CORRESPONDENCE

Exposure to asphalt or bitumen fume and renal disease

Editor,—The correspondence from Dittmer and Armitage provides further support for a causal association between exposure to various hydrocarbons and the development of renal disease. Since 1912, some case reports,1,2 case-control studies,3 and cross sectional4 studies together with animal experiments5 have provided compelling evidence for a causative role for hydrocarbon exposure in the development of both tubular and glomerular lesions.

We now report the case of a road worker exposed to asphalt and bitumen fumes who presented in 1990 at the age of 56 with nephrotic syndrome. He was then normotensive, had proteinuria with 24 hour urinary protein of 12.2 g, showed some clinical oedema, and his renal biopsy was consistent with a diagnosis of stage 2 membranous glomerulonephritis. Later that year he presented with an unexplained deterioration in renal function. This followed several weeks of abdominal pain, and he then had haematuria without pyuria, serum creatinine of 208 compared with his previously normal value of 85 µmol/l, and a marked deterioration in his renal biopsy with 20 glomeruli of normal architecture. Time weighted average exposures ranged from 0.4 to 8.9 mg/m3 measured as total organic fume (not including inorganic particulates), but short term or peak fume exposures were as high as 300–900 mg/m3. During all his years exposed to these fumes, the patient had never been provided with or worn respiratory protective equipment.

The study of renal health included 92 people regularly exposed to asphalt or bitumen fumes as road workers, 38 hard rock quarry workers not occupationally exposed to hydrocarbons, and 43 office workers also not exposed to hydrocarbons. Each participant was given a questionnaire about both occupational and recreational exposures and medical history including renal disease. Urine and blood samples were collected for urinary chemistry, blood biochemistry, and microscopic analyses. Any person with an abnormal finding on blood or urine analyses were retested and examined by a nephrologist to assess the presence or otherwise of renal disease.

The criteria which determined an abnormal test result were as follows: (a) persistently raised serum creatinine >120 µmol/l; (b) persistently raised serum urea >7.5 mmol/l; (c) persistent microscopic haematuria or pyuria; (d) 24 hour urinary protein >150 mg/day; or (e) corrected creatinine clearance <90 ml/min.

The presence of renal disease was determined as pre-existing or idiopathic according to the following criteria. Pre-existing renal disease: (a) family history or history of renal disease; (b) abnormal renal ultrasound. Idiopathic renal disease: (a) no known cause for abnormalities; (b) abnormal creatinine, urea, and creatinine clearance; (c) abnormal proteinuria; or (d) abnormal urinalysis—haematuria or pyuria.

The findings of the study are summarised in tables 1–3.

We concluded from this study that: (a) workers regularly exposed to asphalt or bitumen fumes were far more likely to have evidence of early stage renal disease than those working in a quarry or office; (b) workers regularly exposed to asphalt or bitumen fumes were far more likely to have at least one abnormal renal function test than those working in a quarry or office; and (c) the renal dysfunction was non-specific, but the overall findings were consistent with previous findings—such as those from the similar study done by Yaqoob et al.6 We think that chronic membranoproliferative and chronic tubulointerstitial nephritis are renal diseases which may result from exposure to hydrocarbons—such as those experienced from asphalt or bitumen fumes generated during road making.

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1 Dittmer ID, Armitage AJ. Prolonged exposure to an epoxy resin leading to interstitial nephritis. Occup Environ Med 1997;54:405–6.

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Authors’ reply.—The report of Douglas and Carney of a further case of renal disease associated with hydrocarbon exposure, together with their cross sectional study of those with prolonged exposure to bitumen and asphalt further strengthens the case for an association between renal disease and hydrocarbon exposure. Yaqoob et al have also convincingly shown, that in particular, proteinuria may be associated with hydrocarbon exposure.1

This highlights the need for a careful occupational and social history to be taken at the time of presentation. This case also highlights the need for performing a renal biopsy in adults presenting with unexplained proteinuria. If interstitial nephritis is found then a short course of steroids may result in a dramatic improvement in renal function as we noted in the case of our patient exposed to

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Table 1 Age and blood pressure

<table>
<thead>
<tr>
<th></th>
<th>No exposure</th>
<th>Office</th>
<th>Quarry</th>
<th>Exposure to bitumen or asphalt</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>People (n)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (mean)</td>
<td>39</td>
<td>32</td>
<td>35</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>BP (mean systolic)</td>
<td>133</td>
<td>133</td>
<td>133</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>BP (mean diastolic)</td>
<td>86</td>
<td>83</td>
<td>83</td>
<td>84</td>
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</table>

