Nasal carcinoma and occupational exposure to wood dust

Report by the Industrial Injuries Advisory Council in accordance with Section 171 of the Social Security Administration Act 1992 reviewing nasal carcinoma and occupational exposure to wood dust

Presented to Parliament by
the Secretary of State for Work and Pensions
By Command of Her Majesty

September 2017

Cm 9499

Nasal carcinoma and occupational exposure to wood dust

Report by the Industrial Injuries Advisory Council in accordance with Section 171 of the Social Security Administration Act 1992 reviewing nasal carcinoma and occupational exposure to wood dust

Presented to Parliament by
the Secretary of State for Work and Pensions
By Command of Her Majesty

September 2017

Cm 9499

This publication is available at **https://www.gov.uk/government/publications**

Any enquiries regarding this publication should be sent to us at **iiac@dwp.gsi.gov.uk**

ISBN 978-1-5286-0025-5

CCS0917931116 09/17

Printed on paper containing 75% recycled fibre content minimum

Printed in the UK by the APS Group on behalf of the Controller of Her Majesty's Stationery Office.

INDUSTRIAL INJURIES ADVISORY COUNCIL

Professor K T PALMER, MA, MSc, DM, FFOM, FRCP, MRCGP (Chair)

Dr P BAKER, MA, DM, BS, MRGCP, MFOM

Mr K CORKAN, BA

Professor P CULLINAN, MD, BS, MB, MSc, FRCP, FFOM

Dr S DE MATTEIS, MD, MPH, PhD

Mr P FAUPEL, CBiol, MRSB, FIOSH (Retired)

Professor S KHAN, BMedSci, FFOM, FRCGP, FRCP, DM

Dr I MADAN MB, BS (Hons), MD, FRCP, FFOM

Professor D McELVENNY, BSc, MSc, CStat, CSci

Ms K MITCHELL, LLB

Professor N PEARCE, BSc, DipSci, DipORS, PhD, DSc

Mr H ROBERTSON

Mr D RUSSELL, BSc (Hons), MSc, CMIOSH

Professor A SEATON, CBE, MD, DSc, FRCP, FRCPE, FMedSci

Dr K WALKER-BONE, BM, FRCP, PhD, Hon FFOM

Dr A WHITE, BSc (Hons), PhD, CMIOSH, AIEMA

Former Council Members

Mr R EXELL, OBE

HSE Observer:	Mr A DARNTON
IIAC Secretariat:	
Secretary:	Mrs H NORTON-HALE/Ms A LOAKES
Scientific Advisor:	Dr M SHELTON (Until May 2016)
	Mr I CHETLAND (From September 2016)
Administrative Secretary:	Ms C HEGARTY

Nasal carcinoma and occupational exposure to wood dust

Dear Secretary of State

Nasal carcinoma and occupational exposure to wood dust

Rarely, occupational exposure to wood dust results in an aggressive cancer of the nose and associated air sinuses. This association is recognised within the Industrial Injuries Disablement Benefit Scheme as Prescribed Disease (PD) D6, where sinonasal cancer develops in an occupation involving “attendance for work in or about a building where wooden goods are manufactured or repaired”. However, tribunals have placed a narrow interpretation on the meaning of “building”, effectively restricting coverage to claimants working in premises which exist to manufacture or repair wooden goods, and placing outside the scope of benefit, for example, the carpenter who is exposed to wood dust during the fitting out of shops or on a construction site. This report has looked in detail at the terms of PD D6 to ensure that coverage is appropriate and optimal for purpose.

Evidence drawn from publications of the International Agency for Cancer, the Health and Safety Executive, and more than 40 other research reports indicates that there is a strong case for prescribing also for employed earners who develop sinonasal cancer following occupational exposure to wood dust in the machine processing of wood. The Council therefore recommends extending the prescription, as set out in Table 8 of this report.

Fortunately, sinonasal cancer is a rare tumour, with only some 440 cases occur per year across the UK; claims for benefit under the Scheme are rare. Therefore, any associated impact of the Council’s recommendations on claims activity will be very small.

Yours sincerely

Professor Keith Palmer
Chairman, Industrial Injuries Advisory Council

Summary

1. Wood dust is classified by the International Agency for Research on Cancer (IARC) as a 'definite' human carcinogen. Markedly higher risks of sinonasal cancer (carcinoma of the nasal cavity and associated air sinuses) have been found in workers exposed occupationally to this agent.
2. The association is recognised for purposes of Industrial Injuries Disablement Benefit (IIDB) in subsection (a) of Prescribed Disease (PD) D6, which provides for the affected claimant who has worked as an employed earner.
3. The wording of PD D6(a) has remained unchanged for 35 years, over which time further evidence on the hazard has accumulated, while the legal meaning of words in the prescription, such as "in or about", "a building", "wooden goods", "manufactured" and "repaired", has been debated by tribunals and decision makers.
4. The Council has undertaken a review of PD D6(a) to ensure that the wording of the prescription accurately reflects available scientific evidence and is up to date and optimal for purpose.
5. Evidence has been drawn from publications by IARC, the Health and Safety Executive (HSE) and other parties, and in particular some 40 original research reports which are summarised in detail.
6. Sinonasal cancer is known to occur in many occupational groups, including carpenters and joiners, wheelwrights and wainwrights, wood machinists, sawmill, forestry, and timber workers, boat pattern makers, woodcarvers, and makers of wooden shoes, vats and boards.
7. Risks (relative to background rates) have been notably high among workers from the furniture industry. The wording of the prescription was conceived in this context, but broadened later to recognise evidence on risks outwith furniture manufacturing.
8. The Council recommends that the terms now be further broadened to refer to "attendance for work in or about a *workplace* where wooden goods *or wooden products* are manufactured or repaired". Additionally, it recommends that cancer of the nasal cavity or associated air sinuses be recognised in relation to occupational exposure to wood dust in the course of the machine processing of wood. Further details are set out in Table 8 of the report.
9. Data from the HSE in 2000 indicate that wood dust exposures are relatively high in small businesses in Britain, while national statistics on mortality of sinonasal cancer

by occupation, for 1979-2000 in England and Wales, confirm the enduring relevance of the hazard in modern workplaces.

10. Fortunately, sinonasal cancer is a rare tumour. Only about 440 cases occur per year across the UK. Between 2002 and 2012, fewer than 6 claims per year were made to the IIDB Scheme in relation to PD D6. Any associated impact of these recommendations on costs and claims processing activity will therefore be very small.

Background

1. This review was prompted by correspondence from an MP concerning a case of nasal cancer in a constituent occupationally exposed to wood dust.
2. A relationship between the tumour and wood dust is generally accepted for purposes of award of Industrial Injuries Disablement Benefit (IIDB), the terms for prescription being those set out in Schedule 1 of the Social Security (Industrial Injuries) (Prescribed Diseases) Regulations 1985 for Prescribed Disease (PD) D6, "carcinoma of the nasal cavity or associated air sinuses (nasal carcinoma)".
3. At initial claims consideration, the constituent's circumstances of exposure were deemed not to match those appearing in the schedule. As these terms are unchanged since 1981, the Industrial Injuries Advisory Council (IIAC) decided (without regard to the outcome of the claim) to revisit the prescription, to ensure that it accurately and fully reflects available scientific evidence on the disease-exposure relationship and is up to date and optimal for purpose. This report details the Council's review of evidence and its recommendations.

The Industrial Injuries Disablement Benefit Scheme

4. The IIDB Scheme provides a benefit that can be paid to employed earners because of an occupational accident or 'prescribed' disease (listed in Schedule 1 of the 1985 Regulations). The benefit is no-fault, tax-free, non-contributory and administered by the Department for Work and Pensions. It is paid in addition to other incapacity and disability benefits but is taken into account when determining the level of payment for income-related benefits.

The Industrial Injuries Advisory Council

5. IIAC is an independent statutory body established in 1946 to advise the Secretary of State for Social Security on matters relating to the IIDB Scheme. IIAC advises on the prescription of occupational diseases; matters referred by the Secretary of State; draft regulations or proposals concerning the Scheme; and any other matter relating to the Scheme or its administration. IIAC is a non-departmental public body and has no power or authority to become involved in individual cases or in their decision

making processes.

Sinonasal cancer

6. Sinonasal cancer affects the nasal cavity (the space inside the nose) and/or the anatomically contiguous para-sinuses, which are small, air-filled cavities in the bones around the nose. The malignancy is rare, with only around 440 cases diagnosed in the UK each year. It is more common in men than women but less common in the UK than in other countries, such as Japan and South Africa. The tumour has an appreciable 5-year mortality.
7. It exists in several histological types, the two main ones being squamous cell carcinoma (a tumour developing from skin-like lining cells) and adenocarcinoma (a tumour developing from glandular cells). Some 60% of cancers in the nasal cavity and paranasal sinuses are of the former type and 10% are of the latter.
8. Known non-occupational risk factors for sinonasal cancer include tobacco smoking, infection with human papilloma virus, and radiotherapy for certain unusual indications.
9. Additionally, there are several well-recognised and some suspected occupational causes of the disease. Among the former and compensable under the IIDB Scheme are oxides and sulphides of nickel, from nickel refining before 1950 (PD C22(a)), inorganic chromates and hexavalent chrome (PD C32), and leather dust from footwear manufacture or repair (PD D6 (b), PD D6(c)). The position in relation to wood dust is taken up below, but PD D6(a) prescribes for the tumour in occupations involving “the manufacture or repair of wooded goods”.

Prescribed Disease provisions of the IIDB Scheme

10. The Social Security Contributions and Benefits Act 1992 states that the Secretary of State may prescribe a disease where he or she is satisfied that the disease: (a) “Ought to be treated, having regard to its causes and incidence and any other considerations, as a risk of the occupation and not as a risk common to all persons; and (b) Is such that, in the absence of special circumstances, the attribution of particular cases to the nature of employment can be established or presumed with

reasonable certainty."

11. In other words, a disease may only be prescribed if there is a recognised risk to workers in an occupation, and the link between disease and occupation can be established or reasonably presumed in individual cases.
12. Some occupational diseases are relatively simple to verify in these terms, as the link with occupation is clear-cut. Some only occur due to particular work (e.g. pneumoconiosis in coal miners); or are almost always associated with work (e.g. mesothelioma in the UK); or have specific medical tests that prove their link with work (e.g. occupational asthma); or have a rapid link to exposure or other clinical features that make it easy to confirm the work connection (e.g. certain infections and chemical poisonings). Thus, for example, the proof that an individual's dermatitis is caused by their occupation may lie in its improvement when they are on holiday and regression when they return to work, and in the demonstration that they are allergic to a specific substance with which they come in contact only at work.
13. However, many other diseases are not uniquely occupational and, when caused by occupation, are indistinguishable from the same disease occurring in someone who has not been exposed to a hazard at work. In these circumstances, attribution to occupation depends on epidemiological evidence that work in the prescribed job or with the prescribed occupational exposures causes the disease on the balance of probabilities (previous reports of the Council give further detail). In turn the Council looks for evidence that a particular occupational exposure or circumstance increases the risk of developing the disease by a factor of two or more.
14. The requirement for, at least, a doubling of risk follows from the fact that if a hazardous material doubles risk, for every 50 cases that would normally occur in an unexposed population, an additional 50 would be expected if the population were exposed to the hazard. Thus, out of every 100 cases that occurred in an exposed population, 50 would only do so as a consequence of their exposure while the other 50 would have been expected to develop the disease, even in the absence of the exposure. Therefore, for an individual case occurring in the exposed population, there would be a 50% chance that it would have occurred even without the exposure. Below the threshold of a doubling of risk only a minority of cases in an exposed population would be caused by the hazard and individual cases therefore could not be attributed to exposure on the balance of probabilities; above it, they may be. The epidemiological evidence required should ideally be drawn from

several independent studies, and be sufficiently robust that further research at a later date would be unlikely to overturn it.

