Does nuclear pollution cause childhood leukaemia?
Evidence from the Menai Strait, North Wales

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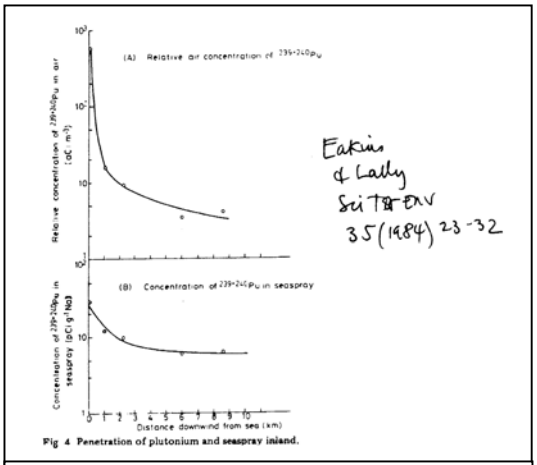
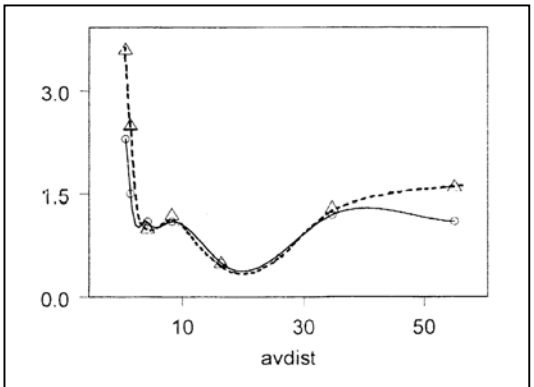
Summary
High levels of childhood cancer, particularly leukaemia and brain tumours, near the shores of the Menai Strait in Gwynedd, north Wales, have been discovered by researchers working for HTV. This supports earlier research by Green Audit (for the Irish State) showing excess childhood and adult cancer in north Wales between 1974 and 1989 driven by risk in coastal areas of low tidal energy contaminated with material from Sellafield. Childhood leukaemia 0-4 in Caernarfon was 22-times the national average between 2000 and 2004 (4 cases, 0.18 expected; p = 0.0001).

Introduction
Leukaemia has been associated with radiation since the discovery of high rates in those exposed to the Hiroshima and Nagasaki A-bombs, the persistent excess in Seascale and nearby coastal villages, and near Dounreay and La Hague. Leukaemia clusters have also been reported from areas near other nuclear sites, particularly those where contaminated river, estuary or marine sediment is involved, or particles of radioactive material are dispersed to the atmosphere [ECRR2003]. In 1994 Wales Cancer Registry (WCR) data 1974-1990 for small areas (Areas of Residence or AoRs) became available to Green Audit, allowing populations to be defined by distance from the sea. A sharp rise in risk close to the coast in north Wales was shown in leukaemia and cancer (mainly brain tumours) in children [Busby 2000, BNES 2002]. The trend correlated strongly with deposition of plutonium and seaspray. It was driven by towns near coastal areas where intertidal sediment is contaminated with man-made radioactivity and increased in 1982-1990, the latter half of the period studied. Examples were Colwyn Bay AoR, Bangor and Caernarfon (RR = 5.6, 11.2, 8.1 respectively, calculated on basis of 1981 populations and England and Wales 1979 rates). Elevated risks were also found for brain tumours ages 0-4 in Bangor, Llandudno and Prestatyn (RR = 11, 14, and 10 respectively). In the coastal strip defined by 16 AORs (0.8 Km mean distance from the sea) overall risk was RR=3.0 falling sharply to RR=1.6 in the 0.9 to 2 Km zone. The sea coast effect was also apparent in adult cancer and leukaemia [Busby 2000] and has been reported in review in a number of conferences [e.g. Busby 2004].



