CANCER AND LEUKAEMIA AND RADIOACTIVE POLLUTION FROM HM DOCKYARD, PLYMOUTH

RESULTS OF THE CANSAR QUESTIONNAIRE SURVEY 2003 in the wards of Keyham and Torpoint

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Summary

The recent authorisation to increase discharges of the radioactive isotope Tritium from the Devonport Royal Dockyard by 700% has caused concern among local groups. The question of the health effects of historic releases of radioactivity by the dockyard to the river Tamar is addressed by a study analysis of a cancer and leukaemia questionnaire carried out by CANSAR, a local organisation in the wards of Keyham near the dockyard and Torpoint opposite. The questionnaire was administered to a random number of houses in the two wards. There were 364 individuals listed in responses in Keyham and 415 in Torpoint, representing about 3% and 5% respectively of the 1991 census population of the wards. There were 39 cases of cancer in Keyham and 76 cases in Torpoint in the households who responded. Within these there were 7 cases of leukaemia in Keyham and 4 in Torpoint. In addition, there were 11 deaths from cancer in Keyham and 20 in Torpoint which were not included in the statistical results reported here. The dates of diagnosis for the individual cases were not available so the period over which the cases were diagnosed was assumed to be 10 years. On this basis, comparison with England and Wales National rates for cancer and leukaemia (1997) gave a Relative Risk of 18.4 for Leukaemia all ages in Keyham (E= 0.38; O = 7; p = 0.00000) and 4.7 in Torpoint (E = 0.84, O = 4; p = 0.0001). The excess was greatest in younger people. In the age group 0-54 Keyham had RR = 30.6 based on 3 reported and 0.098 expected. This age effect was not found in Torpoint for leukaemia.

For all cancers, the risks were also elevated in both wards and greatest in younger people. For Keyham all ages, RR = 1.9; O = 39, E = 20; p = 0.0001 and Torpoint RR = 1.7; O = 76, E = 45.8; p = 0.0001. In the age group < 54, Keyham RR = 4.5; O = 18; E = 3.98; p = 0.00000 and Torpoint RR = 6.3; O = 10; E = 3.03; p = 0.0000. For the age group <44, Keyham RR = 7.46; O = 10; E = 1.34; p = 0.00000 and Torpoint RR = 9; O = 7; E = 0.78; p = 0.00000.

In a proportional incidence study, the numbers of leukaemias reported were compared with the numbers of cancers reported. This method removes the need to know the period of time over which the cases were diagnosed. In Keyham the ratio of leukaemia to cancer was 19.8 times that expected (7/32) on the basis of national rates and in Torpoint the figure was 5.1 times roughly in good agreement with the Relative Risk calculation.

In the discussion, these worrying and highly significant increases are suggested to be a manifestation of a sea-coast effect on cancer and leukaemia found by Green Audit researchers in small area cancer risk studies near the Irish Sea and near nuclear sites in Somerset and Essex. In the discussion, attention is drawn to data included in the submission to the consultation process by the local health authority which showed the existence of a 25-30% excess leukaemia risk in Plymouth between 1995-7. It is suggested that these data were indicative of the existence of a connection between historic discharges from the dockyard and local ill health. The health authority is criticized for not investigating further and for using poor scientific methods to marginalize this finding.

Finally, the authors draw attention to recent evidence that the risk model of the International Commission on Radiological Protection used to underpin the Environment Agency's authorisation is unsafe when applied to exposure to internal man-made radioactivity of the kind released by the dockyard.