15. Since sinonasal cancer is not specific to occupation and not clinically distinguishable in occupational instances from those which are unrelated to occupation, the principles in paragraphs 13 and 14 are relevant to this report.

Occupational exposure to wood dust

16. Historically, the highest occupational exposures to wood dust have occurred in furniture and cabinet manufacture, especially during machine sanding and allied operations. Additionally, relatively high levels of dust have been measured in the finishing departments of plywood mills, where wood is sawn and sanded, and in the areas of sawmills near chippers, saws and planers. Substantial exposures can also arise in joinery shops, window and door manufacture, wooden boat manufacture, pattern and model making, construction, carpentry and sundry other industries (Young *et al*, 2012).
17. In Britain, an Occupational Exposure Limit (since replaced by a Maximum Exposure Limit (MEL)) of 5 mg/m^3 has applied since 1998 for total inhalable hardwood dust and, since 1997, for total inhalable softwood dusts. A survey by HSE in 2000 found that wood dust exposures exceeded this limit in almost 30% of the small businesses studied, sometimes by a considerable margin (Dilworth, 2000). The situation was worse, however, in 1988/89, when only one in eight establishments controlled exposures to below 5 mg/m^3.

History of the prescription, PD D6

18. Sinonasal cancer was prescribed within the Scheme following research evidence from the furniture industry around High Wycombe (wood dust) and the boot and shoe industry in Northamptonshire (leather dust), together with a growing, and now large body of international evidence on risks from occupational exposure to wood and leather dusts.
19. Since the 1960s, a large excess risk of sinonasal cancer, particularly adenocarcinoma, has been repeatedly documented in wood-working occupations, often with strong evidence of a dose-response relationship.

20. Risks were particularly high for exposures involving dusts of hardwoods (in Britain, France and Italy); but a tripling or more of risk has been found in studies involving exposures to the dusts of softwoods (in the Nordic countries, Canada, the USA and France).
21. The evidence now covers many countries, including England, France, Denmark, Sweden, Finland, The Netherlands, the USA, Canada and Australia. It is such that wood dust in general is classified by the International Agency for Research on Cancer (IARC) as a class 1 or 'definite' human carcinogen (IIARC 1995, 1998, 2012).
22. Frequently, relative risks of the tumour in woodworkers have far exceeded the doubling of risk threshold normally adopted by the Council when recommending prescription. For example, in a pooled reanalysis of 12 international case-control studies, Demers et al (1995b) estimated that the odds of adenocarcinoma were elevated 14.9-fold for men with any occupational exposure to wood dust and 45.5-fold for those classed as highly exposed. Odds for all histological types of the tumour were also raised 2.2- and 5.8-fold respectively.
23. Because initial evidence was strongest for carcinoma in furniture and cabinet makers, the first prescription for sinonasal cancer was framed only in relation to this association. In parallel, a separate prescription was added for sinonasal cancer in workers engaged in the manufacture or repair of footwear made wholly or partly of leather or fibre board.
24. *Cmnd 8393 (Industrial Diseases: a review of the schedule and the question of individual proof) (1981)* brought together the early prescriptions for nasal cancer in these industries (PD 45 & 51); restructuring of the schedule led to PD D3, which has since been renumbered PD D6.
25. In 1981 the Council identified further evidence on risk in woodworkers, which enabled the exposure definition for sinonasal cancer to be broadened. It wrote about *Nasal cancer (Diseases Nos. 45 and 51)* as follows: *"*We received evidence that there was an increased risk of nasal cancer in woodworkers other than workers in the furniture industry (to whom the cover provided by Disease No. 45 is at present restricted), and a review of the research material on the subject showed a much higher incidence of nasal cancer among workers exposed to any fine wood dust than among the population in general. We therefore recommend an extension of the occupational cover of Disease No. 45 to *the manufacture of all wooden goods*. We

also recommend extending cover to those involved in *the repair of wooden goods*. In addition, we should also like to take the opportunity provided by the review of the Schedule to combine Diseases Nos. 45 and 51 for the sake of simplicity. Disease No. 45 would, as a result, cover carcinoma of the nasal cavity, rather than adeno-carcinoma as at present, but we think that this would present no problems" (emphasis added).

26. At the time of the 1981 report the prescription schedule for nasal cancer was as set out in Table 1; but following implementation of the Council's advice and with some renumbering it was revised as set out in Table 2. This is its current form and is unchanged since the early 1980s.

Table 1: Prescription of nasal cancer at the time of the Council's 1981 report, Cmnd 8393

PD	**Disease**	**Any occupation involving**
45	Adeno-carcinoma of the nasal cavity or associated air sinuses	Attendance for work in or about a building where wooden furniture is *manufactured*
51	Carcinoma of the nasal cavity or associated air sinuses (nasal carcinoma)	(a) Attendance for work in a building used for the *manufacture* of footwear or components of footwear made wholly or partly of leather or fibre board; or (b) attendance for work at a place used wholly or mainly for the *repair* of footwear made wholly or partly of leather or fibre board.

Table 2: The current terms of prescription of nasal cancer

PD	**Disease**	**Any occupation involving**
D6	Carcinoma of the nasal cavity or associated air sinuses (nasal carcinoma)	(a) Attendance for work in or about a building where wooden *goods* are *manufactured* or *repaired*; or (b) attendance for work in a building used for the manufacture of footwear or components of footwear made wholly or partly of leather or fibre board; or (c) attendance for work at a place used wholly or mainly for the repair of footwear made wholly or partly of leather or fibre board

27. The words highlighted in Tables 1 and 2 were not so emphasised in the original text.

They indicate that a desire to broaden coverage in relation to wood dust led to the phrase “wooden furniture” (PD45) being changed to one about “wooden goods” (PD D6(a)).

28. The evidence available to the Council in 1981 was not described. It is conceivable that some of it related specifically to nasal cancer and the repair of wooden goods. Another possibility, however, is that the Council, in seeking on the one hand to recognise a broader range of exposures to wood dust, and on the other to combine PD 45 (which referred only to “manufacture”) and PD51 (which, in respect of leather dust, referred also to “repair”), opted in the combined prescription to include the word “repair” in part (a) to make it consistent with part (b). The effect would have been to widen the field of eligibility to some employed earners with nasal cancer and exposure to wood dust.
29. It is unclear from past reports whether exposures other than those in manufacture and repair of wooden goods (e.g. the processing of wood itself) were evaluated and explicitly excluded from prescription.
30. However, over time distinctions have been drawn by tribunals and decision-makers, seeking to put precise legal meaning to terms such as “attendance for work”, “in or about”, “a building”, “manufactured”, “repaired” and “wooden goods”. The effect has been to rule some claims ineligible despite established exposure to wood dust, because circumstances were similar but not identical to those appearing in PD D6. Thus, for example, in CI/12678/1996, a claimant had been working as a painter for 45 years and had spent a large proportion of his time sanding wood. It was contested, but finally held that doors, skirting boards and parquet flooring were “wooden goods”; it was held that the claimant “repaired” these goods; and it was accepted that the claimant “undoubtedly had inhaled over many years quantities of wood dusts which are apparently recognised carcinogenic agents”. The claim failed though, because the Commissioner ruled that PD D6(a) “covered only work in buildings such as factories or warehouses where the manufacture or repair of wooden goods was carried out *as part of the nature of the building*” (and not settings such as shops, offices, private dwellings and building sites). Cases like this illustrate how closely the terms of the prescription are read.
31. In 2007 the Council found “insufficient grounds to indicate a need to alter the terms of prescription” of PD D6 (paragraph 70, *Cm 7003, Completion of the review of the scheduled list of prescribed diseases*). However, later in that year, *Cm 7162*

introduced a new prescription for cancer of the nasopharynx, an adjacent anatomical site, in wood-working occupations; and such exposures were defined more broadly to include “processing of wood” as well as the “manufacture or repair” of “wood products” (rather than “goods”). The terms of PD D13 appear in Table 3, for comparison with those of PD D6(a) in Table 2.

Table 3: The current terms of prescription of cancer of the nasopharynx

PD	Disease	Any occupation involving
D13	Primary carcinoma of the nasopharynx	Exposure to wood dust in the course of the processing of wood or the manufacture or repair of wood products, for a period or periods which amount in aggregate to at least 10 years

32. Since the current terms of PD D6(a) were written some 35 years ago (over which time the evidence may have changed), since the terms of prescription for wood dust exposure and cancer at an anatomically adjacent site appear less restrictive than those for PD D6, and since the exposure terms of PD D6(a) are critically read by tribunals and decision-makers, the Council identified a need to revisit the current terms of prescription. The aim has been to ensure they accurately reflect available scientific evidence and are up to date and optimal for purpose.

Method of investigation

33. Relevant reports were identified from several sources: the most recent IARC monograph on wood dust (IARC, 2012); a detailed review on sinonasal cancer (Young *et al*, 2012) commissioned by the Health and Safety Executive within its ‘burden of cancer’ work programme; a recent peer-reviewed systematic review on occupational causes of sinonasal cancer (Alonso-Sardón *et al*, 2015); and a systematic search of the Council’s own, undertaken on behalf of its Research Working Group.

Research evidence

34. There follows a more complete account of the evidence base, with particular

emphasis on what can be discerned about patterns of exposure to wood from their descriptions in individual studies.

35. Some of the reports found by the search were of the cohort type, in which instances of sinonasal cancer were identified from among workforces with established historic (often high) exposure to wood dust and compared with expected numbers from a reference group (e.g. the general population), Owing to the great rarity of the cancer, however, a more practical starting point is a collection of cases, and most reports were of the case-control type, in which cases of sinonasal cancer known to medical services were compared with non-cases in terms of their previous occupational history of exposure to wood dust. Estimates of exposure typically depended then on the recall of patients or their next of kin; also, owing to small numbers in different occupational settings and to allow meaningful numbers for analysis, exposure groups were often combined. There are therefore some inevitable limitations in the evidence base. Nonetheless, the hazard has been extensively studied.

Acheson *et al*, 1968

36. Cases of sinonasal cancer resident in Oxfordshire and parts of Buckinghamshire in the Oxford Hospital Region through 1956-1990 were identified using the Oxford Cancer Registry, local hospital records, a check of death registers and correspondence with records offices out of area and all the general practitioners in the area. The number of woodworkers was estimated from data in the 1961 census. Histological samples were obtained where possible.
37. About one-quarter of (24 of 108) cases were in the furniture industry and five more in ex-furniture workers, also four in “other” woodworkers. One patient was a wood machinist at a factory making general household furniture; one was a French polisher at the same factory and one worked as a cleric to an ecclesiastical furniture maker, while one was a timber yard labourer in the furniture industry. Fifteen cases of adenocarcinoma were diagnosed between 1956 and 1965, all of whom were known to have worked in the furniture industry at some time; in three cases exposure was as brief as five, seven and nine years respectively. Average annual incidence rates of adenocarcinoma were elevated about 6-7 fold in cabinet, chair, and veneer makers and wood machinists (‘woodworkers’ in the furniture industry) relative to all occupations. No increase in risk was found in carpenters and joiners, but the

numbers were too small to draw firm conclusions. Histologies other than adenocarcinoma comprised two-thirds of the case material, but no risk estimates were presented for them.