Table 2 Renal disease

<table>
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<th></th>
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<th>Quarry</th>
<th>Exposure to bitumen or asphalt</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people</td>
<td>43</td>
<td>4 (9.3)</td>
<td>38</td>
<td>92</td>
<td>173</td>
</tr>
<tr>
<td>Pre-existing renal disease (n (%))**</td>
<td>0</td>
<td>0 (0)</td>
<td>2 (5.3)</td>
<td>1 (1.1)</td>
<td>7 (4.0)</td>
</tr>
<tr>
<td>Idiopathic renal disease (%)**</td>
<td>0</td>
<td>0 (0)</td>
<td>12 (13.0)</td>
<td>12 (9.6)</td>
<td></td>
</tr>
</tbody>
</table>

**p<0.01.

Table 3 Renal function

<table>
<thead>
<tr>
<th></th>
<th>No exposure</th>
<th>Office</th>
<th>Quarry</th>
<th>Exposure to bitumen or asphalt</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>People (n)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haematuria</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Proteinuria</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Raised creatinine</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>At least one abnormality (n (%))**</td>
<td>4 (9.3)</td>
<td>2 (5.3)</td>
<td>24 (26.1)</td>
<td>30 (17.3)</td>
<td></td>
</tr>
</tbody>
</table>

**p<0.01.

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References

1 Dittmer ID, Armitage AJ. Prolonged exposure to an epoxy resin leading to interstitial nephritis. Occup Environ Med 1997;54:405–6.
Cancer risk in the rubber industry: a review of recent epidemiological evidence

There are 29 references cited in this article. Here are some of them:


Authors’ reply—We thank Straughan for his comments. We agree that some of the studies we reviewed provide a picture of 80 years of cancer experience in the industry, which is not the situation existing today (in industrialised countries). We tried to identify and report separately results for studies examining workers first employed in the 1980s. These studies did not clearly indicate the absence of an excess risk of cancer. Unfortunately the number of subjects and cancer deaths or cases in these studies is small and does not allow definite conclusions to be drawn yet.

Considerable heterogeneity exists between and within countries in exposure circumstances in the rubber industry. What we did in our review was to give a picture of risks of cancer in this industry. This overall picture does not apply to all countries, nor to all periods. However, an overall picture may highlight conditions that are not easily recognised at a local level. One example is the identification of an increased risk for laryngeal cancer, which had not been previously reported although it seemed consistent between centres. Another example is that there was no significant excess risk, which is correct. What can be distinguished, however, looking at the overall picture (see figure 1 of our review) is a small but consistent excess risk for bladder cancer even in studies conducted in relatively late periods. There is a lack of detailed exposure information in most studies but it is probable that β-naphthylamine was not used in these late periods. We agree with Straughan that it is difficult to exclude the possibility that the observed small excess risk is due to a late effect of early exposures.

The findings of the large BRMA study are, indeed, more stable and more comprehensive than those of studies in the Nordic or other countries, but they are not necessarily either more or less confounded than those of other studies. We understand Straughan’s plea for a full meta-analysis in which large studies are not given the same weight as small studies. The variability of exposures over time, geography, and process argue against performing a meta-analysis which presumes homogeneity of exposure.

It is commendable that the BRMA has been and continues to be actively involved in examining risk of cancer among workers in the rubber industry. We welcome the new study initiated by the BRMA which will do justice to the concluding sentence of our paper: “The preventive measures taken in the rubber industry in recent years may decrease risks, but this has not been documented yet in epidemiological studies”.

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Inhalation of ammonium nitrate fuel oil explosive (ANFO): and possible concomitant exposure

Editor—Donoghue1 reports on respiratory symptoms and rhinorrhea in a miner after exposure to ammonium nitrate fuel oil explosive (ANFO). As diesel fuel is the most commonly used fuel in ANFO the vapour he refers to might be components of diesel fuel. He excludes concomitant exposure to nitrogen dioxide because the inhalation occurred before any explosion took place. Although diesel powered machines are commonly used in underground work he does not discuss possible exposure to diesel exhaust. We have measured up to 15 ppm nitrogen dioxide during construction of a tunnel where the only known source was diesel exhaust. Exposure to such high concentrations may contribute to respiratory symptoms and rhinorrhea. Therefore nitrogen dioxide should not be excluded as a concomitant causative factor. In a study of the contribution of gases from diesel exhaust and from the blasting cloud caused by ANFO explosive during excavation of a tunnel, diesel exhaust contributed most to the total amounts of nitrogen dioxide in the tunnel.2


Occupational asthma due to amylase

Editor—In a letter to you,1 Hendrick points out my inadvertently overlooked report in The Lancet on allergy to u-amylase and papain,2 and makes generous reference to my other work on enzymes.

