the second one is the availability of the necessary data.
Table 1 shows clearly that the main cohort of interest is the radiation workers in the nuclear industry. Workers in other industries e.g. persons working with luminous paints, may also be important.
As discussed above, there are three main sources of dosimetric data in Switzerland:

- the SNDR,
- dosimetry services,
- Radiation Booklets.

Dosimetric data for the workers in the nuclear power plants are easily obtainable from the SNDR but with the following limitations:

- personal data are generally complete only for the personnel of the nuclear power plants, not for the contract workers;
- complete exposure information is obtainable starting with the year 1990;
- "previous exposures" are known for about 50% of the nuclear power plant personnel;
- at present there are no data on internal exposure.

To complete the data obtainable from the SNDR, the Radiation Booklets deposited by the nuclear power plants, or their dosimetry files, would have to be looked into. For the contract workers one would have to search in the files of different employers. This would certainly be a very time-consuming and costly job. The problems of data confidentiality would have to be solved too. Further open questions concerning radioepidemiological studies, which are, however, not within the scope of this paper, are the links to the relevant medical information and cancer data.

Conclusion

The Swiss National Dose Registry offers easily accessible data on occupational radiation exposure in Switzerland. Since it started in 1990, it is rather future-oriented and does not cover the complete dose histories of all radiation workers, particularly not of those who have left their jobs or have retired. For the purpose of radioepidemiological studies, it would be necessary to complete missing data from other, not easily accessible dosimetric sources.
The statistical analysis of the radiation exposures shows that the main group of interest might be the radiation workers in the nuclear industry, since employees in nuclear power plants have a good chance of having complete dose histories. This is a small group, which received comparatively high dose levels (Table 1). The most promising study would be participation in an international pool analysis.

Summary

In 1990 the Swiss National Dose Registry started a test phase of data collection and processing. The question has been raised whether this new, centralised database with its computerized, easily obtainable data on occupational radiation exposure in Switzerland can be used for radioepidemiological studies. This paper sketches the organisation of personal dosimetry in Switzerland, describes the dose registry and other dosimetric data sources and discusses their suitability and limitations for radioepidemiological studies.

Résumé

Données dosimétriques sur les travailleurs exposés aux radiations en Suisse: valeur et limites pour la recherche épidémiologique
En 1990, le Registre National Suisse des doses a mis route une phase-pilote de collecte et de traitement de données. La question s'est posée de savoir si cette nouvelle base de données centralisée comprenant des données faciles à obtenir sur ordinateur peut être utilisée pour les études radioépidémiologiques. Cet article décrit l'organisation de la dosimétrie personnelle en Suisse, du registre des doses, et d'autres sources de données dosimétriques; il étudie leur validité et leurs limites pour les études radioépidémiologiques.

Zusammenfassung

Dosimetriedaten der beruflich strahlen-exponierten Personen der Schweiz:
Eignung für epidemiologische Studien
Das Zentrale Schweizerische Dosisregister begann im Jahr 1990 eine erste Phase der Datenerfassung und Auswertung. Es ist nun die Frage, ob diese neue, zentrale Datenbank für radioepidemiologische Studien Verwendung finden kann – die Dosen aller beruflich strahlenexponierten Personen sind dank der Speicherung auf EDV rasch zugänglich. Die vorliegende Arbeit zeigt, wie die Personendosimetrie in der Schweiz organisiert ist, beschreibt das Dosisregister mit den Datenquellen und erörtert die Eignung wie auch die Grenzen des zentralen Dosisregisters für radioepidemiologische Studien.

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