Acheson *et al*, 1972

38. This case-control study was based on 107 cases of adenocarcinoma and 110 controls who were patients with nasal cancer of other histological types, matched by age, sex and region. Subjects were identified through cancer registries in England. 34 cases worked with wood at some time, mostly in the furniture industry. Cases in the furniture industry included cabinet and chair makers, wood machinists, turners, sawyers, upholsterers, a wood stainer, a French polisher, also three woodworkers of crafts unspecified. Among eight of the nine cases of adenocarcinoma for whom there was a detailed occupational history and certainty that they had never worked previously in the furniture industry, three were classed as joiners, one as a carpenter, one as a joiner-carpenter, one as a wheelwright-carpenter, one as a sawyer in a timber yard and one as a packing case maker; in four of the cases the principal exposure was to soft wood dust. In six other cases outwith the furniture industry (but in whom the occupational history was not detailed enough to exclude previous employment in the furniture industry), two were carpenters, one was a carpenter-joiner, one labourer in a carpentry shop, one a wood machinist and one said simply to be a "woodworker". Data were presented to illustrate the challenge of precise histological classification: 107 'cases' were originally designated as adenocarcinoma, but a second pathologist identified only 78, there being agreement in 74 instances. Similarly, the first pathologist identified 58 cases of squamous cell carcinoma, the second 62, and both agreed over 50 of the cases.

Ironside *et al*, 1975

39. These authors identified all cases of cancer of the nose or paranasal sinuses in the case records of the Cancer Institute in Melbourne Australia, covering patients from the state of Victoria. Files were scrutinised for information on occupational history. Among 99 cases of nasal cancer, 19 were adenocarcinomas (18 of these in men). Occupational history was incompletely recorded by admission clerks, but for 13 cases of adenocarcinoma with such information, seven were in a woodworking occupation (two carpenters, a sawmill proprietor, a timber worker, two builders). By

contrast, in the Victoria census of 1966, the group “carpenters, joiners, cabinetmakers and related workers” comprised only 3.8% of the male workforce and 0.3% of the group described as “timber getters and other forestry workers”. Also in comparison, among 80 other cases with cancer of the nose or paranasal sinuses but histology other than adenocarcinoma, four patients were woodworkers. No details were available on duration or intensity of exposure to wood dust.

Andersen *et al*, 1977

40. This report involved a case series of 186 patients treated for sinonasal cancer at the ear, nose, and throat (ENT) department of a community hospital in Aarhus, Denmark, between 1965 and 1974. Adenocarcinoma was found in 17 patients (15 male), of whom 12 had a history of exposure to wood dust in the furniture industry – as cabinet makers and chair makers (10), turners (1) and coach makers (1). There were also cases of squamous cell cancer in a carpenter, a turner, a sawyer, a forestry worker and a brush maker. The authors commented that: “Adenocarcinoma of the nose is a rare disease with an annual incidence of 0-9 per million in the total population. More than two-thirds of those affected were woodworkers in the furniture industry, making it abundantly clear that this disease is associated with work in the furniture industry.” Exposures were assessed contemporaneously in a sample of eight workplaces in the furniture industry in the county during 1974-5: it was estimated that 63% of workers were exposed at dust concentrations >5mg/m^3.

Brinton *et al*, 1977

41. This case-control study of nasal cancer was based on death certificate statements in North Carolina. Data on deaths between 1956 and 1974 were obtained for counties where at least 1% of the total population had been employed in furniture and fixture manufacturing. The industry and occupation recorded on the death certificate were used to classify exposures to wood dust. Cases were deaths from sinonasal cancer and these numbered 37 in all. Two controls per case were matched by age, sex, race, county, aged death, and year at death and were drawn from other causes of death (two-thirds were cardiovascular, 11% involve cancers other than sinonasal). Exposed individuals were those working as a furniture maker (8 cases), a lumber-sawmill worker (3), or carpenter (2). Odds ratios (OR) were presented for different study periods (1955-64, 1965-1974) and two age bands (<65 and ≥65 years). In the

earlier period, among younger men, 18.2% of cases were exposed vs. 4.8% of controls (OR 4.0), while among older men the respective figures were 33.3% and 5.6% (OR 6.0); in the later period, 33.3% vs. 0% for men aged up to 65, and 9.1% vs. 13.6% for older men.

Cecchi *et al*, 1980

42. In this case-control study, 13 cases of adenocarcinoma of the nose or paranasal sinuses were identified through the ENT clinic and radiology Institute of the University of Florence during 1963-77, of whom 11 were successfully interviewed (subjects or next of kin). They were compared with matched controls from two sets – other patients admitted to the department of medicine without cancer and admissions with cancers other than those affecting the nose or paranasal sinuses. Among the 11 cases, four were “woodworkers” or “wood cutters” with an average employment duration of 17 years (range 10-30 years), a highly significant difference from controls ($p < 0.0001$). Other exposure information is lacking. This study also illustrated a challenge over classification: among 47 patients with biopsy material whose histology was independently reviewed, adenocarcinoma was confirmed in 7 of 8 instances and squamous cell carcinoma in 16 of 18 instances; while at the second reading, 4 of 8 cases originally designated ‘anaplastic carcinoma’ were reclassified as squamous cell carcinoma.

Roush *et al*, 1980

43. This case-control study took its materials from the Connecticut Tumour Registry. Cases with deaths from sinonasal cancer between 1935 and 1975 who were resident in Connecticut at the time of death; controls were a random sample of men dying in the state over the same period. Job titles for ascertained from death certificates; occupations were grouped according to exposure to certain agents including wood dust. In all, 216 cases and 662 controls met the study criteria and had job information. Exposure to wood dust was said to be based on the occupational titles studied by Acheson, Andersen and Brinton, but no further details were given. The summary OR for wood dust was 2.8. Histological types other than adenocarcinoma did not appear to be more common among woodworkers, but numbers were small and the findings were vulnerable to the play chance.

Acheson *et al*, 1981

44. New cases of sinonasal cancer in England and Wales during 1963-7 were identified using cancer registries and occupational histories obtained from the patient, a relative, hospital notes, or death certificates. In the occupational order of "woodworkers", 59 cases were observed vs. 20.8 expected – a Standardised Incidence Ratio (SIR) of 2.84 ($p < 0.01$); for cabinetmakers, the SIR was 9.66 for chair makers, 6.6 for machinists and other woodworkers 2.93 ($p<0.01$), and it was elevated for carpenters and joiners (SIR 1.49), although not significantly so at the 5% level. Some 8% of cases were adenocarcinomas; risk estimates were not presented separately for different histological subtypes.

Rang *et al*, 1981

45. This cohort study followed 5,371 men who had worked at any of 9 furniture factories in Buckinghamshire (and were on the High Wycombe Furniture Manufacturers Association register) for an average of 19 years. Over 96% of cohort members were traced at follow-up. Cancers were identified from a regional cancer registry (the Oxford Regional Cancer Register). Records were identified of job titles at different times and periods of time in such employment were assigned an assumed level of dustiness to wood ("very dusty" = cabinet and chair makers, sanders, wood machinists; "dusty" = polishers, veneerers and maintenance men; "less dusty" = office workers, upholsterers, and yard men); where a man had several levels of exposure from several different jobs, he was assigned the dustiest. Cancer incidence was compared with expected rates of the male population of the Oxford Regional Hospital Board area and standardised registration ratios (SRRs) calculated. Considering all histopathologies, eight cases of sinonasal cancer were observed vs. 1.1 expected (SRR 7.27, 95%CI Confidence Interval (95%CI) 3.14-14.33). Seven of the cases occurred in very dusty jobs (SRR 11.67, 95%CI 4.69-24.04) and 1 (v.0) in dusty jobs (SRR 5.0, 95%CI 0.13-27.86). All of the cancers were adenocarcinomas, however, and the respective figures were, for dusty jobs, SRR 23.33 (95%CI 9.38-48.1, 7 observed cases vs. 0.03 expected) and for very dusty jobs, SRR 100 (95%CI 2.5-557.2, 1 observed case vs. 0.01 expected). No cases occurred in less dusty occupations.

Battista *et al*, 1983

46. In this case-control study from Siena, 36 male cases diagnosed between 1963 and 1981 by local medical services were compared with 164 male controls admitted to the medical clinic at Siena for all causes except nasal neoplasia, matched by age and time of admission. The area was chosen because 7.7% of men and 4.3% of women in the 1971 census were actively employed in the wooden furniture industry. Among those who had ever worked in the wood or furniture industry (woodworkers or cabinetmakers), the OR for nasal cancer was 4.7 (95% CI 1.7-12.8), but for adenocarcinoma it rose to 89.7 (95% CI 19.8-407.3). Among seven cases from the wooden furniture industry, one was exposed for six years, one for 10 years, and the others for more than 30 years. An estimate was made of incidence, for which data were restricted to the province of Siena: the incidence rate ratio for any histology of nasal cancer was 3.0 (95%CI 0.8-11.1) and that for adenocarcinoma was 35.9 (95% CI 6.5-198.4). No risk estimates were presented for histological subtypes other than adenocarcinoma, but only one of 17 cases of squamous cell carcinoma (and two of 14 other cancer types) had worked in the wood and furniture industry, as compared with 4 of 5 cases of adenocarcinoma.

Hernberg *et al*, 1983a; 1983b

47. All new cases of sinonasal cancer in Denmark, Finland and Sweden during 1978-80 (167 cases with 18 adenocarcinomas and 95 squamous cell carcinomas) were identified through national cancer registries (and in Denmark, also, several oncology centres). Controls were selected from the same registries and were cases of colonic or rectal cancer. Standard telephone interviews collected histories if all jobs lasting a year or more up to the 10 years before diagnosis. Hygienists assessed and coding the intensity, duration and calendar time of exposures – e.g. "heavy" in the furniture industry if work involved grinding, drilling and planing; "moderate" in sawmill workers and carpenters at construction sites. Those with moderate and heavy exposure were combined and compared with those with light or no exposure (i.e. sawmill workers and carpenters were mixed in with furniture workers); no data were presented by intensity, duration or calendar time of exposure. The OR for exposure to hardwood dust only was 2.0 (95% CI 0.2 -21.0), that for softwood dust only was 3.3 (95% CI 1.1-9.4), and that for exposure both to hardwoods and to softwood dusts was 12.0 (95% CI 2.4-59.2). Cases were often cabinetmakers; but several were sawmill workers and construction carpenters, while a case of adenocarcinoma occurred in

someone sawing oak parquet, a second in an individual sanding parquet floors and a third in a boat pattern maker; one case had carpentry only as a hobby with 4 to 6 hours of exposure per week. Risk estimates were not presented by histological subtype of sinonasal cancer.

