CORRESPONDENCE

Reporting of occupational and environmental research: use and misuse of statistical and epidemiological methods

Rushton's recent article¹ on the reporting of occupational and environmental research raises several useful points that all researchers would do well to remember when writing up epidemiological findings for publication. Without expressly intending to do so, however, the article also emphasises the hazards of establishing formal criteria or checklists for the evaluation of scientific work. Good epidemiological practices certainly exist, but one of the pitfalls inherent in attempts to codify them is that, by their nature, lists of the features of "good" research tend to impose a "one size fits all" standard, which—like clothing of the same description—fits nothing particularly well.

The prospect of developing formal guidelines for reporting analyses based on multivariable models illustrates the difficulties. Science involves many kinds of activities, but the significant advances come about through the creative application of human intellect, rather than by rote repetition of the familiar. Like other aspects of science, epidemiological data analysis blends attention to factual detail with creativity, intuition, judgement, and even aesthetics. From the initial choice of model form to the final specification of covariates and interaction terms, there may be many reasonable ways to model a given data set. Researchers should be at liberty to analyze their data according to their individual scientific insights. In subsequent evaluations of methods and results, reviewers likewise should be encouraged to apply their scientific judgement, rather than following a recipe.

The opportunity cost involved in complying with guidelines for good practice may also be considerable, as Rushton suggests.¹ Between the growing fear of litigation and mounting demands for accountability, especially in the United States, epidemiologists may soon spend more time documenting adherence to protocol than doing science.

My particular fear, however, is that guidelines will be used to assail sound research on the grounds that it fails to comply with supposed standards of good science. The misuse of Hill's ideas about causality illustrates the danger. Hill intended his suggestions as an aid to researchers, not as evaluative standards for critics; he wrote: "I do not believe...that we can usefully lay down some hard-and-fast rules of evidence that *must* be obeyed before we accept cause and effect. None of my nine viewpoints ... can be required as a *sine qua non*. What they can do, with greater or less strength, is help us to make up our minds on the fundamental question."² Yet Hill's ideas are often presented as criteria that must be fulfilled for a study's evidence to be accepted.³ The involvement of such obviously self interested groups as the Chemical Manufacturers Association in promoting "good epidemiological practices" makes the potential misuse of guidelines to suppress good research seem all too likely.

I do not mean to suggest that all epidemiological research should be published or accepted at face value, far from it. There will

always be a need for review to ensure the quality of published work and to protect the public from policies based on unsound science. I am convinced, however, that peer review coupled with the opportunity for criticism and debate in open publications provide the best pathway to this goal. By contrast with standardised criteria, these processes allow multiple, independent readers' perspectives on the methodological quality, and the substantive importance of research to be heard. As a result, they reduce the chances that unconventional but valuable views will be suppressed or that an interested group could gain control over the process for their own purposes.

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- 1 Rushton L. Reporting of occupational and environmental research: use and misuse of statistical and epidemiological methods. *Occup Environ Med* 2000;57:1-9.
- 2 Hill AB. The environment and disease: association or causation? *Proc R Soc Med* 1965;58: 295-300.
- 3 Gamble JF. PM_{2.5} and mortality in long term prospective cohort studies: cause-effect or statistical association? *Environ Health Perspect* 1998;106:535-49.

L Rushton replies

Loomis draws attention to the potential dangers of the rigid use of checklists and guidelines to judge occupational and environmental research. I agree with these sentiments, in particular the concerns about the increasing number of papers which use compliance with these guidelines as a justification for conclusions on causality. There is, however, one rapidly expanding area of research which would benefit from the development of minimum standards for presentation of results. This is the field of epidemiological meta-analysis, in which data are generally abstracted from published papers. Difficulties can arise in deriving a common set of definitions for variables. For example, in a meta-analysis of use of oral contraceptives and risk of breast cancer,¹ 42 different categories of duration of use of oral contraceptive were published in the 24 papers analysed for this variable. Debate within the scientific community is needed to decide categorisations which would be most useful. Editors could then encourage authors either to use these in their papers or at least be prepared to make them available on request.

L RUSHTON

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- 1 Rushton L, Jones DR. Oral contraceptive use and breast cancer risk: a meta-analysis of variations with age at diagnosis, parity and total duration of oral contraceptive use. *Br J Obstet Gynaecol* 1992;99:239-46.

