Epidemiological Studies Using the National Dose Registry of Canada

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Introduction

The National Dose Registry(NDR) is a centralised record keeping system for occupational doses of all monitored workers in Canada(1,2). Its foundation is Canada's National Dosimetry Service which was started by Health Canada in 1951. Since that time the Registry has expanded to receive and include records from nuclear power stations which perform their own dosimetry, uranium mines, and other dosimetry processors. It currently includes records for 520,000 workers some of which date back to the early 1950's. The workers are classified into 80 different occupational categories(e.g. radiologist, reactor mechanical maintenance)and the employing organizations into 14 different categories(e.g. hospital, reactor). The Registry resides on an HP3000 Model iX computer. It contains approximately 3.4 million annual summary dose records and an estimated 16 million discrete transaction or dosimeter records.

In addition to its use in epidemiological studies the Registry is also used to: i)assist the regulatory authorities in their control of occupational radiation exposures; ii)monitor long term dose trends and; iii) provide dose histories for use in radiation exposure planning and for use in compensation claims. The NDR is involved in a number of epidemiological studies on the long term effects of radiation. These will be described separately below.

Paternal Radiation Exposure and Childhood Leukaemia

This case control study(4) was undertaken in collaboration with the Ontario Cancer Treatment and Research Foundation who were the initiators and lead agency in the study. The study was prompted by findings which suggested a link between paternal radiation exposure and childhood leukaemia(3). Funding was provided by the Atomic Energy Control Board of Canada and Health Canada.

Cases were children ages 0-14 , living within the proximity of a nuclear facility in the province of Ontario who died from leukaemia or were diagnosed between 1950 and 1988. The facilities covered in the study are listed below.

Type of Facility	Location	Dates of Operation
Research and development	Chalk River	1944 - Present
Uranium Mining/Milling	Elliot Lake	1954 - Present
Uranium Refining	Port Hope	1934 - Present
Nuclear Generating Station	Rolphton	1962 - 1971
Nuclear Generating Station	Bruce	1967 - Present
Nuclear Generating Station	Pickering	1971 - Present

Out of a total of 3,366 childhood leukaemia cases in the province 112 were from within the proximity of one of the nuclear facilities. 8 controls per case were selected, matching on date of birth(within 3 months of case) and the region where the mother lived at time of birth.

Parents' names were taken from the children's birth certificates and a computer file of parents names was created. The names in this file were then linked to the records of the National Dose Registry in order to obtain any dose record information. Linkage was by computer and involved weighted linkage based on agreement of identifiers.Out of the 1002 fathers of the children(cases and controls), 95 linked to dose records in the Registry(84 controls and 11 cases) .

Dose records included dose from external gamma and neutron doses as well as internal dose from tritium and Radon daughters.Gamma doses for Uranium miners were available back to 1981. Prior to that date dose estimates were used based on occupancy factors and mine characteristics.

The overall odds ratio was 1.07 with the 95 % confidence interval (95%CI)from 0.22 to 2.29. The findings thus do not support the hypothesis that paternal radiation exposure prior to conception is related to childhood leukaemia. Further details are shown in the table below.

Category	# Cases	# Controls	Odds Ratio(95%CI)
Never Exposed	101	806	1.00
Reactor Worker	4	48	0.64(0.22-1.86)
Uranium Miner	5	26	7.27(0.59-88.7)
Other/Unknown	2	10	1.59(0.34-7.44)
All Linked	112	890	1.07(0.50-2.29)

Cohort Mortality Study(1987)

This large scale cohort study(5) was initiated by Health Canada in the mid 1980's. Funding was by Health Canada, the Atomic Energy Control Board, and Statistics Canada. The cohort consisted of 206,426 workers(105,346 males, 101,168 females) in Canada who were monitored for external radiation between 1951 and 1983, and who had at least a surname, first given name, sex, and year of birth in their records. (This was necessary to ensure the successful linkage of the records). The total collective dose for the cohort was 12.9 person-Sv. The median attained age(as of 31, December 1987) was 41 years for males and 36 for females indicating that this is a relatively young cohort.

This cohort was linked to the mortality data base maintained by Statistics Canada using probabilistic record linkage techniques(6). Records in both files were grouped into phonetically equivalent "pockets". The identifiers of records in corresponding pockets of each file were then compared and assigned a weight based on the agreement between the identifiers. Records above a certain threshold weight were then deemed to be linked and belong to the same individual. This threshold weight was set at the point where the false positive link rate was equal to the false negative rate. The false links were identified by reviewing a sample of linked records and comparing with subsidiary information such as occupation and place of last employment.