Brinton *et al*, 1984

48. This case-control study identified all cases (live and dead) of sinonasal cancer from four hospitals in North Carolina and Virginia during 1970-80 and compared their work histories with, for life cases, hospital patients (without certain cancers of the upper airways, ENT conditions or mental health disorders) and, for deceased cases, deceased individuals identified through state vital statistics offices. Telephone interviews were conducted with the subject or next of kin for 160 (of 193) cases and 240 (of 272) controls. Exposure was defined in terms of ever vs. never working in a given industry, with no information on duration or intensity of exposure. The overall OR for sinonasal cancer and ever working in carpentry was 1.60 in men (13 exposed cases) and that of ever working furniture manufacture was 0.74 in men (5 exposed cases). Risks were not elevated for squamous cell carcinoma, but they were more than doubled for adenocarcinoma in relation to furniture making, carpentry and construction, and for other cancer types following work in the lumber industry or carpentry (see Table 4). Findings were only significant statistically for adenocarcinoma, in furniture makers and woodworking overall.

Table 4: Risks of carcinoma of the nose and nasal sinuses by industry (from Brinton *et al*, 1984) [*p<0.05]

Industry	OR (exposed cases)		
	Adenocarcinoma (n=17)	Squamous cell carcinoma (n=53)	Other cancer types (n=27)
Furniture	5.68 (4)*	0.25 (1)	-
Lumber	1.58 (4)	1.10 (12)	2.23 (10)
Carpentry	2.88 (3)	1.05 (5)	2.28 (5)
Construction	2.75 (6)	0.88 (11)	1.43 (8)
Other wood	-	1.16 (3)	-
One or more of the above	3.68 (10)*	0.78 (22)	1.19 (14)

Hayes *et al*, 1986

49. This case-control study identified male cases, newly diagnosed between 1978 and 1981 in six institutes in the Netherlands involved in treatment of head and neck

cancers and compared them with an age-stratified random sample comprised partly of living males resident in the Netherlands in 1982 and partly of deceased males in 1980. Interviews were conducted with subjects or their next of kin in respect of 91 (of 116) cases and 195 (of 259) controls. Industry-task job titles were assigned on the basis of work histories to those ever working in furniture and cabinet making, joinery and carpentry in a joinery factory, carpentry in housing and "other" (machinists in wood-related workplaces, sawmills, and wooden shoe makers). An industrial hygienist assigned a probability of exposure on a nine-point scale, where "high" exposures were allocated to furniture makers, factory shop carpenters and producers of wooden products (e.g. vats and shoes) and "medium" exposures to workers in forestry, furniture factories (if not furniture makers) and building carpenters. Relative risks were as in Table 5.

Table 5: Risks of sinonasal cancer by woodworking industry (from Hayes *et al*, 1986)

	OR (90%CI)		
	All nasal cancers	Adenocarcinoma	Non-adenocarcinoma cancers
Furniture/cabinet making	12 .5 (3.9-52.6)	139.8 (31.6-999.4)	0.9 (0.00-8.7)
Factory joinery/carpentry	2.1 (0.5-7.9)	16.3 (2.8-85.3)	0.6 (0.00-4.7)
Housing carpentry	0.6 (0.1-2.7)	- (0-12.0)	0.7 (0.1-3.0)
Other 'wood-related'	1.1 (0.3-3.6)	- (0-10.5)	1.3 (0.3-3.9)
Any of the above	*2.5 (1.4-4.6)*	*17.6 (6.9-49.2)*	*0.9 (0.4-2.0)*
Paper and wood industry	*1.7 (1.0-2.9)*	*11.9 (4.9-31.2)*	*0.5 to 0.7*

50. Risks for adenocarcinoma were very high among furniture and cabinet makers (OR 139.8), but also high among factory carpenters and joiners (16.3) and among woodworkers overall (17.6). For non-adenocarcinomas risks were not elevated, although numbers were small. Risks were further assessed in relation to level of dust and dates of exposure (Table 6). For adenocarcinoma, among those highly exposed to wood dust, the OR was 26.3. In this group relative risks were substantially and significantly elevated (OR>22) for all time periods through to 1981 (the date of assessment). Risks did not decrease for at least 15 years after termination of exposure. For squamous cell carcinoma, risks were not much elevated overall (OR 1.3); for other cancer types, risks were more than doubled only for high exposures (OR 2.2), a finding that was not significant statistically.

Table 6: Risks of sinonasal cancer by level of wood dust exposure (from Hayes *et al*, 1986)

	OR (90%CI)		
	Adenocarcinoma	Squamous cell carcinoma	Other cancers
Low	- (0-4.1)	2.5 (1.1-5.2)	1.2 (0.2-5.1)
Moderate	1.6 (0.1-12.3)	0.7 (0.2-2.4)	1.5 (0.2-6.4)
High	26.3 (9.3-85.5)	0.5 (0.1-1.9)	2.2 (0.5-8.0)
Any	8.5 (3.4-25.4)	1.3 (0.7-2.4)	1.5 (0.6-3.9)

Fukuda *et al*, 1987

51. In this case-control study, 106 cases of squamous cell carcinoma of the maxillary sinuses were compared with 212 matched controls. Cases were identified at two university and two medical college hospitals during 1982-4, while controls were chosen at random from telephone directories. RRs for working for >1 year as a "carpenter, joiner, furniture worker or other wood worker" (28% of cases) were elevated 2.9-fold ($p < 0.05$) in men and 2.0 ($p > 0.05$) in women. Some 50% of workers were said to have had only one job. However, "the small number of subjects prevented a precise specification of high risk occupations".

Olsen, 1988

52. In this case control study, 382 cases of sinonasal cancer, diagnosed between 1970 and 1974, were identified through the Danish Cancer Registry. Employment data were obtained from the Danish Supplementary Pension Fund (a compulsory pension scheme for wage earners from 1964): standardised proportional incidence ratios (SPIR, a form of relative risk) were calculated based on the longest held occupation. The SPIR (relative risk) was 3.38 (5 cases, $p<0.05$) in men engaged in the manufacture of furniture and fixtures and 3.60 (also 5 cases, $p<0.05$) in men engaged in the manufacture of wood furniture. For women, the respective risk estimates were 4.15 and 5.23 (although based on only one case). In carpentry, 4 cases were observed vs. 2.4 expected. No cases were found in manufacturers of particleboard or wooden building materials (but only 0.1–0.8 cases were expected). Risks were not presented separately by histological subtype.

Olsen *et al*, 1986

53. This study had a similar design to Olsen 1988. Cases of nasal (287) and paranasal (179) cancer diagnosed between 1970 and 1982 in Denmark were identified from the files of the Danish Cancer Registry, together with three times as many controls (2,465), matched on age, sex, time of diagnosis from among cases with cancer of the colon, rectum, prostate or breast over the same period. Job titles were obtained by record linkage from the Supplementary Pension Fund and Danish Central Population Registry. A hygienist assessed whether exposure to wood dust (and formaldehyde, which was the main exposure of interest in the analysis) was probable or not. For squamous cell carcinoma, relative risks were not much elevated (RR 1.3); but for nasal adenocarcinoma, the RR for working in an occupation where wood dust exposure was probable was 16.3 (95% CI 5.2-50.9), or, assuming a 10 year lag, 30.4 (95% CI 8.9-103.9). No information was provided on the types of wood dust exposure.

Shimizu *et al*, 1989

54. This study identified 66 patients with squamous cell carcinoma of the maxillary sinus diagnosed at six hospitals in north-east Japan during 1983-5 and compared them with matched controls chosen from telephone directories local to the health centres. A questionnaire asked about employment in “woodworking or joinery”: the OR was 2.1 (95%CI 0.8-5.3) and 7.5, p=0.02) in a subcategory of woodworkers or joiners only doing sanding or lathe work.

Elmwood, 1991

55. This case-control study compared 121 male cases of sinonasal cancer, identified through main cancer treatment centres in British Columbia during 1939-1972 with several age and sex matched comparison groups – the next clinic patient whose tumour had no significant relationship to outdoor exposure or smoking; the next patient whose tumour had no significant relationship to outdoor exposure; the next clinic patient whose tumour had no significant relationship to smoking. Overall, the RR for an occupation "involving exposure to wood" was 2.3 vs. any other occupation. Among 28 exposed cases, 10 were loggers, seven were carpenters, four were labourers in the forestry industry, four were construction workers, two were log scalers and one was a cabinet maker. Exposures were mostly to native softwoods. RRs for squamous cell carcinoma and adenocarcinoma were elevated to a similar

extent. The authors were not able to test if more intense exposure or longer duration gave even higher RRs and no minimum exposure duration or level was specified.

Vaughan *et al*, 1991

56. In this population-based case-control study from Washington State, cases of squamous cell sinonasal cancer diagnosed during 1979-1987 were identified using a surveillance system and registry operated by the National Cancer Institute, while controls were selected by random digit dialling and unmatched on age and sex. Some 71% of eligible cases (or next of kin) and some 80% of controls were interviewed and an occupational history taken. A "wood-related occupation" was defined as working as a carpenter, forestry and logging worker, precision woodworker (including pattern maker, cabinetmaker or other furniture maker or finisher), or an operator of woodworking machines. Some 26% (7) of cases were ever employed in such an occupation before diagnosis: none of the seven had worked as a furniture maker – three had been loggers, three had been woodworking machine operators and one was a carpenter. The overall OR for ever working in one of these occupations was 2.4 (95% CI 0.8-6.7) or 3.1 (95% CI 1.0-9.0) for exposures ≥15 years before diagnosis. Among this last group, for those who had also worked at least 10 years up to this point, the OR was 7.3 (95% CI 1.4-34.2). The authors emphasised that their cases, which were squamous cell carcinomas rather than adenocarcinomas, had arisen outwith the furniture industry.

Comba *et al*, 1992a, 1992b

57. In one of two case-control studies by this research group, cases of sinonasal cancer diagnosed by the ENT and radiotherapy departments of Bresica Hospital in north-east Italy between 1980 and 1989 (and resident in the area) were compared with subjects attending the same units with tumours of the head and neck other than those of the tongue, oral cavity, oropharynx, hypopharynx or larynx. In all, 35 cases and 102 controls were identified. Subjects or their next of kin were interviewed by standard questionnaire, blinded to case-control status. The exposure of interest comprised work in the "wood industry", not otherwise defined. There were three exposed cases (OR 11.0, 90% CI 0.85-159).
58. A related analysis identified cancers of the nose and paranasal sinuses from the hospitals of Verona and Siena during 1982-1987. In all, 78 cases and 254 controls

(admitted to the same hospitals with similar timings and no history of tumour or chronic nasal/sinus disease or nasal bleeding) were compared. Male woodworkers (those "having ever worked with respect to wood") had an OR of 5.8 (90%CI 2.2-15) for sinonasal cancer (15 exposed cases) relative to never having such work, while among women woodworkers the OR was 3.2 (based on a single case). For adenocarcinoma in men, the OR was substantially higher, at 13.9 (90%CI 3.1-62) and for squamous cell carcinoma it was 1.7 (90%CI 0.42-7.2).