Occupational exposures and pancreatic cancer: a meta-analysis

A meta-analysis that was recently published in this *Journal*¹ suggested an association between excess pancreatic cancer risk and exposure to nickel and nickel compounds (meta-risk ratio 1.9, 95% confidence interval (95% CI) 1.2 to 3.2, based on four studies). Through correspondence with the authors (Ojajärvi *et al*), I learned that their analysis excluded the many epidemiological studies that had been conducted on workers in the nickel refining and alloy production industries. Although most of these studies could not contribute to the meta-analysis due to a failure to specifically examine risk of pancreatic cancer, I found two studies of nickel workers that provide relevant data.

I think that one of these studies, which examined mortality in 11 500 nickel mining and smelting workers,² should have been included in the meta-analysis by Ojajärvi *et al*,¹ based on the criteria used for study selection. Another study of more than 30 000 workers exposed to nickel and nickel compounds in the production of nickel alloys³ was published a few months after the May 1998 cut off that Ojajärvi *et al* used to establish the data base for their meta-analysis. The results from these studies^{2,3} add substantially to data used in the analysis by Ojajärvi *et al*.

Combining the data from all of these studies with the meta-analysis random effects model used by Ojajärvi *et al*¹ produces a meta-risk ratio (MRR) of 1.3 (95% CI 0.9 to 1.9). Interestingly, the two studies designed specifically to detect excess cancer risks associated with occupational exposure to nickel^{2,3} show the lowest relative risks for pancreatic cancer and differ substantially from the MRR for nickel exposure calculated by Ojajärvi *et al* (1.9). Moreover, the estimated relative risk (0.9) from the study of nickel alloy workers³ is significantly smaller ($p < 0.05$) than even the lower 95% confidence limit (1.2) for the MRR of Ojajärvi *et al*.¹

The fact that the MRR of Ojajärvi *et al*¹ for nickel related pancreatic cancer significantly overestimates the risk found in a large cohort of nickel workers indicates that their meta-analysis risk estimates should be viewed with an appropriate degree of caution. These results of the meta-analysis may be considerably biased because of limitations of the studies on which they are based. In studies that relate to nickel, the potential for misclassification bias is strong because of the complete confounding of nickel exposure with known carcinogenic hazards such as cadmium,⁴ or asbestos, polycyclic aromatic hydrocarbons, chromium, beryllium, polychlorinated biphenyls, and hydrazine.⁴ Similarly, in the meta-analysis of Ojajärvi *et al*¹ the case-control study⁷ that contributed the most substantial evidence of a risk of pancreatic cancer related to nickel provides equally strong statistical evidence of associations between excess pancreatic cancer and expo-

Table 1 Cancer risks in studies of workers exposed to nickel and its compounds

Study	Study type	Included in Ojajärvi <i>et al</i> ¹	Pancreatic cancer deaths	RR	95% CI*
Thermoelectric plant workers ⁴	Cohort	Yes	1	3.6	0.1 to 19.9
Cadmium/nickel battery workers ⁵	Cohort	Yes	3	1.7	0.3 to 4.9
Los Angeles workplaces ⁶	Case-control	Yes	6	1.5	0.4 to 5.7
Montreal workplaces ⁷	Case-control	Yes	12	2.1	1.1 to 3.9
Nickel mining and smelting workers ²	Cohort	No	12	1.3	0.7 to 2.3
Nickel alloy production workers ³	Cohort	No	131	0.9	0.8 to 1.1

*SMR/100 for cohort studies.

tures to 10 other substances, some of which are likely to be correlated with occupational exposure to nickel.

Although Ojajarvi *et al*¹ are to be congratulated on their investigation of the aetiology of pancreatic cancer, it is my opinion that their results are most appropriately viewed as hypotheses that require further investigation, rather than compelling evidence that links substances to the induction of pancreatic cancer. As Ojajarvi *et al*¹ correctly suggest, research to test these hypotheses requires large studies and more refined measures of exposure. With respect to nickel and nickel compounds, data from large studies that were not included in the analysis of Ojajarvi *et al*¹ call into question the veracity of a hypothesis that links nickel exposure to increased risk of pancreatic cancer.