For clarification, I should point out that the evidence, supported by the findings with amylase, that sensitisation and consequent symptoms may occur from proteases independently of proteolytic activity, must not obscure the fact that the proteolytic mechanisms may cause other clinical or subclinical effects. As well as skin irritation, non-sensitised people may experience epistaxis or haemoptysis, whereas rhinorrhea or asthma are more likely to be due to allergy. Proteolytic activity causing proteolytic effects varies between different proteases, and susceptibility to such effects varies between people.3 I think I have experienced such effects myself;4 and possible long term consequences have been described.5

Although he concurs with the use of skin prick tests as an index of sensitisation, Kenrick expresses reservations about my evidence of causality in respect of chest symptoms from u-amylase. This is understandable if I relied solely on his condensation of an already condensed theory. Although my report derived from a comprehensive ongoing investigation, I had hoped I had summarised sufficient information to make my point. His reservations seem to derive from the fact that papain was also handled in the workplace, and that some of those sensitised to u-amylase were also sensitised to papain.

At this factory papain and u-amylase were handled in pure form, seldom, and at different times and places. The association between handling one or other material and the development of symptoms was clear cut, and because of the short period of handling, with intervals of at least a month between these periods, there was time for symptoms to regress between exposures.

I had already validated a skin prick test for papain sensitivity,1 and was able to use the same test to validate sensitisation to u-amylase. Positive prick test findings seemed to confirm the specificity and likely mechanism of the typically asthmatic symptoms from each enzyme.

Hadj I have no reasonable doubt as to causality I would not have published the warning. Happily, subsequent reports, including the excellent one by Aitkin et al.,6 which is the best, included inhalation challenge tests with fungal u-amylase,7 have endorsed my conclusions and added further knowledge.

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5 Musk AW, Gandeva B. Loss of pulmonary elastic recoil in asthma. Patients have been exposed to proteolytic enzyme (alcalase) in the detergent industry. J Ind Med 1976;38:558–65.

Health of children born to medical radiographers

Editor—There are increasing concerns that parental workplace exposure to potentially hazardous agents could affect the health of future offspring. There is little evidence to support this.7,8 Romand et al9 have developed a questionnaire based method for collecting data on reproductive outcome and child health which has not been applied to a study population comprising (predominantly female) members of the College of Radiographers. I have recently had cause to revisit their report of this work in more detail and have several comments.

The study relies on postal questionnaires for details of adverse pregnancy outcomes, major congenital abnormalities, and malignancies, but only reports of cancer were validated by reference to national registration schemes and medical records. Comparisons with national cancer registration rates for England and Wales and congenital malformation rates derived from data compiled by the Liverpool Congenital Malformation Registry showed little evidence to suggest an increased risk for cancer or for major congenital malformations. Within specific systems no excess relative risk was evident. Although there has been a significantly increased relative risks were found—for “other musculoskeletal” malformations and for “chromosomal anomalies other than Down’s syndrome”—both dominated by adverse outcomes reported by female radiographers. My particular interest is with the group of six cases of chromosome anomalies other than Down’s syndrome.

Four cases of Turner’s syndrome were reported by female radiographers diagnosed before birth and the pregnancies terminated. The Turner phenotype, recognised in live born infants, is characterised by monosomy X and has a birth incidence in females of 1/2000–1/5000.10 However, the frequency of monosomy X at conception is much higher, occurring in 1%–2% of all clinically recognised pregnancies.11 Over 99% abort spontaneously,70% of these between 11 and 14 weeks gestation.12 The incidence of Turner’s syndrome will vary considerably with different stages of pregnancy and this has implications for the calculation of expected numbers of cases. When evaluating Turner’s syndrome in relation to aetiological factors it is important to have accurate information on the timing and method of diagnosis, and comparisions must be made with appropriate registry data. In around 80% of cases the X chromosome present is maternal13 but two therefore, by contrast with most cases of Down’s syndrome, an error in meiotic non-disjunction cannot be attributed to the mother. Of those diagnosed after birth, some are mosaics with a normal XX cell line and an abnormal cell line or a cell line with one normal and one abnormal X chromosome, and it has been suggested that mosaicism increases the likelihood of survival during pregnancy.14 Such mosaics are assumed to have arisen post-zygotically. Turner’s syndrome is, therefore, most likely to occur due to an error in non-disjunction arising either during spermatogenesis or after fertilisation, and the origin of the error can often be determined by undertaking cytogenetic analyses.15 In other studies, consequently, it is unlikely that maternal preconceptional exposure is relevant to the occurrence of the cases of Turner’s syndrome reported to Roman et al10 although it is possible that events immediately after conception could be implicated in the origin of any with a mosaic karotype. It is unfortunate that Roman et al provide no karotypic data nor information on whether the mothers were working as radiographers when they conceived as this would have assisted in the interpretation of this association.