1. Introduction and background

The decision to increase capacity for servicing Vanguard nuclear submarines at HM Dockyard Plymouth resulted in the requirement to increase discharges of radioactivity to the environment and accordingly in May 2000 Devonport Management Limited (DML) which operates the Devonport Royal Dockyard (DRD) applied to the Environment Agency (EA) to vary its authorisation to dispose of radioactive waste in the tidal river Tamar which borders the densely populated area of Plymouth. The new work would result in a substantial increase of the annual amount of Tritium to the Tamar river at Hamoaze from 120GBq to 800 GBq. There would also be an increase in atmospheric Tritium discharges from 1 to 5GBq/annum together with a new requirement for 45GBq of Carbon-14 and 15GBq of Argon-41. Local anti-nuclear groups and others were concerned at the possible health risks that such an authorisation would entail. Despite the assurances given by DML and other bodies that the exposures involved were very low compared with natural background, these arguments were seen by many to be based on the erroneous risk model of the International Commission on Radiological Protection (ICRP) which is presently under discussion by the new UK Department of Health Committee Examining Radiation Risk from Internal Emitters CERRIE. One question asked was whether historic releases from HM dockyard over the 20 years of its operation at the lower levels permitted by its previous licence had caused ill health. This question was apparently answered in a submission by the South West Devon Health Authority (SWDHA) to the public consultation. The SWDHA report concentrated on leukaemia in the Plymouth area, since it has been believed widely since the observation of correlation between exposure to ionising radiation and leukaemia (e.g. in the Hiroshima bomb survivors) that the disease is a flag for radiation exposure effects. Using figures from the South West Cancer Intelligence Unit, the SWDHA report showed that there was indeed a statistically significant 25- 30% excess of leukaemia incidence in men and women in all ages in Plymouth in 1995-7. However, the SWDHA report concluded that these increases were not related to the releases from the dockyard because (a) the crude death rates from leukaemia were not highest in the wards closest to the dockyard, Keyham and Torpoint and (b) radiation exposure from the releases was too small to cause any measurable increases in leukaemia. As we shall argue, (a) is a false analysis and (b) is an assumption based on the incorrect ICRP risk model.

We have examined the levels of cancer and leukaemia in the two wards closest to the river and Dockyard, Keyham and Torpoint using a questionnaire study similar to the one recently undertaken in Burnham on Sea near the Hinkley Point nuclear complex in Somerset.

Green Audit has made several studies of populations living near contaminated intertidal sediment e.g. in Wales, Ireland, Somerset and Essex and all have shown that there is an increased risk of both cancer and leukaemia in such populations [see attached references e.g. Busby 2000, Busby et al 2002, Busby et al, 2002A, Busby 2004].

2. The CANSAR survey

This small random survey was based on the earlier Burnham on Sea survey carried out be Parents Concerned about Hinkley (PCAH) (Busby et al 2002). That study, was in turn based on the original prototype carried out in by STAD and Green Audit in Carlingford, Ireland in 1999 (Busby 2001). The Burnham on Sea study had intended to survey all the houses in Burnham North. In the event, due to lack of volunteers and other factors, only about a third of the households in the ward were visited. This

however provided a random sample of about 1400 people who were shown to be a reasonable cross section by age of the 1991 census ward population. In the event, an oversight was made in transposing the Burnham questionnaire into a CANSAR questionnaire and the dates of diagnosis of the reported cancers and leukaemias were not asked for. The questionnaire was given by a volunteer from CANSAR to a small random selection of houses in the wards of Keyham (on the eastern side of the Tamar near the dockyard) and Torpoint (on the western side, opposite the dockyard) and the project was explained. It was filled in for each household surveyed by the head of or some responsible person in the household, with the assistance of an interviewer. The questionnaire asked for the sex and age of all persons living at the address. It then asked if any person at that address has been diagnosed with cancer, leukaemia or lymphoma in the previous ten years. Any deaths in the last ten years from cancer or leukaemia were also filled in separately. In the Burnham on sea questionnaire study, details of this person were then asked for, such as the type of cancer (site), their sex, the age at diagnosis and the year of diagnosis. This data enabled the direct calculation of relative risk in the sample population, relative to the national population. However, this question was omitted from the CANSAR survey by mistake. It was therefore necessary to analyse the results on the basis of limiting assumptions about the period over which the reported diagnoses spanned and also using the method of proportional incidence.

The population at risk

The 1991 census population of Keyham is given in Table 1 together with the ages and sex of the people in the houses visited. Table 2 covers Torpoint. It is clear that unlike Burnham, where about 30% of the ward responded, in Keyham only about 3% of the census population of the ward are included in the survey and in Torpoint about 5%. The population of the two wards is more than six times greater than the population of Burnham on Sea. However, if these are random samples, the results should be representative for the wards.

The methods

Two methods were used to evaluate the risk of leukaemia and cancer in the wards. First, using the previous method we have applied to such surveys, the population at risk was assumed to be those people living at the houses which returned fully completed questionnaires. The sex and age of these people are given in Table 1 and 2. We then calculated the expected number of (a) all leukaemias ICD9:204-208 and (b) all malignancies except non- melanoma skin cancer on the basis of the latest (1997) England and Wales national rates as published by the Office for National Statistics (ONS Cancer Statistics Registrations, Series MB1). Since we did not have the dates of diagnosis, the Relative Risk was then calculated by dividing the total number of leukaemias or cancers reported by the (a) ten year expectation. In previous surveys of this type, we have noted that the number of cancers or leukaemias reported for diagnosis in years more than ten years before the date of the survey represents less than 5% of the total, due to population leakage from the area. Thus the ten year period probably represents the best conservative estimate of risk, especially since the survey questionnaire asked for deaths within ten years of the survey.