Luce *et al*, 1992; 2002

59. A case-control study was conducted in France to examine occupational risk factors for sinonasal cancer; 207 cases and 409 controls were included in the study. Detailed information was collected on occupational history and other potential risk factors for nasal cancer. The risk of adenocarcinoma in men was significantly elevated for cabinetmakers (OR 35.4, 95% CI 18.1-69.3), carpenters and joiners (OR 25.2, 95% CI 14.6-43.6), and wood-working machine operators (OR 7.4, 95% CI 3.4-15.8), whereas the ORs were below one for loggers and wood preparation workers. ORs for squamous cell carcinoma ranged, in carpenters, from 1.56 (ever employed) to 1.86 (employed >15 years) and in woodworking machine operators, from 1.24 to 1.42; but were more than doubled in cabinet making and wood manufacturing. For other histological categories, ORs were significantly raised in cabinetmakers (OR 11.2, 95% CI 2.7-45.9) and in carpenters and joiners (OR 5.8, 95% CI1.8-18.6). In a second report, a job exposure matrix was applied to estimate exposure levels in different jobs and time periods (the focus of interest being on distinguishing between the risks posed by formaldehyde and wood dust). For 'probable or definite' exposure to wood dust at a 'medium to high' average lifetime level in men, the OR for adenocarcinoma was 288.6 (95%CI 135.5-615.1), that for squamous cell carcinoma was 1.0 (95%CI 0.4-2.6) and that for other histological types was 2.9 (95%CI 1.1-7.9); 77 of the 80 cases of adenocarcinoma had this pattern of exposure.

Magnani *et al*, 1993

60. This population-based case-control study from Biella, north western Italy, identified 33 cases of sinonasal cancer diagnosed during 1976-1988 (14 adenocarcinomas) and compared them with 131 controls. Excess risks of sinonasal cancer were observed in wood and furniture workers (OR 4.4, 95% CI 1.41-13.4) associations

being notably strong for adenocarcinomas 22.0 (95% CI 4.4-124.0). For squamous cell carcinoma, the OR was 0.9 (95%CI 0.4-8.3), based on a single case and with much statistical uncertainty in the risk estimate.

Leclerc *et al*, 1994

61. This case-control study included 207 histologically-confirmed cases of sinonasal cancer from 27 participating hospitals in France and 409 controls comprising (i) patients of the same hospitals with 15 other cancer types and (ii) a second group of names provided by the cases. An occupational history was obtained (activity, place of work, years of employment, tasks for eight jobs of interest), and an expert job exposure matrix was applied based on likelihood of exposure, and likely frequency and intensity of exposure. Associations were extremely strong in relation to hardwood dust in patients with adenocarcinoma (with ORs of 86, 262, and 303 respectively for ≤15, 16-35, and >35 years of employment, and 530 (95%CI 104.2,696) for high average intensity level). For squamous cell carcinoma, RRs were much smaller (0.9-1.7 for softwoods and 1.11-1.7 for hardwoods), and only more than doubled (2.2 and 2.5 respectively, $p<0.05$) before 1946.

Demers *et al*, 1995; 1995b

62. This analysis pooled data from five cohorts internationally – British furniture workers, members of a union of furniture workers in the US (from factories making wooden furniture and other wood products), two cohorts of plywood workers and one cohort of wood model makers for the US automobile industry. Inclusion criteria varied – e.g. plywood workers had to have worked for a year or longer, the model makers for a month or longer, and no restriction applied to US furniture workers. In all, 11 cases of sinonasal cancer were observed vs. 3.5 expected, a standardised mortality ratio (SMR) of 3.1 (95%CI 1.6 -5.6); among furniture workers there were 11 cases (2.5 expected), an SMR of 4.3 (95% CI 2.2-7.8); among plywood workers, no cases were observed (although the upper confidence limit was 11.5). A variable quality of exposure information was available, but in High Wycombe the mean wood dust level was 4.3 (range 0.3-53) mg/m^3 during 1970-80 and 8.5 (2-32) mg/m^3 in 1976-7; in the US furniture industry a range of 0.1-14.4 mg/m^3 had been reported; in the plywood industry, the range was believed to be 0.1-3.3 mg/m^3 and among wooden model makers to be 0 .1-13.9 mg/m^3.

63. Results were pooled and presented by certainty of exposure (possible, probable, definite), calendar time (pre-1940 through to post-1960) and duration (from <10 years to ≥30 years). SMRs were only much elevated for a) 'definite' exposures (9 cases observed vs. 1 expected, SMR 8.4, 95%CI 3.9-16.0); b) exposures pre-1940s (9 cases observed vs. 0.7 expected, SMR 12.5, 95%CI 5.7-23.7); and c) prolonged durations of employment (20-29 years, 3 vs. 1.2, SMR 2.6, 95%CI 0.5-7.6; ≥30 years, 8 vs. 1.1, SMR 7.6 (95%CI 3.3-15.0). However, expected numbers were small, such that upper estimates of the confidence interval could not exclude a more than doubling of risk for exposures later in time than 1940 (e.g. for post-1960 exposures, 0 cases but 0.4 expected, with an upper confidence limit of 8.5).

Robinson *et al*, 1996

64. This study considered the mortality of 27,362 members of the US Carpenters' Union dying between 1987 and 1990. Some 32% of cohort members were exposed to wood dust through employment in the construction industry and 30% through work in the wood products industry. Estimates of RR were reduced for cancer of the nasal cavities (0.80, 95%CI 0.26-1.87 in white men; 0.74, 95%CI 0.20-1.90 in construction carpenters), based on 5 cases , 4 employed for ≥30 years. The study had a power of 90% to detect a doubling of risks in carpenters. The failure to detect a higher risk was ascribed to the predominant exposure to softwood, which is known to be less hazardous. Only one case of adenocarcinoma was mentioned on the five death certificates, although doubt was expressed about the certainty of coding.

t'Mannetje *et al*, 1999

65. This study pooled data from four studies in Italy, and one each in The Netherlands, France, Germany and Sweden (included in this summary). In all, 555 cases of sinonasal cancer were identified and compared with 1,705 controls. Details of exposure estimation varied somewhat between studies, but among men occupational exposure to wood dust resulted in an OR of 2.36 (95%CI 1.75-3.20) overall: 12.20 (95%CI 7.43-20.0) for adenocarcinoma; but only 0.72 for squamous cell carcinoma.

Innos *et al*, 2000

66. This retrospective cohort study involved workers employed between 1946 and 1988

at two large Estonian furniture factories. Subjects were identified from employment records and their exposures classified following wood dust measurements made near wood processing machines during 1974–1985. Exposures mostly exceeded 4mg/m^3 in sawing, sanding, and drying. "High" exposures were those among machinery processing workers (involved in planing, sanding, sawing, polishing, joinery and carving, cabinetmaking and carpentry); "medium" exposures were assigned for other duties in the machine processing area (seasoners, assembly workers, inspectors, sorters, veneerers, packers, upholsterers, transport workers, cleaners); "low/no" exposures were assigned to technical workers and clerics. In all, 6786 workers were studied (with 2.3% loss to follow-up), and cancer incidence and expected numbers obtained from the Estonian Cancer Registry. The overall SIR for cancer of the nose and nasal sinuses was 1.87 (95% CI 0.88 -1.26), but there were only three cases. All occurred in highly exposed jobs and risks in this group were elevated >2-fold among men and >3-fold among women, although findings were not significant at the 5% level. Assuming a 20 year latency, all three cases occurred among workers with <5 years of exposure (SIR 2.69, 95% CI 0.56-7.87).

Hemelt *et al*, 2004

67. Using a nationwide Swedish Family-Cancer Database, Hemelt *et al* calculated SIRs for 52 occupational groups using data from four census periods across 1961-2000. Significantly elevated SIRs for nasal adenocarcinoma were observed in male woodworkers (‘main occupation’, SIR 5.36, 95%CI 4.02-6.99), among whom risk increased with duration of exposure to softwood in combination with hardwood. For squamous cell carcinoma, the SIR was 0.88 (95%CI 0.53-1.38).

Laakkonen *et al*, 2006

68. A cohort of all economically active Finns born between 1906 and 1945 was followed over 30 million person-years of observation during 1971-95 for incident cases of respiratory cancer using the Finnish Cancer Registry. Occupations from the population census in 1970 were used to estimate exposures to various organic dusts using the Finnish Job Exposure Matrix. Cumulative exposures were estimated and SIRs calculated using the economically active population as the reference standard. In all, 412 cases of nasal cancer were identified (292 in men): however, only one man had ‘high’ exposure to wood dust (defined as >50 mg/m^3-years) and 17 men

and one woman had medium exposure (3-50 mg/m^3-years). SIRs were only marginally elevated in these groups (1.29-1.74) and were not significant at the 5% level. In the FINJEM, the highest exposures were estimated to occur in woodworking machine operators (2.5 mg/m^3), while exposures of around 1.0 mg/m^3 were estimated in bench carpenters, plywood and fibreboard makers and cabinetmakers and joiners. Exposures were lower than in some other studies and settings.

Pukkala *et al*, 2008

69. In this report, data on nasal cancer from the registries in several Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) were compared and combined. Some 355 incident cases among men and 10 among women were identified during 1961-2005, ranging from 1 in Iceland to 160 in Sweden. The combined SIR for sinonasal cancer and being a "wood worker" in men was 1.84 (95% CI 1.66-2.04) and 1.88 (95%CI 0.90-3.46) in women. For adenocarcinoma in men (122 cases), the SIR rose to 5.50 (95%CI 4.60-6.56). No data were published on risks of squamous cell carcinoma or other histological types, however. Details on the specific activities of woodworkers were not available.

Pesch *et al*, 2008

70. This case-control study concerned workers insured in German wood-working industries. Cases of adenocarcinoma of the nose and paranasal sinuses were identified from cases of occupational disease known to the insurers between 1994 and 2003 (no case was rejected due to insufficient wood dust exposure). Of 129 male cases, 86 agreed to participate in person or through next of kin. Controls were randomly recruited from a parallel database of accidents incurred during shift working or commuting: 204 male controls who had ever been employed in woodworking industries participated (response rate 75%), with frequency matching on age. A structured questionnaire was used to identify job activities, types of wood and wood preservatives, and a job-exposure matrix and database of wood dust measurements in the industry was used to estimate cumulative exposures. Average inhalable wood dust concentrations between 1986 and 2002 range from 1.24 mg/m^3 in manufacturing wooden boards to 2.14 mg/m^3 in manufacture of other wood products; exposure data were also obtained for sawmilling, manufacture of furniture, manufacture of wooden boards, builders' carpentry and manufacture of wooden

containers. Among cases, the median average exposure to inhalable wood dust was estimated to be 4.9 mg/m^3 (interquartile range 4.4-5.7 mg/m^3), the median cumulative exposure was 159 mg/m^3 years, and the median duration of exposure was 35 years.

71. A large fraction of cases and controls (84.9% vs. 61.6%) had ever worked as a cabinetmaker or joiner – OR vs. never worked in this trade 2.96 (95% CI 1.46-6.01) among sawmill workers, the OR was reduced (0.15, 95% CI 0.03-0.68). Risks were particularly elevated in intermediary and final processing of wood (OR>4.0) as compared with raw wood processing (OR 1.84, 95% CI 1.93-3.65). Only high exposure to hardwood dusts was associated with an increase in risk (OR 3.98, 95% CI 1.92-8.25), with reduced risks for high exposure to softwood, particle board and medium density fibreboard (although this apparent reduction may have been influenced by the choice of a control group drawn from the woodworking profession). Risks increased substantially with average exposure: in comparison with <3.5 mg/m^3, the OR for ≥3.5-<5 mg/m^3 was 10.54 (95% CI 3.34-33.27) and that for>5 mg/m^3 was 48.47 (95% CI 13.30-176.63). No consistent pattern was found with duration of exposure, but risks increased with time since first exposure.