Two further pregnancies with chromosomal abnormalities were described—a 45,X ovarian mosaicism reported by a female radiographer and a trisomy 17 reported by a male radiographer—both of which were terminated. Referral to results of chromosomal studies would have probably excluded the possibility of the gross chromosomal anomaly being the result of a familial rearrangement could then have been explored. Trisomy 17 is rather a surprise as this is considered incompatible with embryo development16 and has not, to my knowledge, been detected by antenatal diagnosis. There must be a possibility that this information is incorrect.

Aetiological mechanisms must be considered when assessing the biological plausibility
of epidemiological associations, and reliance on personal memory will not provide the detailed data which allow chromosomal abnormalities to be grouped in a meaningful way when exploring possible environmental influences. The study of Roman et al illustrates the need to confirm diagnoses reported in questionnaires and to test for possible, and to obtain any additional information that may assist in the scientific evaluation of epidemiological results.

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CORRECTION


The section entitled “Statistical methods: cross sectional study” (page 687), should read:

In the cross sectional study, crude preval- ence and age adjusted (Mantel-Haenszel) relative prevalences (95% confidence intervals (95% CIs)) were calculated by occupational group for the following outcomes: age adjusted hearing loss at 1-6 kHz greater than 30 decibels (dB) in either ear, pathological findings at lung auscultation (which were defined as rales, rhonchi, or crackling), forced expiratory volume in one second (FEV1) less than 80% predicted, diastolic blood pressure (DBP) ≥95 mm Hg, abnormal findings in the electrocardiogram (ECG), body mass index (BMI) >27.8 kg/m2, γ-glutamyl-transprop- dase (GGT) >28 U/l (measured at 25 "C), reduced mobility of the spine (fingertips to floor test, Schober sign), local pain at the spine or tenderness of the paravertebral muscles (assessed by the paravertebral muscles and percussion of the spine), abnor- mal findings in the limbs (limited or disturbed mobility, pain, swelling, deformation, or am- putation) and skin abnormalities (eczema or inflammation, itching, or dysludrosis).

Also corresponding headlines in tables 2 and 3 (page 688) should read age adjusted hearing loss ≥30 dB (not hearing loss at 2, 3, and 4 kHz >105 dB) and diastolic blood pressure ≥95 mm Hg (not diastolic blood pressure >95 mm Hg).

The authors deeply regret these errors, which do not alter the conclusions of the paper. We kindly ask the reader to comply with these corrections when interpreting the data presented in tables 2 and 3.

BOOK REVIEWS

Book review editor: R L Maynard

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As indicated by the title, this is the next in a series of proceedings of symposia on inhaled particles. These international symposia, held in 1980, 1985, 1970, 1975, 1980, 1985, 1991, and 1996 at various venues in the United Kingdom, were all sponsored by the British Occupational Hygiene Society (BOHS). Since the 1975 meeting, the proceedings were also issued simultaneously as special issues of the BOHS journal "Annals of Occupational Hygiene." These symposia and their proceedings have served as landmarks documenting the state of the art in knowledge and techniques concerning human exposures to airborne particles, their deposition and clearance within the respiratory tract, and their health effects.

The broadening depth and scope of the symposia to now include radioactive, outdoor and indoor particulate matter have put a great strain on the organisers and especially on the editors. Additional pressures resulted from the fact that the two previous proceedings did not appear until three years after the meetings. Thus, the publication of this volume only one year after the symposium is a significant accomplishment and a tribute to the dedication of its new editors. A price for this accomplishment was the restriction of the 127 papers to four to six pages each, and the elimination of external peer reviews. The reviews and editing were done by the editors alone. Also, for the first time, there were no abstracts included in the papers and the questions from the audience, and authors’ responses, that were notable features of the earlier volumes, were not included.

