Under-ascertainment of multiple myeloma among participants in UK atmospheric atomic and nuclear weapons tests

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An inter-comparison of cases of multiple myeloma among UK participants in the UK’s atmospheric atomic and nuclear weapons tests ascertained by direct follow up methods detected at least a third more cases than a strategy relying solely on data linkage between the Office of National Statistics and the Service Records Offices. These finding have implications for the conduct and robustness of follow up studies of long term health effects among participants in nuclear weapons tests.

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In June 1999, Roff reported that 54 cases of multiple myeloma had been identified among the approximately 22,000 veterans of the UK’s atmospheric atomic and nuclear weapons tests programmes in response to a postal self administered questionnaire to the approximately 2200 members of the British Nuclear Tests Veterans Association. The study had generated considerable publicity which itself prompted some veterans to report their cases to the researcher. Since this was more than twice the number of cases of multiple myeloma reported in the second study of the veterans that had been conducted by the National Radiological Protection Board (NRPB) under commission from the Ministry of Defence (MoD), the issue was raised whether the data collection strategy used by the NRPB—a linkage between the Office of National Statistics registries of cancer incidence and mortality with records of participants in the weapons tests drawn from the Service Records Office—was adequate. The NRPB maintained that it had captured 85% of the cohort, although it acknowledged that figure might have fallen to around 74% for Royal Air Force (RAF) veterans. The NRPB accepted that if more than 15% of the multiple myeloma cases were ascertained among veterans not included in the 85% reported in their studies, their results could not be considered representative of the full cohort.

If the level of under-ascertainment proved to be equal in both the study cohort (potentially exposed to ionising radiation) and controls (probably unexposed group) the validity of the methodology would have been reasonable, but as the following data indicate, the under-ascertainment rate in the 15% of the study population was probably at least 30% or twice the rate in the 85% for whom data were analysed.

Criteria for eligibility

The population of the third NRPB study is essentially the same as that in the second analysis. Contemporary records held by the MoD had been searched to identify test participants among servicemen and civilian employees of the Atomic Weapons Establishment (AWE) and Atomic Energy Research Establishment. These men had visited at least one of the test locations (Monte Bello Islands, Emu Field, and Maralinga range in Australia; Malden and Christmas Islands in the Pacific Ocean) at the relevant times, or had sampled radioactive clouds. The analysis in the third study is based on 21,357 test participants, of whom 29% were in the Royal Navy, 27% were in the Army, 40% were in the Royal Air Force, and 4% were civilians. A control group of 22,333 men who did not participate in the tests was also identified from MoD archives. The controls were selected from other servicemen who served in tropical or subtropical areas and other men employed by AWE at the time of the tests. The participants and controls had very similar distributions by service and rank, as well as by year of birth, year of enlistment or employment, and year of discharge or end of employment.

Disease definition

The inter-comparison was conducted on a wide definition of multiple myeloma, namely the 9th revision of the International Classification of Diseases codes 203.0, 203.1, 238.6, 273.1, as derived from a review of up to date haematological information.

Methods of follow up of vital status and death certificate retrieval and coding

In the third NRPB study test participants and controls were followed up to 1 January 1999, using information from the NHS Central Registers for England, Wales, and Scotland, and the Central Services Agency in Northern Ireland. In the third NRPB study any cases not identified by this data linkage but otherwise acknowledged to meet the eligibility criteria as above were not included in the main study but were treated separately as “independent responders”. Causes of death were coded according to the 9th revision of the International Classification of Diseases. In analysing cancer incidence, information on deaths from cancer as underlying cause was...
supplemented by cancer registrations and by death certificates where cancer was listed as a contributory cause. Where more than one type of cancer was mentioned, myeloma was selected in preference to other cancers in the incidence analysis.

Sources of information for ascertainment of incident cases
At the time that this follow up was conducted, cancer registration data were thought by the NRPB to be complete up to the end of 1994. Registration data up to the end of 1998 were included in the analysis because, although these data are likely to be incomplete, cancer incidence rates in participants have been compared with rates in controls, based on the same follow up mechanisms, rather than with national rates.

Loss to follow up
The NRPB analysts reported that as of January 1999, 9% of participants and 8% of controls had emigrated; 23% of both participants and controls had died; 68% of participants and 69% of controls had emigrated; 23% of both diagnostic criteria reported above, but also refused to include among confirmed participants according to the eligibility and by the present researcher as valid cases of multiple myeloma. The NRPB analysts reported as of January 1999, 9% of these 35 cases among the nuclear test veterans had also been included in the analysis because, although these data are likely to be incomplete, cancer incidence rates in participants have been compared with rates in controls, based on the same follow up mechanisms, rather than with national rates.

RESULTS
The NRPB ascertained 35 cases of multiple myeloma among the 21 357 nuclear test veterans included in their study utilising the data linkage between the Office of National Statistics (ONS) and the Service Records Offices (SROs). They reported the same number of cases among the 22 333 controls who were veterans of the armed services who had not served at nuclear weapons test sites. Two thirds (66%) of these 35 cases among the nuclear test veterans had also been ascertained by the present researcher. At the time of the inter-comparison the NRPB indicated that it was aware of five cases not detected by the ONS-SRO data linkage method but which they accepted were confirmed cases of multiple myeloma among confirmed test participants. Three (60%) of these cases were also ascertained by the present researcher. The NRPB termed these five cases “independent responders” and declined to include them in what they term “the main study”.