D'Errico *et al*, 2009

72. This case-control study collected incident cases of sinonasal cancer from hospitals throughout the Piedmont region of Italy known to the regional Sino Cancer Registry. Controls, matched by age sex and residency, were recruited from ENT and orthopaedic departments of the hospitals treating the cases. Trained interviewers collected information on job title, tasks, work environment and substances used occupationally. The probability and estimated intensity of exposure to wood dust was rated independently by three experts blinded to case-control status and a job exposure matrix was also applied. A 10-year latency was assumed in analysis. In all, 113 cases and 316 controls were studied, among whom 50 cases and 22 controls were exposed to wood dust (OR 11.4, 95% CI 6.29-20.74). In those with high-intensity exposures, the odds of sinonasal cancer were elevated 30.6 fold and those of adenocarcinoma 179.9-fold. Risks more than doubled for adenocarcinoma within five years of exposure and for all sinonasal cancer within 10 years; they then rose steadily up to 35 years, at which point the OR overall was 53.4 and that for adenocarcinoma was 279.3. At a given duration of exposure, risks were 2-5 times

greater for adenocarcinoma than for sinonasal cancer as a whole. For squamous cell carcinoma, the OR was 0.85 (95%CI 0.19-3.83, based on only 2 cases) and for other histotypes it was 5.5 (95%CI 1.99-15.24, 7 cases). Odds of the latter rose with cumulative exposure (from 1.51 with ≤5 years to 17.8 with >35 years) and were doubled after 10 years of exposure (OR 2.3, 95%CI 1.49-3.48).

Mayr *et al*, 2010

73. In this case-control study of adenocarcinoma of the nose and paranasal sinuses, cases were identified from among cancers of the nasal cavity diagnosed between 1973 and 2007 in a German university department of otolaryngology and head and neck surgery. The control group had squamous cell carcinoma of the oral cavity and were chosen from treatment survivors. Standardised interviews assessed the extent and duration of exposure to "harmful inhalable wood dust". In all, 31 cases of adenocarcinoma were studied and 85 controls with other cancers. Primary exposure in a woodworking occupation was defined to include employment as a carpenter, wainwright, wheelwright or woodcarver: the prevalence of such occupations was 32.9 times higher in the cases than in controls. Some 43% of cases were exposed to hardwood dust. Among those in a primary wood processing occupation, the mean exposure was 32 years and among cases the mean latency from first employment in a relevant occupation was 43.5 years.

Harris *et al*, 2010

74. This national analysis of occupational mortality for England and Wales considered the 93% of deaths in men aged 20-74 years during 1979-80 and 1982-2000 with a recorded occupation. Proportional mortality ratios (PMRs), standardised for age and social class, were calculated for pre-specified combinations of occupation and cause of death, for which excess mortality could reasonably be attributed to work. Observed deaths exceeded the number expected for sinonasal cancer overall among “paper and wood machine operatives combined”, carpenters and joiners, and cabinet makers (see Table 7).

Table 7: Trends in occupational mortality from sinonasal cancer among woodworkers in England and Wales, 1979-2010 (from Harris *et al*, 2010)

Job group	1979-80, 1981-1990			1991-2000		2001-2010	
	Obs	PMR (95%CI)	Obs	PMR (95%CI)	Obs	PMR (95%CI)	
Paper & wood machine operatives	14	2.77 (1.52-4.65)	5	2.27 (0.74-5.31)	2	1.65 (0.20-5.97)	
Carpenters & joiners	19	1.28 (0.77-2.01)	17	1.61 (0.94-2.59)	15	1.65 (0.93-2.73)	
Cabinet makers	10	4.57 (2.19-8.41)	12	9.01 (4.65-15.73)	13	13.36 (7.11-22.84)	

Greiser *et al*, 2012

75. This German population-based case-control study occurred in an area chosen because of the high prevalence of snuff usage in the local population. Male cases of sinonasal cancer born after 1925 were identified through cancer registries in Bavaria and ENT departments in Barden-Württemberg. Age and sex quota matched controls were drawn from community residency registries. Lifetime occupational histories were obtained by a computer-assisted telephone interview with the subject or next of kin. In all, 112 cases of nasal cancer and 135 of paranasal cancer were studied. Exposure to wood dust was analysed by dust type (softwood, hardwood, chipboard) and duration of employment. Risks were increased only for hardwood dusts. Exposure for at least a year, daily or several times per week, carried an OR for all sinonasal cancers of 2.33 (95% CI 1.40-3.91) and for adenocarcinoma, of 18.98 (95% CI 8.24-43.71). No risk estimates were presented for squamous cell carcinoma or other histopathologies. When considered by thirds of employment duration, among those with <8 years of exposure the OR for sinonasal cancer was 2.08 ($p>0.05$) and for those with 8-24 years it was 1.26 ($p>0.05$); but for $\geq$24 years it was 13.07 (95% CI 3.44-49.70). Risk per year of exposure rose by 4% (95% CI 1-7%) for all sinonasal cancers and 6% (95% CI 3-10%) for paranasal tumours.

Siew *et al*, 2012

76. In this study, a cohort of all Finnish men born between 1906 in 1945 and employed in 1970 were followed through the Finnish Cancer Registry for cancers of the nose during 1971-1995 and their occupations at population census were converted into exposure categories using the Finnish Job Exposure Matrix. Cumulative exposure was estimated based on assumed level and duration of exposure. Data on mean exposures to wood dust in 194-59 and 1960-84 were available for certain occupations as well as the proportion of workforce exposed. High exposure occurred in woodworking machine operators (2.5 mg/m^3 with 95% of workers exposed), followed by cabinetmakers and joiners (95% exposed at 1.0-1.4 mg/m^3), bench

carpenters (1.1-1.2 mg/m^3) and plywood and wooden board makers (1.0 mg/m^3). Several SIRs for nasal cancer were more than doubled in woodworking occupations, although the number of cases was small and findings were not significant at the 5% level. Jobs at higher risk included timber workers (SIR 2.03,1 case), sawmill workers (2.23, 6 cases), plywood and wooden board makers (2.55, 2 cases), boat builders (4.25, 2 cases), and woodworkers not elsewhere classified (7.34, 2 cases). Relative risks were not much elevated in construction carpenters (SIR 1.28, 16 cases), bench carpenters (0.85, 1 case) or cabinetmakers and joiners (1.25, 1 case), but numbers were too small to exclude a possible doubling of risk. Among those with a cumulative exposure of ≥10 mg/m^3, the SIR for nasal cancer was 1.57 and that for squamous cell carcinoma was 2.06 (95% CI 0.91-4.68, 7 cases). The authors suggested that the predominant exposure to softwoods (pine and spruce) explained the considerably lower relative risks than in other investigations.

Emanuelli *et al*, 2016

77. In this case-control study, 32 cases of adenocarcinoma of the nose and paranasal sinuses were compared with 21 subjects with sinonasal cancer of other histopathology. Subjects were identified from a database of the ENT department and endoscopy service of Padua's University Hospital covering 2004-15. Occupational histories were taken by interview focusing on (for wood dust), the intensity, duration, type and frequency of exposure, as well as use of risk reduction measures such as masks and local exhaust ventilation. "High" exposure was defined as cutting, sanding, or planing wood, as well as use of compressed air in the woodworking industry. Some 50% of adenocarcinoma cases worked in this industry. ORs were substantially elevated in all time periods, both in those with low and high frequency exposure to wood dust, both for hardwoods (OR 3.8, 95% CI 3.22-351) and other woods (OR 10.0, 95% CI 1.78-56.1); and for exposures of ≥15 years (OR 12.2, 95% CI 2.52-58.7). In those with "high" protection from wood dust the OR was 9.37, as compared with 22.5 in those with "low" protection. The choice of control group in this study was unconventional, as the control group were at increased risk from wood dust exposure, albeit not to the extent the case group were.

Discussion

78. A complication in assessing the evidence base on sinonasal cancer and wood dust is that differences in risk exist by histological type of cancer, by type of wood dust, and by intensity of exposure (which will vary by era and between countries and settings).
79. A further challenge is that studies have used different definitions of exposure. Not uncommonly, because cases in any one occupation were rare, several occupations were grouped. However, the choice of groupings varied substantially. For example, in the reports by Hernberg *et al* events in sawmill workers and carpenters were analysed with those in furniture workers; in that by Fukada *et al* the occupations of "carpenter, joiner, furniture worker [and] other wood worker" were amalgamated; in that by Mayr *et al* the occupations of carpenter, wainwright, wheelwright and woodcarver were combined; and in Vaughan *et al* the analysed group potentially included carpenters, forestry and logging workers, precision woodworkers and operators of woodworking machines. Numerous other studies defined exposure in general terms, without specifying the occupations encompassed – for example: "woodworking occupation" (Ironside *et al*); "woodworkers or woodcutters" (Cecchi *et al*); "wood industry" or "having ever worked with respect to wood" (Comba *et al*); "woodworkers" (Helmet *et al*); "wood worker" (Pukkala *et al*); "intermediary and final processing of wood" (Pesch *et al*); exposure to "harmful inhalable wood dust" (Mayr *et al*). Still other reports used expert judgements and job exposure matrices to define exposure groups which were assigned different likelihood of exposure. However, terms varied and the underlying choices were not transparent. Examples of this kind included: 'wood dust exposure probable' (Olsen *et al*, 1986); 'probable or definite exposure to wood dust at a medium to high average lifetime level' (Luce *et al*, 2002); 'high intensity of exposure' (D'Erico *et al*); and the pooled analyses by Demers *et al*.
80. These issues notwithstanding, the Council has felt able to draw several broad conclusions.

Risks in the furniture industry

81. One obvious conclusion is that the case supporting prescription of cancer of the nose and nasal sinuses in workers from the furniture making industry is overwhelmingly strong. Many studies (e.g. Acheson *et al*, 1968, 1972, 1981; Andersen *et al*, 1977; Rang *et al*, 1981; Battista *et al*, 1983; Brinton *et al*, 1984;

Hayes *et al*, 1986; Olsen, 1988; Luce *et al*, 1992; Magnani *et al*, 1993; Pesch *et al*, 2008; Harris *et al*, 2010) confirm a substantially more than doubled risk of the disease. The consistency of findings is impressive. So are the particularly high relative risks reported in relation to adenocarcinoma in this occupational group (e.g. Rang *et al*, 23.33 to100; Battista *et al*, 35.9 to 89.7; Hayes *et al*, 139.8; Olsen *et al*, 1986), 30.4; Luce *et al*, 1992, 35.4; Magnani *et al*, 22.0; Harris *et al*, 13.4). Risks were highest in the most heavily exposed jobs (furniture, cabinet and chair makers; wood machinists; sanders; turners; sawyers), but most jobs in the industry were implicated, including, upholsterers, wood stainers, French polishers, maintenance workers, and even yard workers and in one case a cleric to an ecclesiastic furniture maker; also, risks extend to and are sufficiently high for other cancer types (e.g. Hayes *et al*, 1986; Shimizu *et al*, 1989; Luce *et al* 1992).

Risks in other settings

82. It is also clear that cases of sinonasal cancer can arise in settings other than the furniture industry (e.g. Acheson *et al*, 1972; Ironside *et al*, 1975; Brinton *et al*, 1977, 1984; Herberg *et al*, 1983; Hayes *et al*, 1986; Vaughan *et al*, 1991; Luce *et al*, 1992). In case reporting, affected occupations have included carpenters and joiners; wainwrights and wheelwrights; wood machinists; sawmill, forestry and timber workers and loggers; boat pattern makers; woodcarvers; and makers of wooden shoes, vats and boards. Evidence on the size of relative risks outwith the furniture industry is harder to distil, however, for the reasons highlighted in paragraph 79.
83. Present terms of PD D6(a), as interpreted by tribunals, effectively recognise all histological subtypes of sinonasal cancer in workers from furniture making and repairing premises, but not more generally (e.g. not among carpenters fitting out shops or working on building sites – see paragraph 30). The Council has considered the case for extending these terms, taking each of the main cancer subtypes in turn and then considering the overall position.