Penetration of plutonium and seaspray inland. From Eakins and Lally, Sci. Tot. Env. **35** (1984) 23-32

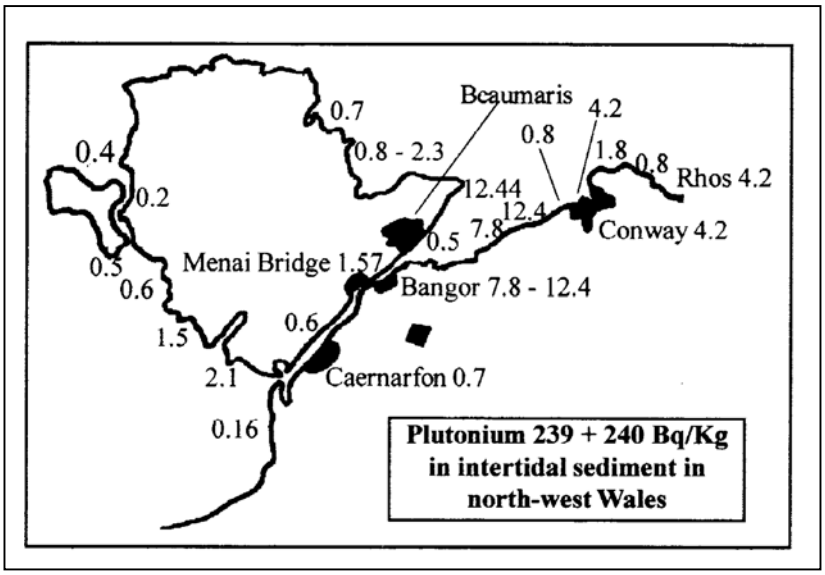


Child cancer 0-4 in Wales 1974 – 89 aggregated into AoRs by distance from Irish Sea. (Circles and line 1974-89, triangles 1984 – 88) Vertical axis = relative risk, Horizontal axis = kilometers

The north Wales coast, particularly the Menai Strait and even more particularly its northern entrance, has fine intertidal sediment contaminated with plutonium and other radioactive materials from Sellafield. We advanced the hypothesis that sea to land transfer of radioactive particles followed by inhalation represents a risk to those living in the 0-1 Km coastal strip since the particles can be translocated from the lung to the lymphatic system resulting in leukaemia and other cancers and also producing germ cell damage and foetal damage *in utero* leading to effects in children.

Materials and methods

In the last two years HTV researchers using snowball interview methods have obtained information on children with cancer and leukaemia in the area around the Menai Strait which confirms the existence of the sea coast effect. A documentary was broadcast on 10th February 2004. The children's names, their illness, dates of diagnosis and where they live or used to live are largely known. The raw data are not given here for reasons of patient confidentiality.



HTV collected data from interviews with the families and friends of another 34 cancer patients aged 0-14 who had died in north Wales since 1996. More reports are still being obtained. The reported cases and deaths cannot be the entire number, but they provide a baseline for estimating risks. We looked at the period 2000-2004 since this is the most current period and would involve the smallest data leakage due to memory loss and emigration. We analysed incidence in Caernarfon and, in order to control for the influence of random fluctuation, at the larger area around the Menai, specifically all the wards proximal to the Menai strait which are either in contact with the sea or have more than half of their area within 10 Km of the coast.

Results

(a) Leukaemia 0-4

Table 1. Leukaemia in children 0-4 in Caernarfon 2000 – 2004.
Based on 2001 populations and 1997 [ONS 1997] rate for *all leukaemias* (=0.000067)

Children aged 0-4	Leukaemia Expected per year	Expected 5 years	Observed 00 - 04	Relative Risk (P value)
528	0.0354	0.177	4	22.6 (0.00005)

Table 2. Leukaemia in children 0-4 2000 – 2004 in 34 wards bordering the Menai or largely within 10 Km, with and without Caernarfon.
Based on 2001 populations and 1997 [ONS 1997] rate for *all leukaemias* (=0.000067)

	Children aged 0-4	Leukaemia Expected per year	Expected 5 years	Observed 2000 – 04	Relative Risk (p- value)
Including Caernarfon	3824	0.256	1.28	7	5.4 (t.b.c)
Excluding Caernarfon	3566	0.238	1.19	3	2.52 (t.b.c.)