The implications of the under-ascertainment reported for one marker condition, multiple myeloma, should be considered in relation to the other potentially radiogenic conditions.

DISCUSSION
At least 30% of the confirmed cases of multiple myeloma among documented test participants who were not included in the third NRPB study to 16—which is to say that nearly a third (31%) of the 51 confirmed cases are not included in the results of the third NRPB study. An additional case was excluded from the study because the individual served in the Merchant Navy at the tests and the NRPB stated that it could not track Merchant Navy participants. Another was excluded because he was considered a civilian, even though he had been seconded to the RAF during his service at the tests as a meteorologist. Civilian members of the Atomic Weapons Establishment and the Atomic Weapons Research Establishment are included in the study.
they were already aware of—served in the Royal Air Force at the
tests in what is acknowledged by the NRPB and the
Ministry of Defence to have been activities particularly
vulnerable to radiation exposure. Air crews flew through
mushroom clouds to collect fission samples; ground crews
worked on known contaminated planes. The NRPB's second
study estimated that only 74% of eligible RAF participants
had been included in the main study's cohort.2 Of the 21 358
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Similarly, Dickinson and colleagues 8 concluded that the
96% of cases and documented 11 cases not reported by the
5
In contrast, the Five Series studies9 of the participants in
the US nuclear weapons tests termed Operation Crossroads
used multiple ascertainment strategies to include 99% of
cases in their studies:

“The assembled information for this epidemiologic study
comes from more than 100 distinct sources. Handwritten
paper logs, microfilm or microfiche, computer files,
medical records, word orders, transport orders, memoirs,
interoffice memoranda, testimony, secondary compilations
of primary sources, letters from spouses, death certificates,
film badge records, computer programs, and benefits and
compensation claims represent a diverse sample.”

The Five Series study also relied on the Nuclear Test
Personnel Review database which included a nationwide toll-
free call-in program set up by the Defence Nuclear Agency
(which became the Defence Special Weapons Agency in 1996) for veterans of the US atmospheric tests to report
details of their participation. The Five Series researchers also
utilised the National Association of Atomic Veterans Medical
Survey of 1784 veterans, advertised in a range of veterans’
journals, and held public meetings. Similar methods had
been used earlier by Watanabe and colleagues10 in their study
of cancer mortality risk among military participants of a 1958
US atmospheric nuclear weapons test.

The NRPB argues that it would bias the findings to include
the cases identified by strategies other than the simple data
linkage that was used for the control group. But as we have
seen, the SROs were deficient in their record keeping,
particularly for the RAF subjects. It was known to the
NRPB researchers that a significant lag can occur in ONS
registrations. Since the incidence of multiple myeloma
among the independent responders is at least 30%—or twice
the 15% rate estimated by the NRPB in deciding to settle for
an 85% sample cohort—the NRPB studies seriously under-
report the incidence of this marker radiogenic condition
among veterans of the UK’s atmospheric atomic and nuclear
weapons tests.

Although it is accepted that any “healthy soldier effect”
would have been present in both the study cohort and the
control group because both were drawn from the population
of service personnel, and equally that any exposure mis-
classification is likely to have impacted both groups, it is clear
that failures of ascertainment within both the 85% of the
nuclear test participants included in the third NRPB study
and the 15% not included resulted in an under-ascertainment
of the marker condition, multiple myeloma, and may have
also occurred in relation to other potentially radiogenic
conditions.

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REFERENCES
1 Roff SR. Incidence of haemopoietic cancers in a sample of veterans of UK
nuclear weapons test. Paper presented to First International Conference on
Multiple Myeloma and Amyloidosis, Manchester, 1999.
participants in the UK atmospheric nuclear weapons tests and experimental
programmes, NRPB-R266. Chilton, Didcot: National Radiological Protection
Board, 1993.
3 Muirhead CR, Bingham D, Haylock RGE, et al. Follow up of mortality and
incidence of cancer 1952–98 in men from the UK who participated in the UK’s
atmospheric nuclear weapons tests and experimental programmes. Occup
4 Muirhead CR, Bingham D, Haylock RGE, et al. Mortality and cancer incidence
1952–1998 in UK participants in the UK atmospheric nuclear weapons tests
and experimental programmes, NRPB-W27. Didcot, Oxfordshire: National
5 Quinn MJ, Batting B, Foote D, et al. A Registration of ovarian cancer in
6 Darby SC, et al. Mortality and cancer incidence in UK participants in UK
atmospheric nuclear weapons tests and experimental programmes, NRPB-
registry and direct follow-up in the ascertainment of ovarian cancer. Br J
8 Dickinson HO, Salotti JA, Birch PJ, et al. How complete and accurate are
cancer registrations notified by the National Health Service Central Register
9 Thaul S, et al. The Five Series study mortality of military participants in U.S.
10 Watanabe K, Kang HK, Dalager NA. Cancer mortality risk among military
participants of a 1958 atmospheric nuclear weapons test. Am J Public Health
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