The quality of the papers and editing remain at a high level, and this volume should be a valuable addition to the bookshelf of all scientists, health professionals, and public health authorities who are seriously inter- ested in the health effects of airborne particles. It is a little regretful that the price is high enough to limit its readership.

MORTON LIPPMANN


Airborne fibre concentrations have been evaluated by the membrane filter method for over 30 years. The original method, which was developed for use in asbestos factories, has been adapted for use with many different types of fibre in both occupational and non-occupational situations. By the 1970s it was clear that there were substantial differ- ences between laboratories when evaluating the same samples. Dishottering could be attributed to variations in the detailed methodology and this started the quest to devise a “standardised” version of the membrane filter method. This book is the latest attempt to standardise the method on this occasion to harmonise methods used for analysis of asbestos—for example, the Euro- pean Reference Method (ERM) used throughout the European Union, with the previously published World Health Organisation method for man made mineral fibres (rockwool and glasswool). The new method is applicable to all fibre types, both organic and inorganic.

The method specification is contained within 17 statements which are supple- mented by more detailed descriptions. It contains details of everything required from the type of filters to be used to the character- istics of the fibres to be measured. The accuracy, precision, and lower limit of measurement are also provided.

This is a specialist book which will be of limited interest to those not directly involved with measurement of exposure to fibres. However, it is clearly the authors’ intentions to influence the appropriate national authori- ties to incorporate this version of the membrane filter method into their legislation. If this method does replace the ERM then measured fibre concentrations would prob- ably increase, for some industries perhaps as much as 50%. The implications for epide- miological studies, risk assessment, and standards setting need to be carefully consid- ered.

JOHN W CHERRIE


This book is aimed at managers and others who wish to obtain an understanding of the principles of occupational safety and health in the United Kingdom. It is published by the Institution of Occupational Safety and Health (IOSH) and it is the recommend text for their safety appreciation course, Managing Safety.

The text is divided into four sections: safety technology, occupational health and hygiene, safety management, risk assessment, and law. There are 68 short chapters which cover the essential factual information required by someone responsible for managing health and safety. Each chapter includes several self assessment questions and a bullet point sum-
This book, one of a series of reviews produced by the World Environment and Health, provides a useful summary of the current understanding of the risks associated with both asbestos and more importantly, and less well-known, man-made mineral fibres. It provides useful background information on the many types of fibre produced and used in industry and documents comprehensively the amount and types of fibre to be found in materials and in buildings in the United Kingdom. After reviewing the difficulties of measuring tiny respirable fibres, it summarises the scientific literature on fibre concentrations to be found in the general and domestic environment and makes estimates of the exposure of the United Kingdom population. Much of the information is derived from the fact that we have some 300 million people in the UK who are exposed daily by the inhalation of animal and vegetable fibres. However, calculating up a total lifetime exposure over 70 years can give a figure as high as almost 30 million fibres in total which of course would not be unreasonable as microscopically it would appear reassuring. It then goes on to discuss the experimental animal and in vitro evidence with respect to man-made fibres. There is useful discussion of fibre deposition, clearance, and solubility leading to conclusions which in my view are wholly sensible. For asbestos, the authors argue against a general policy of removal and for management in situ until the material is releasing unacceptable amounts of dust. For man-made mineral fibres, the authors express caution about the production of fine diameter fibres but point out that almost all the material used commercially is not respirable and that there is no reason to suppose that current levels of exposure pose any real risk to the public. All in all this is a remarkably informative book containing much information on mineral fibres that is not readily available elsewhere. The debate about the harmfulness of fibres needs to shift back to the protection of exposed workers and away from theoretical risks to the general population.

ANTHONY SEATON


“Every 10 seconds, another person dies as a result of tobacco use”. This is the stark introductory sentence to this reference book compiled by the World Health Organisation as a source of standardised baseline information on tobacco production, trade, consumption, health effects, and control in WHO member states. The book is divided into two parts: the first, comprising 60 pages, attempts to summarise the global situation in the late 1980s and early 1990s. The second and larger part provides a series of “country profiles” for each of the member states, typically of one or two pages. These list the latest available information on demographic and general health indicators, tobacco production, trade and industry, tobacco consumption, and smoking prevalence by age and sex, and national tobacco control policies and programmes.