Adenocarcinoma of the nose and paranasal sinuses

84. Occupational exposure to wood dust clearly carries a high risk of adenocarcinoma. Almost all of the research agrees on this point (e.g. paragraphs 36-7, 39, 42-3, 45-6, 48-9, 53, 59-61, 65, 67, 69, 71-3, 75 and 77).
85. However, the Council has been impressed by the strength of associations between

adenocarcinoma and even very general definitions of exposure, such as “exposure to wood dust” (Roush *et al*; Olsen *et al* 1986; Leclerc *et al*; t’Mannetje *et al*; Griesler *et al*), “having ever worked with respect to wood” (Comba *et al*) and “woodworker” (Cecci *et al*; Pukkala *et al*; Hemelt *et al*). In all of these examples risks were more than and sometimes considerably more than doubled.

86. Where separate risk estimates were produced, a strong and indeed striking relationship was found between sustained higher intensity occupational exposure to wood dust and risks of adenocarcinoma of the nose and paranasal sinuses (e.g. Rang *et al*; Hayes *et al*; Luce *et al*; Leclerc *et al*; D’Errico *et al*), ORs ranged from 23 to more than 500.

87. In several reports, relative risks of adenocarcinoma were also more than doubled in certain occupations defined alone or in circumscribed groupings – notably in carpenters and joiners (Brinton *et al*, 1985; Hayes *et al*; Luce *et al*; Mayr *et al*), (OR 2.88 to 32.9) and wood machinists (Luce et al, OR 7.4). In this respect it should further be noted that wood machinists were often identified as a highly exposed occupational group (e.g. Rang *et al*; Innos *et al*; Lakkonen *et al*; Siew *et al*; Emanuelli *et al*), implying, as indicated in paragraph 86, a high risk of adenocarcinoma. Among sawmill workers and sawyers, the OR for adenocarcinoma was reduced in the study by Pesch *et al* (paragraph 71). However, the comparator was other woodworkers and the apparent lowering in relative risk might reflect a much higher risk in other woodworking occupations, rather than a particularly low one among sawmill workers.

88. Thus, in respect of adenocarcinoma, the present terms of PD D6(a) seem unduly restrictive. Since the relationship to wood dust is so strong and so insensitive to alternative formulations of the exposure definition, a good case can be made for recognising this histological subtype of sinonasal cancer for prescription in *any* occupation involving more than minor exposure to wood dust. The balance of probabilities that the disease is occupational would be likely to lie with the claimant in these circumstances.

89. Defining “more than minor” has some inherent challenges; but for this tumour the *de minimis* threshold is likely to be reached in occupations that involve the machine processing of wood. This would be compatible with the evidence discussed in paragraphs 86 to 88.

Squamous cell carcinoma

90. The case for extending prescription in respect of squamous cell sinonasal carcinoma is less compelling. Indeed, much of the evidence is against a doubling of risk in many circumstances. See for example the studies by Roush *et al*; Battista *et al*; Brinton *et al* (1986); Hayes *et al*; Olsen *et al*; Comba *et al*; Luce *et al*; Magnani *et al*; Leclerc *et al*; t'Mannetje *et al*; Hemelt *et al*; and D'Errico *et al*, in which relative risks range from 0.5 to 1.7.

91. Exceptions to this occurred however, including the studies by Shimizu *et al*, Elmwood *et al* and Vaughan *et al*, in all of which risks from woodworking were doubled for this histological subtype.

92. Studies by Brinton *et al* (1986), Hayes *et al* and Luce *et al* did not indicate a doubling of risks of squamous cell sinonasal carcinoma in carpenters; and that by Luce *et al* indicated an elevation in risk, but well below a doubling (OR 1.24 to 1.42) in wood working machine operators. By contrast, Shimizu *et al* reported a high risk (OR 7.5) of this cancer type in joiners only doing sanding and lathe work; while in the study by Vaughan *et al*, odds were raised more than two-fold among a group of seven wood workers among whom three were machinists and none worked in furniture manufacture.

Other cancer subtypes

93. Evidence on the risks of sinonasal cancer is mostly restricted to the two main subtypes of tumour, squamous cell and adenocarcinoma. However, a few reports distinguish the risks for other histopathologies combined as a group of "other" cancers, and these have generally indicated a more than doubling of risk of cancer.

94. Thus, in the report by Hayes *et al* (paragraph 50), the OR was 2.2 among those highly exposed to wood dust; in that by Luce *et al* (paragraph 59) the OR was 2.9 for "probable or definite exposure" and 5.8-11.2 for working as a carpenter or wood machinist; and in the study by D'Errico *et al* (paragraph 72), it was 5.5 in those with high intensity exposures, with risks doubled after 10 or more years of such exposure. However, the reports by Roush *et al* and Battista *et al* (paragraphs 43 and 46) did not suggest a more than doubling of risks.

The issue of histopathology

95. The evidence summarised in paragraphs 84 to 89 suggests an addition to the terms

of PD D6(a) in respect of adenocarcinoma of the nose or nasal sinuses, while that in paragraphs 93 and 94, to an extent, supports prescription in cancer sub-types other than squamous cell cancer. However, for squamous cell carcinoma the data are more equivocal (paragraphs 90 and 92).

96. An option the Council has considered, therefore, is whether to subdivide PD D6 by histopathology, in order to preserve the current appropriate coverage for all types of sinonasal cancer among workers from the furniture industry while enabling an extension for certain subtypes of sinonasal cancer but not others.

97. Set against this, clinical challenges are well recognised in distinguishing between different histological types of sinonasal cancer (paragraphs 38 and 42), a view that has been affirmed by expert pathologists consulted on this point by the Council and which has been acknowledged in other reports (e.g. Franchi *et al*, 2011). Although this problem may not exist on a large scale (given the consistent demonstration of far greater risks for adenocarcinoma than for other cancer types), it could nonetheless lead to erroneous decisions in some individual claims. Restriction of eligibility by pathology would also impose an extra burden on claimants and the Scheme's administrators to collect the necessary further information. There is some evidence that such information is often unclear in medical records or missing from them (e.g. Kuijpens *et al*, 2012).

98. The Council has therefore weighed the case for prescription taking the claimant 'as seen' and without restriction by histological subtype. It happens that many research reports which studied sinonasal cancer but did not distinguish its pathology found a more than doubling of risk in workers heavily exposed to wood dust. Thus, the case can be sustained for retaining the present simpler broad definition of disease in a revised prescription.

Recommendations

99. The Council recommends that the terms of PD D6 be updated to provide for a broader definition of the occupational circumstances eligible for benefit in respect of sinonasal cancer and wood dust, namely: "exposure to wood dust in the course of the machine processing of wood". Reference to the "processing" of wood would bring the wording of the prescription in line with that for PD D13, a cancer of an anatomically adjacent site also arising from wood dust exposure.

100. The Council considers that the section of the exposure schedule relating to the furniture making and repairing industry should refer to "attendance for work in or about a *workplace*", rather than "… a *building*", since risk-conferring exposures can arise in a broader range of environments than implied by present wording. Evidence was received for example, that highly mechanised operations can generate high local exposures to wood dust in outdoor environments.

101. For PD D13 reference is made in the prescription to "*wooden products*", whereas PD D6a refers to "*wooden goods*". In case the legal meaning of "products" differs from that of "goods", and for the avoidance of doubt, the Council considers it expedient that PD D6(a) should refer to both "wooden goods" and "wooden products"; this will necessitate a minor rewording of the prescription.

102. The revised terms of prescription suggested are as set out in Table 8.

Table 8: Proposed new terms for prescription of nasal cancer (additions in italics)

PD	**Disease**	**Any occupation involving**
D6	Carcinoma of the nasal cavity or associated air sinuses (nasal carcinoma)	(a) Attendance for work in or about a *workplace* where wooden goods or *wooden products* are manufactured or repaired; or (b) attendance for work in a building used for the manufacture of footwear or components of footwear made wholly or partly of leather or fibre board; (c) attendance for work at a place used wholly or mainly for the repair of footwear made wholly or partly of leather or fibre board or (d) *exposure to wood dust in the course of the machine processing of wood*

Notes on application of the recommendations

103. Even the most potent of occupational carcinogens rarely induces cancer with fewer than five years of exposure; but reports by Acheson et al (1968), Cecchi *et al* and Battista et al indicate that sinonasal cancer can develop after only a few years of occupational exposure to wood dust (instances occurred with as little as 5-10 years

of employment in a relevant job). Normally then, and in most circumstances, a minimum exposure period of 5 years can be expected to apply.

104. Since only 40-50 cancers of sinonasal cancer of all types occur annually from all causes, any costs of arising from over-prescription would be nugatory, the balance of probabilities almost always lying in favour of the claimant. In 2010, about 30 cases of PD D6 (sinonasal cancer of all histological types and all causes) were in payment, while between April 2002 and December 2012 there were 60 new claims, fewer than 6 per year.

Prevention

105. As highlighted in this report, inhalation of wood dust can adversely affect workers' health. The Control of Substances Hazardous to Health Regulations 2002 (COSHH) aims to protect workers from being exposed to hazardous substances in the workplace and applies to a wide range of substances including wood dust and other materials with the potential to cause harm if inhaled, ingested, or absorbed through the skin.

106. COSHH requires the employer to carry out a risk assessment to establish the hazards associated with the substances they are using, and for the employer to put processes in place to control those risks. COSHH requires wood dust exposure to be controlled to as low a level as reasonably practicable. Where it is not possible to prevent exposure by substitution with a safer substance or by totally enclosing the process, exposure must be adequately controlled by the use of appropriate work processes, systems and engineering controls and measures including local exhaust ventilation systems to control exposure at source. Suitable respiratory protective equipment may be used where adequate control cannot otherwise be achieved.

Equality and diversity

107. The Industrial Injuries Advisory Council is aware of issues of equality and diversity and seeks to promote as part of its values. The Council has resolved to seek to avoid unjustified discrimination on equality grounds, including age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion or belief, gender and sexual orientation. During the course of this review of

sinonasal cancer and exposures to wood dust no diversity and equality issues were apparent.

Acknowledgements

The Council is grateful to Dr Brendan Conn (Consultant in Oral, Head and Neck Pathology, Royal Infirmary of Edinburgh and Honorary Clinical Senior Lecturer, University of Edinburgh) who provided evidence on the histological classification of sinonasal cancer for this report.

References

Acheson ED, Cowdell RH, Rang EH. Adenocarcinoma of the nasal cavity and sinuses in England and Wales. Brit J Ind Med1972; 29: 21-30.

Acheson ED, Cowdell RH, Rang EH. Nasal cancer in England and Wales - an occupational survey. Brit J Ind Med 1981; 38: 218-224.

Acheson ED, Cowdell RH, Hadfield E, *et al*. Nasal cancer in woodworkers in the furniture industry. Brit Med J 1962; 2: 587-596.

Alonso-Sardón M, Chamorro AJ, Hernández-García I, *et al*. Association between occupational exposure to wood dust and cancer: A systematic review and meta-analysis. PLoS One 2015; 20;10(7):e0133024.