(b) Brain and spinal tumours

Table 3. Brain and spinal tumours in children 0-14 in Caernarfon based on 1991 census populations and ONS 1997 rate

Children aged 0 – 14	Expected 1996 – 2003	Observed 1996 – 2003	Relative Risk (p-value)
1655	0.28	4	14.3 (<0.00001)

Table 4. Brain and spinal tumours in children 0-14 in 34 wards bordering the Menai or largely within 10 Km, with and without Caernarfon. Based on 1991 census populations and ONS 1997 rate

	Children aged 0-14	Expected 1996 – 2003	Observed 1996 – 2003	Relative Risk (P value)
Including Caernarfon	12205	2.1	10	4.7 (0.0001)
Excluding Caernarfon	10550	1.81	6	3.3 (0.01)

(c) Retinoblastoma

Seven cases were reported. Three were in Caernarfon and Conwy on the mainland coast. Four were on Anglesey. Reported ages range from 3 years (one case) to "teen age" (three cases). Other information is sparse.

In the 0 – 14 age group within the 34 wards of the study area 0.25 cases would be expected between 2000 – 2004. However, age specific national rates of this condition vary widely and it is very rare after the age of six. This raises a need for histopathological confirmation. We include this information in order to establish the need for an investigation.

Discussion

The possible link between leukaemia and radioactivity resuspended from contaminated estuaries was first investigated more than ten years ago [Alexander 1990]. A positive effect was found but in a more recent study this effect seems to have disappeared [Lloyd 2002]. However, this may be due to confounding exposures from Chernobyl which intervened between the two periods studied. The findings of excess leukaemia and brain tumours in children reported in Busby 2000 were supported by the highly significant sea coast effect in adult cancers also found in the same study. Green Audit's analyses have been disputed by the Welsh Assembly Government, the Welsh Cancer Intelligence and Surveillance Unit and COMARE [Steward 2001] on the basis of assertions that the Wales Cancer Registry (WCISU) data were erroneous. However, we have replied that it was WCR themselves who drew attention to high levels of child leukaemia in Wales [Welsh Office 1994] and in 1995 they said that 95% of the registrations had been validated [Cotter 1995]. The data we obtained from WCR contained one anomalous column which related only to childhood leukaemia. We have shown that when it is excluded the sea coast effect remains for childhood and adults. WCISU revised the data in a questionable manner, and did not reproduce our methodology, despite claiming the contrary. We have shown that when our methodology is applied the effect is still apparent.

The information obtained by HTV was largely from the area around the Menai Strait and since it is very likely that the interviews identified only a fraction of the total number of cases little can be said about the general levels in the whole of north Wales. However, anecdotal evidence suggests a general excess; figures given in 2001 by parents of a north Wales cancer patient suggest that 10 new cases were being diagnosed each month in children living on the north Wales coast [Daily Post 2001]. This would represent a 10 to 20-fold excess.

Retinoblastoma has been well characterised as a genetic disease and its genetic locus is known but the illness has also been shown to occur with a high frequency (> 20 fold) in the offspring of those

living near or working at Sellafield. Since the excess risk of retinoblastoma appears to be located in the same areas as the leukaemias it suggests a common origin.
Radioactive contamination of the environment is now widespread and radioactive particles become concentrated in coastal areas of low tidal energy by geophysical factors which are well known. Inland migration of radioactivity is well described. The higher levels of radioactivity on the coastal strip present an opportunity to examine the hypothesis that such contamination has a causal impact on childhood leukaemia. The data presented here support the hypothesis, in stark contrast to the current risk factors advised by the ICRP. We have argued for some time that the ICRP's modelling is unsafe [e.g. Busby 1998, 2004].
Resources permitting, we will continue to research this link by means of questionnaires, environmental monitoring, and case-control study similar to that of Pobel [Pobel 1997]. Using Scottish data [ISD 2002] we have also begun mapping childhood mortality from cancer and leukaemia with regard to proximity to contaminated intertidal sediment in Scotland.

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