antibodies, particularly their opsonising activity. Assays are available in our unit to measure the ability of patients' serum to opsonise pneumococci and enhance the ingestion of these organisms by phagocytes. These tests may supplement quantitative antibody tests in determining the need for reimmunisation.

As pneumococcal vaccine contains capsular polysaccharide from only 23 serotypes of *Streptococcus pneumoniae* it does not provide full protection against pneumococcal septicaemia, and lifelong prophylaxis with antibiotics must be recommended. The reported incidence of pneumococcus that is resistant to penicillin, however, is over 40% in Spain,[5] which makes it crucial to recommend antibiotics resistant to penicillinase for high risk patients.

Finally, *Capnocytophage canimorsus* must be added to the list of organisms of which people who have undergone splenectomy and have contact with animals should be aware. This organism can be transmitted by animal bites, especially dog bites, and can lead to septicaemia and death. It remains susceptible to penicillin.

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## Revaccination may cause relapse

EDITOR,—Merck Sharp & Dohme has amended the datasheet for pneumococcal vaccine (Pneumovax II) to include a section on revaccination.[1] This brings it into agreement with the recommendations of the Department of Health that patients who have had a splenectomy (among others) should be considered for revaccination. The original diagnosis warranting splenectomy does not seem to have been considered in these recommendations, and I fear that some patients may be more at risk than others of suffering adverse reactions.

A 29 year old patient under my care had developed idiopathic thrombocytopenic purpura as a child and had had a splenectomy when he was 5. Since he was 21 he had suffered several episodes of thrombocytopenia and developed autoimmune haemolytic anaemia. He was vaccinated uneventfully with penumococcal vaccine in June 1990. In February 1993 he was inadvertently revaccinated by his general practitioner and two days later he became ill with appreciable haemolysis and thrombocytopenia.

Revaccination probably precipitated his relapse,[2] and although the interval between the first and second vaccination was shorter than that recommended in the new datasheet and by the Department of Health, more cases like this one may occur as revaccination becomes more widespread. Although the risk of penumococcal infection may be considered to be greater than those of precipitating a relapse of immune haemolysis or thrombocytopenia, the possibility of a relapse should be taken into account when patients with autoimmune haematological disorders are revaccinated.

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# Cancer in nuclear test veterans

## Important questions unanswered

EDITOR,—S C Darby and colleagues' paper on the health of people who participated in British nuclear tests omits some fairly basic information.[1] In a study of this kind it would be reasonable to present a breakdown of the study group by age, sex, and social class.

The paper argues that the relative risk of leukaemia between participants in the tests and controls was "principally due to the scarcity of cases in the control group and may have been due to chance." No figures are produced to back up this assertion, although it must be fairly easy to estimate the probability of a group of 22 333 men having a standardised mortality ratio for leukaemia of only 0·32 by chance. The approach used calls into question the whole point of having a control group if the authors can call into question its reliability.

The measurements of radiation exposure also raise questions. The paper states, "Information on film badges issued at the tests was made available by the Ministry of Defence for 5686 men." This is only 26·6% of the study group. It seems odd that only a quarter of people potentially exposed should be issued with film badges in an experiment on the effect of nuclear weapons on soldiers. If, on the other hand, fuller data exists in the Ministry of Defence's files, on what basis were the data that were made available chosen? This is important, for these data are quoted as one of the main reasons that authors question the causal hypothesis.

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1 Darby SC, Kendall GM, Fell TP, Doll R, Goodill AA, Conquest AJ, *et al.* Further follow up of mortality and incidence of cancer in men from the United Kingdom who participated in the United Kingdom's atmospheric nuclear weapons tests and experimental programmes. *BMJ* 1993;307:1530-5. (11 December.)

## Statistical analysis inappropriate

EDITOR,—S C Darby and colleagues' study of cancer and atmospheric nuclear weapons tests raises some interesting methodological questions.[1] Exposed servicemen and civilians working with nuclear weapons were compared with a control group matched for age and occupation and with the general population by means of national mortality statistics. Two sided tests and 95% confidence intervals were used to compare the exposed group with the general population. One sided tests and 90% confidence intervals were used to compare the exposed group with the control group. The tests were done in the direction of the observed difference.

In a one sided test the alternative hypothesis is that there is a difference in a specified direction. The null hypothesis is then that there is no difference or a difference in the opposite direction. This is reasonable if a difference in the opposite direction would have the same meaning or result in the same action as would no difference. For the comparison with the general population it could be argued that the exposed group, predominantly servicemen, were selected to reduce the risk of cancer. Men with genetic conditions that might predispose to cancer, such as Down's syndrome, were excluded, but they were included in the general population. Thus it would be expected that if the exposure had no effect the incidence of cancer in the exposed group might be less than that in the general population, by an unknown amount. Fewer cancers than expected in the exposed group would have the same interpretation as no difference, a phenomenon known as the "healthy worker effect." It might be argued that carrying out a one sided test in the direction of more cancers in the exposed group would be appropriate.

For the comparison with the control group this argument does not hold. The controls were chosen so that the risk would be the same apart from any risk due to the exposure. Thus an excess of cancer in the control group would be surprising and lead to the conclusion either that the radiation exposure protected against cancer or that the groups were not comparable. If no difference was found, on the other hand, the conclusion would be that there was no evidence that the radiation influenced the risk of cancer. The conclusions would be different, and a one sided test in the direction of more cancers in the exposed group cannot be justified.

It is even harder to justify a one sided test in the direction of fewer cancers in the exposed group, which is opposite to the research hypothesis. To test in the direction of the observed difference is in fact to carry out tests in both directions simultaneously. As one of these tests assumes that fewer cancers in the controls is equivalent to no difference and the other assumes that more cancers in the controls is equivalent to no difference the tests are contradictory. The procedure is the same as a two sided test at the 10% level and this is not truly one sided at all. Several of the "significant" differences in table IV would disappear at the conventional two sided 5% level.

Though it is not essential to use the arbitrary 5% as the decision point in tests of significance, departures from this convention should be stated clearly, which this paper does not do.

Use of a 10% significance level in place of the usual 5% level does not alter the main conclusions of this paper. In others, however, it might, and the *BMJ* is rightly regarded as a model for medical researchers. I hope that we will not see a rash of one sided tests in the direction of the difference in the future.

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1 Darby SC, Kendall GM, Fell TP, Doll R, Goodill AA, Conquest AJ, *et al.* Further follow up of mortality and incidence of cancer in men from the United Kingdom who participated in the United Kingdom's atmospheric nuclear weapon tests and experimental programmes. *BMJ* 1993;307:1530-5. (11 December.)

## Authors' reply

EDITOR,—Our paper describing the mortality and incidence of cancer in participants in nuclear tests was a summary of our findings. The full details, as we stated, were given in an accompanying report published simultaneously.[1] Most of the information requested by Richard Lawson is given there, and we repeat some of it here.

Lawson asks for a breakdown of the study group by sex, age, and social class. Only men were considered, as we knew of too few women participants for useful study. The table shows the distribution of the participants and their controls by service or employer, rank or social class, and whether or not they were on national service. The distribution in the two groups was closely similar; so was the distribution by year of birth, year of enlistment or employment, and year of discharge or termination of employment.[2]

Overall, the mortality in the control group was much as would have been expected because of the high proportion of officers and the limitation to men fit for service abroad, with standardised mortality ratios of 0·81 and 0·83 for all causes of death and all deaths due to neoplasms, respectively, in the original period of observation (to the end of