Designed as a reference text, this is not a book to be read from cover to cover. Its strength is the near comprehensive coverage of national statistics on tobacco production and use, which are useful summarised in part one. These may suffice for readers with an epidemiological background, among whom the adverse health effects of smoking are taken for granted. For a more general readership, however, a notable weakness of this book is the paucity of information on health consequences of tobacco use. The relevant chapter in the first part runs to only five pages, including four tables, and is supported by only two references, one of which is yet to be published (although it has been cited as a series of recent articles in the Lancet). The discussion of health effects is entirely focused on mortality, mainly from broad groups of causes, such as total mortality, and cancer deaths. Remarkably there is no mention of the disability and loss of productivity related to cardiovascular and respiratory diseases, nor of the consequences of environmental tobacco smoke.

This volume provides a powerful reminder, if such is needed, that tobacco use is a global phenomenon, with one third of adults now smoking, and two thirds of these residing in developing countries. The premise underlying the report is that widespread tobacco consumption and public health are mutually incompatible, but readers seeking a comprehensive collation and consideration of the epidemiological evidence on smoking and ill health will be disappointed. It is apparent that the WHO intends these data to be a baseline for a global programme of surveillance of smoking habits and tobacco control. The report is evidently much needed and it compiles a comprehensively account of the effects of tobacco use on health in many countries, particularly in the developing world. A valuable addition to future editions would be evidence from countries with well developed tobacco control policies of the extent to which lowering smoking prevalence reduces death and disability. This might encourage much needed policy initiatives in many other countries where tobacco control has yet to achieve prominence on the public health agenda.

DAVID P STRACHAN


This monograph gives full details of a study conducted to test the Gardner hypothesis—namely, that childhood leukaemia and non-Hodgkin’s lymphoma result from the father’s...
exposures to ionising irradiation before conception. This study has also been published as a paper in the BMJ, but this volume goes into far greater details than is available elsewhere. This is very much a book for the concerned specialist reader who wants the technical background to the BMJ article.

This study is essentially a record linkage exercise. The exposed fathers (and mothers) were defined as having records with the National Registry for Radiation Workers (NRRW) held by the NRPB. This is a database of over 120,000 people and it was linked with the national register of childhood tumours, a database of over 50,000 children with all types of cancers. Two other data sources on childhood cancers were also included.

For the three sources of data on childhood tumours, controls were found in various ways to ascertain if these children had a father in the NRRW. The parental estimated doses were created from the NRRW. In all a total of 200 fathers and mothers were linked to children with cancer. Eighty two children with leukaemia or lymphoma were linked to fathers’ records at the NRRW, as were 79 control fathers. The corresponding numbers for mothers were 15 and three.

The cases in the original Gardner paper were excluded and the results for fathers showed that case fathers had a 1.77 significant excess risk over control fathers for having a child with leukaemia or lymphoma. However, the risk was associated with the lowest dosages and there were no dose responses in any of the comparisons. In this sense the Gardner hypothesis is refuted!

Furthermore, the risk in mothers was also significantly and greater in magnitude than the fathers. However, the small numbers make this result unreliable and difficult to use to extrapolate risk.

The explanation of the association found in these NRRW members exposed to low doses is not known. It could be chance, it could also be due to misuse of film badges by those in high risk industries. This explanation is unlikely in that the cancers were distributed widely across industries in the United Kingdom and were not confined, by any means, to the nuclear reprocessing or related industries. It may be due to other exposures associated with the wider radiation industries where many other hazardous substances exist as well as ionising irradiation. Finally, it could be some other, more subtle aspect, of wearing a film badge. The authors speculate that this might be associated with the mobility of the parents, thereby linking these results with the Kinlen hypothesis which is based on ideas of infectivity associated with population mixing. They do not produce evidence to suggest that film badge wearers are more mobile than other professions but the differences in behaviour may be more complex.

Further light might be shed on this association when the nuclear industry family study (NIFS) is analysed shortly. This study will answer some criticisms of the present study. For example, it is known that there are differences in behaviour of people within the nuclear industry and those outside it. The NIFS uses internal comparisons and so such differences can be accounted for.

Despite the lack of any explanation of this observation attention is now bound to be focused on other preconceptional and periconceptual exposures in both sexes and their possible links with childhood malignancies.

R A CARTWRIGHT

Health of children born to medical radiographers.

E J Tawn

doi: 10.1136/oem.55.9.647c