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- Ojajarvi IA, Partanen TJ, Ahlbom A, *et al*. Occupational exposures and pancreatic cancer: a meta-analysis. *Occup Environ Med* 2000;97:316-24.
- Shannon HS, Walsh C, Jadon N, *et al*. Mortality of 11 500 nickel workers: extended follow up and relationship to environmental conditions. *Toxicol Ind Health* 1988;4:277-94.
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- Cammarano G, Crosignani P, Berrino H, *et al*. Additional follow up of cancer mortality among workers in a thermoelectric power plant. *Scand J Work Environ Health* 1986;12: 631-2.
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- Siemiatycki J. *Risk factors for cancer in the workplace*. Boca Raton, FL: CRC Press, 1991.

Ojajarvi and Partanen reply

We thank Seilkop for his comment and have, in essence, not much to add to it. The study by Shannon *et al*¹ had obviously been overlooked and the study by Arena *et al*² was published after our deadline for the inclusion of studies.

Seilkop's table has errors for the study by Andersson *et al*.³ The number of pancreatic cancer deaths should be 2; relative risk should be 1.2; and 95% confidence interval should be 0.1 to 4.5.

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- Shannon HS, Walsh C, Jadon N, *et al*. Mortality of 11 500 nickel workers - extended follow up and relationship to environmental conditions. *Toxicol Ind Health* 1991;7:277-94.
- Arena VC, Sussman NB, Redmond CK, *et al*. Using alternative comparison populations to assess occupation-related mortality risk. *J Occup Environ Med* 1998;40:907-16.
- Andersson VC, Elinder CG, Hogstedt C, *et al*. Mortality among cadmium and nickel-exposed workers in a Swedish battery factory. *Current Topics in Environmental and Toxicological Chemistry* 1985;399-408.

Air pollution research databases

I write to inform your readers that the MRC Institute for Environment and Health is compiling two databases on research in air pollution (including indoor air pollution).

These databases are designed to provide funding bodies and policy makers with an up to date source of information which they may use to:

- Identify people and groups with expertise in particular aspects of air pollution research
- Obtain information on current topics of air pollution research
- Identify gaps in research on air pollution
- Identify new advances in the air pollution field
- Assist in the prioritisation of future research on air pollution.

We encourage all researchers in the field to submit information on their work for inclusion in either or both these databases:

- The air pollution research database (APRED).** This will hold data on research into indoor and outdoor air pollution within the United Kingdom. Its particular focus is on the individual researchers, their expertise and areas of interest. It is being prepared on behalf of the United Kingdom Department of Health and the Department of the Environment, Transport, and Regions.
- The CEFIC database.** This will hold data on research being done on indoor air pollution in Europe, including the United Kingdom. Its primary intention is to identify all current research projects in the area. It is being prepared on behalf of the European Chemical Industry Council (CEFIC).

During development the databases will be held within the Institute, but in due course they will be made available through an internet website, in a searchable format.

The Institute is currently in the process of identifying the names and contact details of researchers in the United Kingdom so that they may be sent a questionnaire seeking certain information to enter onto the databases—for example, details about their research, project abstracts, research interests of each person, and details about their organisation.

All interested people should please go to the website address: <http://www.le.ac.uk/iehl/update/update.html#database> which gives a brief outline of the projects, and describes how to obtain a questionnaire and more information on the databases.

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CORRECTION

Personal exposures of children to nitrogen dioxide relative to concentrations in outdoor air. C H LINAKER, A J CHAUHAN, H M INSKIP, S T HOLGATE, D COGGON. 2000;57:472-6

Unfortunately an authors' error occurred in this paper in the conversion of concentrations of outdoor nitrogen dioxide (NO₂) from ppb to µg/m³. As a consequence, all of the NO₂ measurements that were reported in outdoor air should be multiplied by a factor of 3.53. The correlations with personal NO₂ measurements are unchanged, as is the interpretation of our findings. Although higher than originally indicated, the outdoor NO₂ concentrations were nevertheless relatively low.