Table 1 1991 census population of Keyham with details of the survey respondents.

Ages	Males	Females	Survey males	Survey females
0 to 4	510	512	6	8
5 to 9	422	365	7	9
10 to 14	323	309	10	7
15 to 19	768	370	8	9
20 to 24	1378	711	15	15
25 to 29	916	588	11	12
30 to 34	687	438	10	10
35 to 39	420	358	9	12
40 to 44	387	323	14	22
45 to 49	297	250	15	14
50 to 54	267	267	18	18
55 to 59	272	272	14	10
60 to 64	238	250	9	10
65 to 69	248	264	11	10
70 to 74	168	245	7	12
75 to 79	120	202	7	8
80 to 84	73	122		1
85 to 89	26	78	2	4
90+	6	14		
all	7526	5903	173	191

Table 2 1991 census population of Torpoint with details of the survey respondents.

Ages	Males	Females	Survey males	Survey females
0 to 4	298	311	2	4
5 to 9	327	293	7	4
10 to 14	302	267	10	9
15 to 19	258	244	4	7
20 to 24	239	275	8	1
25 to 29	301	369	2	3
30 to 34	407	382	9	7
35 to 39	301	316	8	11
40 to 44	311	297	7	11
45 to 49	236	238	12	9
50 to 54	184	188	15	18
55 to 59	184	190	24	23
60 to 64	166	179	21	20
65 to 69	164	179	15	25
70 to 74	147	193	26	18
75 to 79	84	137	10	21
80 to 84	73	110	11	17
85 to 89	18	64	7	9
90+	8	22		
all	4008	4254	198	217

The second method we used does not depend on the year of diagnosis but is restricted to examining the rates of leukaemia. The method of proportional incidence compares the ratio of leukaemia to cancer in the survey respondents with that found in the England and Wales national figures. Any anomalous increase in leukaemia would then be flagged by a higher ratio of leukaemia to cancer than that expected.

Results

Results are given in Tables 3, 4 and 5. They indicate significant and very substantial excess risk from leukaemia and to a lesser extent cancer in both wards. In addition, the ward of Keyham, close to the dockyard has much higher levels of leukaemia than Torpoint and the incidence is greatest in younger age groups. The proportional incidence method also supports the finding that there is an excess of leukaemia in both these populations, greatest in Keyham, and the relative risks calculated by this latter method are of a similar magnitude to those calculated directly.

Table 3 Relative Risk from All Leukaemia (C91-C95) all ages in Keyham and Torpoint from CANSAR survey 2003 (based on England and Wales rates 1997)

	Expect 10 y	**Reported**	**Relative Risk**	**p-value**
Keyham				
All ages	0.38	7	18.4	0.00000
<54	0.098	3	30.6	0.00000
<44	0.056	2	35.7	0.00000
Torpoint				
All ages	0.843	4	4.7	0.0001
<54		None		
<44		None		

Table 4 Relative Risk from All malignancy (except NMSC: C00-C97 x C44) all ages in Keyham and Torpoint from CANSAR survey 2003 (based on England and Wales rates 1997)

	Expect 10 y	**Reported***	**Relative Risk**	**p-value**
Keyham				
All ages	20	39	1.9	0.0001
<54	3.98	18	4.5	0.00000
<44	1.34	10	7.46	0.00000
Torpoint				
All ages	45.8	76	1.7	0.0001
<54	3.03	19	6.3	0.00000
<44	0.78	7	9	0.00000

*Note: the table does not include 11 deaths from cancer in Keyham and 20 deaths from cancer in Torpoint. Increased RR can be calculated by adding these to the relevant column and dividing by the expected incidence numbers since these deaths were in the 10 years of the survey period.