Through this process a total of 5,430 deaths were identified. Cause of death was taken from the mortality data base and coded to correspond to the 9th revision of the ICD codes(7). Standardised Mortality Ratios(SMR's) relative to the Canadian population were calculated. Trend tests for mortality were undertaken in which the dose was lagged by 2 years for leukaemia and 10 years for solid tumours. A relative risk regression model was used to determine the excess relative risk(ERR).

A selection of the results is summarized in the table below. The overall SMR was 0.59 for males and 0.62 for females indicating a strong "healthy worker effect". While for males and females there were no specific sites which showed a significant trend($p<0.05$) or excess relative risk, the p-value for all cancers(males) was significant(0.041) as was the ERR(3.0). However this appears to be a weak association which disappears at the 95% confidence level.

Summary of Results - Males

Cause of Death	# Obs. Deaths	SMR	Dose Trend p value	ERR(% per 10mSv) (90% Conf. Int.)
Prostate	71	0.88	0.708	2.6(-5.0,10.1)
Multiple myeloma	17	0.73	0.802	6.5(-17.0,29.9)
Leukaemia	56	0.77	0.855	0.1(-4.7,5.0)
Leukaemia(Ex CLL)	46	0.83	0.733	0.4(-4.9,5.7)
Myeloid Leukaemia	27	0.88	0.379	1.9(-6.2,10.1)
All Cancers	1136	0.68	0.041	3.0(1.1,4.9)

Summary of Results(Cont'd) - Females

Cause of Death	# Obs. Deaths	SMR	Dose Trend p value	ERR(% per 10mSv) (90% Conf. Int.)
Multiple myeloma	5	0.69	0.875	0.2(-70.6,71.0)
Leukaemia	26	0.85	0.835	-0.2(-19.4,19.1)
Leukaemia(Ex CLL)	23	0.87	0.837	-0.2(-20.3,20.0)
Myeloid Leukaemia	11	0.71	0.858	-0.2(-20.5,20.2)
All Cancers	495	0.71	0.756	1.5(-3.3,6.3)

Cohort Cancer Incidence Study(1987)

A cancer incidence study using the cohort(1987) from the mortality study is currently in progress. This study is being funded by Health Canada. The cohort has been linked, using the same techniques outlined above, to a Cancer Incidence Reporting System maintained by Statistics Canada. A file of linked records for an estimated 5,252 workers from the cohort reported as having cancer has been created and is currently being analyzed. First analysis is expected to be completed in 1996.

Cohort Mortality Study(1994)

An updated NDR cohort has been created in preparation for updating the cohort(1987) study. The study is being funded by Health Canada. This study will include workers monitored between 1984 and 1994 and will also include uranium miners who were not included in the original study. In addition, a number of individuals who were left out of the original study because of lack of adequate identifiers have been fully identified and included in the updated cohort. The new cohort is estimated to contain 380,877 workers with a collective dose of 18,100 person-Sv.

Contribution to the IARC study on Nuclear Industry Workers.

Canada is also participating in the International Agency for Research On Cancer study of nuclear workers(8). A subcohort of the 1994 mortality study will be created for separate analysis and as Canada's contribution to the international study. It is estimated that the cohort of nuclear industry workers will consist of 58,000 workers.

Conclusions

As is shown above it is possible to use a centralised data base of occupational radiation exposures for epidemiological studies as well as for regulatory control and other purposes. While the requirements may be different for different purposes these can be accommodated by the careful design of the dose registries.(9)

References

1. J.P.Ashmore, D. Grogan, *Radiation Protection Dosimetry*. 11,95-100(1985).
2. J.P.Ashmore, *Proceedings of IAEA Seminar on the Application of Computer Technology to Radiation Protection*,505-520(1987).
3. M.J.Gardner, *British Medical Journal*.305,715- (1992).
4. J.R. McLaughlin, *et al, British Medical Journal*.307,959-966(1993).
5. J.P. Ashmore, D.K. Krewski, J Zielinski, *et al, European Journal on Cancer*(in press)(1995).
6. M.E. Smith and H.B. Newcombe, *Canadian Journal of Public Health*, 73, 39-46(1982).
7. World Health Organization, *International Classification of Diseases, Injuries and Causes of Death, 9th Revision*, (1977).
8. IARC Study Group, *Lancet*, 344, 1039-1043(1994)
9. J. P. Ashmore, *European Journal on Cancer* (in press)(1995)