NOTICES

Nordic and National Training Centres Courses and Symposia 2001

Work and stress: somatic effects of physical and mental work

18-23 February, 2001, Geilo Hotel, Geilo, Norway

From intensive work systems to sustainable work systems

13-16 March, 2001, Ljungbergsgården, Tynningö, (Stockholm), Sweden

Challenges of ageing of the workforce

2-8 April, 2001, Hotel Riekonlinna, Saariselkä, Lapland, Finland

Research dissemination

22-26 April, 2001, Ljungbergsgården, Tynningö (Stockholm), Sweden

Safety research

10-15 June, 2001, Metalworkers' Murikka Institute, Tampere, Finland

Bullying and harassment at work

11-15 June, 2001, Hotel Eckerö, Åland, Finland

Introduction to occupational epidemiology

21-25 August, 2001, Hotel Gentofte, (Copenhagen), Denmark

Occupational exposure limits: approaches and criteria

23-28 September, 2001, Hotel Linné, Uppsala, Sweden

Occupational dermatology

11-16 September, 2001, Sokos Hotel Kuusamo, Kuusamo, Finland

Molecular toxicology: molecular epidemiology

14-19 October, 2001, Tallinn, Estonia

Intervention projects in the health care sector

21-25 October, 2001, Nordic School of Public Health, Gothenburg, Sweden

Risk assessment as a basis for the selection of personal protective equipment

28 October - 2 November, 2001, Medical Academy of Latvia, Riga, Latvia

A sister organisation to NIVA is the Nordic School of Public Health.

For more information about NIVA, visit our web-site: www.niva.org

For further information about their courses and seminars, please contact: Nordic School of Public Health, Box 12 133, SE-402 42 Göteborg, Sweden. Tel 0046 31 69 39 00; fax 0046 31 69 17 77; www.nhv.se

5th Annual Conference on Self Directed Learning in General Practice. 24th April 2001. London, UK.

Organised by the Open Learning Unit, University College London, and sponsored by the British Medical Journal. The conference will be organised around the themes of:

- Revalidation
- Web based learning resources for self directed learning.

The day will be based around small group workshops, with some offering hands on training in the use of on line learning resources. Places will therefore be strictly limited and allocated on a first come, first served basis.

For further details please contact: Marcia Rigby on tel: 0044 (0)20 7288 3246; fax 0044 (0)20 7281 8004 m.rigby@ucl.ac.uk. A web-site is in preparation.

EPICOH 2001, Fifteenth Symposium on Epidemiology in Occupational Health. 20-22 August 2001. Copenhagen, Denmark.

The symposium will be attended by 300 researchers in the field of epidemiology in occupational health arranged by the Scientific Committee on Epidemiology in Occupational Health under ICOH. It will consist of 3 days of intensive discussions on submitted papers, keynotes, and seminars.

Seminars

- 1 Measures of work related musculoskeletal disorders: Questionnaires, physical findings and clinical syndromes
- 2 Use of population-based cohort studies in occupational epidemiology
- 3 Repeated measurements
- 4 Health promotion at the workplace

Deadline for abstracts is 1 February 2001 (postmark date). Papers accepted for publication or published elsewhere will not be accepted.

Further information from: Ole J Teller, The Danish Working Environment Council, Ramsgangsvej 7, DK-2500 Valby, Denmark. Phone: 0045 36 14 31 62; fax: 0045 36 14 31 80; email: ICOH.WORKandHEALTH@OSH-Council.dk or WWW.OSH-Council.dk

Premus 2001, 4th International Scientific Conference on Prevention of Work Related Musculoskeletal Disorders. 30 September to 4 October 2001 De Meervaart, Amsterdam, The Netherlands.

Further information from: Ms Beunk-Timmers, Nicolaes Tulp Institute. Telephone 0031 20 566 8585; telefax 0031 20 696 3228; email m.p.beunk-timmers@amc.uva.nl

XXVIth International Symposium of the International Section for the Prevention of Occupational Risks in the Construction Industry. 12-14 December 2001. Paris, France.

Call for papers on the dynamic management of health and safety in the construction industry: practicable solutions.

The aims of this symposium are therefore, on the basis of practical examples, to evaluate, reflect upon and publicise the stakes, strategies, methods and tools for dynamic management of health and safety in the construction industry.