Table 5 Proportional incidence leukaemia vs cancer in Keyham and Torpoint from CANSAR survey (based on ration of all leukaemia to all malignancy of 0.011 in England and Wales 1997)

Ward	Leukaemia cases reported	Cancer cases reported	Ratio	Excess leukaemia -fold
Keyham	7	32	0.218	19.8
Torpoint	4	72	0.056	5.09

3. Discussion

In a submission to the consultation, made by SWDHA in 2000 the mortality from leukaemia was examined with a view to reassuring the public about the historic effects of dockyard releases of radioactivity and to support the view that the increases in discharges would have no effect on the health of the population. In addition, some data on incidence was also supplied by DETR to CANSAR in a letter dated 13 March 2001, and this was included in the submission as an Appendix.

In this letter, and using data for 1995-7 supplied to them by the South West Cancer Intelligence Agency DETR reported that the incidence rates for leukaemia in Plymouth were increased by 25% for men and 29% for women. In the three year period 1995-7 there were 55 cases in men (44 expected; $p<0.05$) and 44 cases in women (34 expected; $p <0.05$). For mortality in the period 1995-9 the excess was only in men.

The SWDHA should have been concerned by this significant discovery, and looked at a longer period of time than three years but instead it decided to deny the existence of any effect by examining death rates from leukaemia in the wards. The argument that the excess leukaemia in Plymouth was not related to radioactivity from the dockyard was based on the observation that the crude leukaemia death rates in the Plymouth wards, unadjusted for the age of the population in the wards did not show that Keyham or Torpoint had a higher number of deaths than any other ward in Plymouth in the 19 years from 1981 to 1999. This is outrageously bad science, since the death rates in the wards should have been compared on the basis of the age of their population. Keyham in particular has a very young population (see Table 1) and this is reflected in the fewer cancers reported there in the survey than in Torpoint. In any case, mortality rates are poor indicators of leukaemia risk since the incidence to mortality ratio for the disease is low and the numbers are very small. In the period 1981 to 1999, the death rate in Keyham was given as between 4.6 and 6.3 per 100,000 persons. The total population of Keyham was about 13,500 and so the number of deaths in this 19 year period was between 11 and 15, or 0.6 to 0.8 deaths per year.

On the basis of our previous findings related to a sea-coast effect near radioactively contaminated intertidal sediments, the official finding of 25-30% elevation in leukaemia in Plymouth immediately begs the question of whether this is driven by increased incidence in wards close to the river Tamar. Leukaemia incidence and mortality figures are not released for independent research. However, the Burnham on Sea survey carried out by Parents Concerned About Hinkley (PCAH) identified a significant excess of leukaemia in the ward of Burnham North (Busby et al, 2002) and although this finding and the survey were attacked by the operators of the nuclear plant (BNFL) and also by COMARE, the government advisory Committee

On Medical Aspects of Radiation in the Environment, it is of interest that the South West Cancer Intelligence Unit (SWCISU) study which was commissioned by the local Health Authority in Burnham did indeed find a significant excess risk of leukaemia in Burnham on Sea and a clear sea coast effect on the disease centred on the contaminated offshore mud flats.

We conclude that the evidence from the CANSAR survey shows a highly significant, substantial and worrying excess of leukaemia in the wards close to the dockyard and in addition an excess of cancer also. This excess is greatest in young people and greater in Keyham close to the dockyard than in Torpoint across the river. The results for leukaemia are supported by a proportional incidence analysis that gives very similar excess rates to those calculated directly from the figures using a ten year period of assumed risk. We conclude that this excess was implicit in earlier data analysed for the public consultation and that the mortality methods used to suggest that the excess was not related to the operation of the dockyard were scientifically insecure.

Finally, with regard to the mechanisms of causation of cancer and leukaemia in populations living close to the sea in areas of contaminated sediment we refer to the many reports on this issue published by Green Audit since 1999 (see www.greenaudit.org and www.llrc.org). The relationship between internal radioactive exposure and cancer and leukaemia cannot be assessed using the averaging risk model of the ICRP. This was shown by the recent discovery of increases in infant leukaemia in the cohort who were exposed in the womb to radioactivity from the Chernobyl accident (Busby and Scott Cato 2001). This evidence and other recent research findings led to the formation of a new UK government Committee Examining Radiation Risk from Internal Emitters (CERRIE) which will report in September 2004 on the validity of the ICRP model. A general discussion of the ICRP risk model and a new alternative and rational risk model is to be found in the recent report of the European Committee on Radiation Risk (ECRR, 2003).

Under these circumstances, it is in contravention of the precautionary principle to increase discharges of radioactivity to the Tamar, particularly when the present study suggests that historic discharges have already had a significant effect on cancer incidence and death rates in the previous ten years.

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