Topics of the symposium

- Challenges of dynamic management of health and safety for humans at work
- Prevention development policy: orientations and prevention principles
- Co-activity and health and safety co-ordination
- Construction and environment
- Construction and quality
- Evolution of occupational diseases
- Situation of new technologies
- Challenges for small and medium firms

- Strategies of risk management in the construction industry : practice and innovations
- Safety management within the overall cost of a project
- Integration of prevention in construction activities
- Experience in project or execution stage
- Impact of safety management on the strategies of prevention experts
- Strategies for small and medium firms
- Methods and tools for dynamic management of health and safety: regulations, company practice and standardization
- Techniques of knowledge of risks
- Techniques for analysis of costs and benefits
- Tools for quality, safety and environment: synergies, complementarity, contradictions?
- Situation and abilities of those involved in the construction process in the management of health and safety
- Which training for management?
- Methods and tools for small and medium firms

Target audience

This symposium is aimed at all people working in the construction industry:

- Employers, employees, and their representatives
- Clients, project supervisors, coordinators
- Prevention experts, safety technicians, occupational physicians
- Academics and researchers
-

Please send all abstracts and requests for information to: CRAMIF, Secrétariat du Colloque AISS-BTP, 17-19 place de l'Argonne, F-75019, Paris. Telephone: 0033 1 40 05 38 02; fax: 0033 1 40 05 38 84; email: comaiss@infonie.fr or <http://www.cramif.fr>

BOOK REVIEWS

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Rapid guide to hazardous chemicals in the workplace, 4th edition. By: R J LEWIS. (Pp 260; £22.95.) 2000. Wiley - Interscience. ISBN: 0 471 35542 9.

This is one of the most useful small books on hazardous chemicals that I have come across. The author and publishers also produce the large three volume *Sax's dangerous properties of industrial materials* of which this book is, in some ways, a selective summary. The rapid guide deals with 760 substances and runs to 260 pages: soft covered it fits easily into either pocket or briefcase.

The coverage is wide: for example, cotton dust and silica are included as well as more straightforward chemicals. For each, details are provided in about 2 inches of page space. Compression of data is inevitable but the author has managed to extract a surprising amount of what is in his larger book. The few lines provided on properties provide a useful rapid review of key toxic effects. This is an excellent book and much handier than many books covering the same ground. All occupational physicians and hygienists should have a copy.

R L MAYNARD

Aerosol technology, second edition. By William C Hinds. (Pp 483; £58.50). 1999. Chichester: John Wiley. ISBN 0 471 19410 7

Aerosol science is a challenge to all inhalation toxicologists. The mathematics and physics can be daunting and many texts are aimed, understandably, at the physical scientist rather than at the biologist or medical worker. Some books do not seem to explain enough; others, far too much. Finding a comprehensive account that a non-mathematician, like me, understands is itself a challenge. But: Hind's book provides the solution. Detailed but clear, it explains just about everything the hygienist and toxicologist need to know about aerosols.

The first edition appeared in 1982 and rapidly became the established text in the field; the second edition appeared last year and is even better. The author has adopted an approach that leads the reader gently through the physics providing examples that can be followed (no use of words such as "immediately" or "thus" followed by some terrible equation) and convinces one that the concepts can be mastered. If this is doubted see the chapter on particle size statistics: this is just outstanding. I remember finding with joy, in the first edition, the distinction between mass mean diameter and diameter of average mass and being reassured that this was regarded as confusing! The explanation is provided in such a clear way that anybody can grasp it.

The author has updated and expanded his chapters on properties of gases, particle motion, filtration, sampling and measurement, and on condensation and evaporation. A new chapter on bioaerosols and much expansion in the chapter on microscopy has allowed the concept of fractals to be added. The discussion of fractal geometry is another example of how well the author explains a difficult issue. Being told that D_f , the fractal dimension, is a measure of the complexity of the edge of an enclosed area is helpful; being told that if the coastline of the United Kingdom were a smooth straight line, D_f would = 1.0 and that if it were maximally complex D_f would = 2.0 helps even more. I hate being unable to deduce such things. The United Kingdom coastline D_f = 1.24. The author then shows how this can be applied to particles, such as the aggregates found in diesel exhaust.

The book concludes with a useful set of appendices providing much valuable data.

This book looks mathematical and may at first glance be off putting. If you are interested in aerosols and not a mathematician do not be put off: this book may well be your only chance of learning enough to be able to talk sensibly to the physicists! At £58.50 this book is excellent value: easily the best in the field.

R L MAYNARD