Andersen HC, Andersen I, Solgaard J. Nasal cancers, symptoms and upper airway function in woodworkers. Br J Ind Med 1977; 34:201-207.

Battista G, Cavallucci F, Comba P, *et al*. A case-referent study on nasal cancer and exposure to wood dust in the province of Siena, Italy. Scand J Work Environ Health 1983; 9:25 – 29.

Brinton LA, Blot WJ, Stone BJ, *et al*. A death certificate study of nasal cancer among furniture workers in North Carolina. Cancer Res 1977; 37:3473-3474.

Brinton LA, Blot WJ, Becker JA, *et al*. A case-control study of cancers of the nasal cavity and paranasal sinuses. Am J Epidemiol 1984; 119: 896-906.

Cecchi F, Buiatti E, Kriebel D, *et al*. Adenocarcinoma of the nose and paranasal sinuses in shoemakers and woodworkers in the province of Florence, Italy (1963-77). Br J Ind Med 1980; 37: 222–225.

Comba P, Barbieri PG, Battista G, *et al*. Canceof the nose and paranasal sinuses in the metal industry: a case-control study. Br J Ind Med 1992;49:193–6.

Comba P, Battista G, Belli S, *et al*. A case-control study of cancer of the nose and paranasal sinuses and occupational exposures. Am J Ind Med 1992b; 22: 511-520.

Demers PA, Boffetta P, Kogevinas M, *et al*. Pooled reanalysis of cancer mortality among 5 cohorts of workers in wood-related industries. Scand J Work Environ Health 1995a; 21: 179-190.

Demers PA, Kogevinas M, Boffetta P, *et al*. Wood dust and sino-nasal cancer: pooled reanalysis of twelve case-control studies. Am J Ind Med 1995b; 28: 151-166.

D'Errico A, Pasian S, Baratti A, et al. A case-control study on occupational risk factors for sino-nasal cancer. Occup Environ Med 2009;66:448–55.

Dilworth, M. Wood Dust Survey 1999/2000. Health and Safety Laboratory: Buxton, 2000.

Elwood JM. Wood exposure and smoking: Association with cancer of the nasal cavity and paranasal sinuses in British Columbia. Can Med Assoc J 1981;124: 1573-1577.

Emanuelli E, Alexandre E, Cazzador D, *et al*. A case-case study on sinonasal cancer prevention: effect from dust reduction in woodworking and risk of mastic/solvents in shoemaking. J Occup Med & Toxicol 2016; 11:35.

Franchi A, Miligi L, Palomba A, et al. Sinonasal carcinomas: Recent advances in molecular and phenotypic characterization and their clinical implications. Critical Reviews in Oncology/Hematology 2011; 79: 265–277.

Greiser EM, Greiser KH, Ahrens W, *et al*. Risk factors for nasal malignancies in German men: the South-German Nasal cancer study. BMC Cancer 2012;12:506.

Harris EC, Palmer KT, Cox V, *et al*. Trends in mortality from occupational hazards in England and Wales during 1979-2010. Occup Environ Med 2016;73:385-393.

Hayes, RB, Gerin M, Raatgever JW, *et al*. Wood-related occupations, wood dust exposure, and sinonasal cancer. Am J Epidemiol1986; 124: 569-577.

Hemelt M, Granström C, Hemminki K. Occupational risks for nasal cancer in Sweden. J Occup Environ Med 2004;46:1033–40.

Hernberg S, Collan Y, Degerth R, *et al*. Nasal cancer and occupational exposures. Preliminary report of a joint Nordic case-referent study. Scand J Work and Environ Health 1983a; 9: 208-213.

Hernberg S, Westerholm P, Schultzlarsen K, *et al*. Nasal and sinonasal cancer - connection with occupational exposures in Denmark, Finland and Sweden. Scand J Work and Environ Health 1983b; 9: 315-326.

Innos K, Rahu M, Rahu K, *et al*. Wood dust exposure and cancer incidence: a retrospective cohort study of furniture workers in Estonia. Am J Ind Med 2000;37:501–11.

International Agency for Research on Cancer (IARC). Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 100C: Arsenic, Metals, Fibres and Dusts, WHO, Geneva, 2012, p407-465.

Ironside P, Matthews J. Carcinoma of the nose and paranasal sinuses in woodworkers in the state of Victoria, Australia. Cancer 1975; 36, 1115-1121.

Jappinen P, Pukkala E, Tola S. Cancer incidence of workers in a Finnish sawmill. Scand J Work Environ Health 1989; 15:18 – 23.

Kuijpens JLP, Louwman MWJ, Peters R, et al. Trends in sinonasal cancer in The Netherlands: More squamous cell cancer, less adenocarcinoma. A population-based study 1973–2009, Eur J Cancer 2012; 48: 2369-74.

Luce D, Leclerc A, Begin D, et al. Sinonasal cancer and occupational exposures: a pooled analysis of 12 case-control studies. Cancer Causes and Control 2002; 13: 147-157.

Luce D, Leclerc A, Morcet J-F, *et al*. Occupational risk factors for sinonasal cancer - a case-control study in France. Am J Ind Med 1992; 21: 163-175.

Magnani C, Comba P, Ferraris F, *et al*. A case control study of carcinomas of the nose and paranasal sinuses in the woollen textile manufacturing industry. Arch Environ Health. 1993;48:94–7.

Mayr SI, Hafizovic K, Waldfahrer F, *et al*. Characterization of initial clinical symptoms and risk factors for sinonasal adenocarcinomas: results of a case-control study. Int Arch Occup Environ Health 2010;83:631–8.

Olsen JH, Asnaes S. Formaldehyde and the risk of squamous cell carcinoma of the sinonasal cavities. Br J Ind Med1986;43:769–74.

Olsen JH. Occupational risks of sinonasal cancer in Denmark. Brit J Ind Med 1988; 45: 329-335.

Pesch B, Pierl CB, Gebel M, *et al*. Occupational risks for adenocarcinoma of the nasal cavity and paranasal sinuses in the German wood industry. Occup Environ Med 2008;65:191-6.

Pukkala E, Martinsen JI, Lynge E, *et al*. Occupation and cancer - follow-up of 15 million people in five Nordic countries. Acta Oncol 2009;48:646-790.

Rang EH, Acheson ED. Cancer in furniture workers. Int J Epidemiol 1981; 10: 253-261.

Robinson CF, Petersen M, Sieber WK, *et al*. Mortality of carpenters' union members employed in the U.S. Construction or wood products industries, 19871990. Am J Ind Med 1996;30: 674-694.

Roush GC, Meigs JW, Kelly JA, *et al*. Sinonasal cancer and occupation: a case-control study. Am J Epidemiol 1980;111:183-93.

Siew SS, Kauppinen T, Kyyrönen P, *et al*. Occupational exposure to wood dust and formaldehyde and risk of nasal, nasopharyngeal, and lung cancer among Finnish men. Cancer Manag Res 2012;4:223–32.

Vaughan TL, Davis S. Wood dust exposure and squamous cell cancers of the upper respiratory tract. Am J Epidemiol1991; 133: 560-564.

Young C, Cherrie J, van Tongeren M, *et al*. The burden of occupational cancer in Great Britain: Sinonasal cancer. RR 933. HSE, 2012.

Glossary

Types of study

Cohort study: A study which follows up a population of individuals (usually defined by a workplace) over time and compared the rate of disease or mortality among those within the cohort or with an external comparison population. The outcome is expressed as a Rate Ratio or **Relative Risk**, **Standardised Incidence Ratio**, **Standardised Registration Ratio**, or **Standardised Mortality Ratio**, depending on the type of analysis and the disease outcome being studied.

Case-control study: A study which compares people who have a given disease (cases) with people who do not (non-cases, also known as controls) in terms of exposure to one or more risk factors of interest. Have cases been exposed more than non-cases? The outcome is expressed as an **Odds Ratio**, a form of **Relative Risk**. In a **nested-case control study**, cases and controls are sampled from the members in a **cohort study** – often, all the cases occurring in the cohort and a sample of non-cases.

Measures of association

Statistical significance and P values: Statistical significance refers to the probability that a result as large as that observed, or more extreme still, could have arisen simply by chance. The smaller the probability, the less likely it is that the findings arise by chance alone and the more likely they are to be 'true'. A 'statistically significant' result is one for which the chance alone probability is suitably small, as judged by reference to a pre-defined cut-point. (Conventionally, this is often less than 5% ($P<0.05$)).

Relative Risk (RR)*:* A measure of the strength of association between exposure and disease. RR is the ratio of the risk of disease in one group to that in another. Often the first group is exposed and the second unexposed or less exposed. A value greater than 1.0 indicates a positive association between exposure and disease. (This may be causal, or have other explanations, such as **bias**, chance or **confounding.**) RR is measured or approximated by other measures in this glossary, such as the **Odds Rati**o, **Standardised Incidence Ratio** and **Standardised Mortality Ratio**.

Odds Ratio (OR): A measure of the strength of association between exposure and

disease. It is the odds of exposure in those with disease relative to the odds of exposure in those without disease, expressed as a ratio. For rare exposures, odds and risks are numerically very similar, so the OR can be thought of as a **Relative Risk**. A value greater than 1.0 indicates a positive association between exposure and disease. (This may be causal, or have other explanations, such as **bias**, chance or **confounding**.)

Standardised Mortality Ratio (SMR): A measure of the strength of association between exposure and mortality; a form of **Relative Risk** in which the outcome is death. The SMR is the ratio of the number of deaths (due to a given disease arising from exposure to a specific risk factor) that occurs within the study population to the number of deaths that would be expected if the study population had the same rate of mortality as the general population (the standard).

By convention, SMRs (and **standardised incidence ratios** and **proportional mortality ratios**, as described below) are usually multiplied by 100. Thus, an SMR (or SIR) of 200 corresponds to a RR of 2.0. For ease of understanding in this report, SMRs (or SIRs) are quoted as if RRs, and are not multiplied by 100. Thus, a value greater than 1.0 indicates a positive association between exposure and disease. (This may be causal, or have other explanations, such as **bias**, chance or **confounding**.)

Standardised Incidence Ratio (SIR): An SIR is the ratio of the observed number of cases of disease (e.g. cancer) to the expected number of cases, multiplied by 100. It is a form of **Relative Risk**. The ratio is usually adjusted to take account of differences in the population evaluated with the comparison or "normal population", due to age, gender, calendar year, and sometimes geographical region or socioeconomic status. The **Standardised Registration Ratio (SRR)** is a similar measure, based on incident cases of disease identified by a disease registry.

Proportional Mortality Ratio (PMR): A PMR is the proportion of observed deaths from a given cause in a given population divided by the proportion of deaths from that cause expected (in a standard population).The value is often expressed on an age-specific basis or after age adjustment. It is a form of **Relative Risk**.

<u>Other epidemiological terms</u>

Job-exposure matrix (JEM): a tool used to assess exposure to potential health hazards in occupational epidemiological studies. A JEM comprises a list of levels of exposure to a variety of harmful (or potentially harmful) agents for selected occupational titles. In large population-based epidemiological studies, JEMs may be used as a quick and systematic means of converting coded occupational data (job titles) into a matrix of possible exposures, obviating the need to assess each individual's exposure in detail.

Meta-analysis: The statistical procedure for combining data from multiple studies. When the treatment effect (or effect size) is consistent from one study to the next, meta-analysis can be used to identify this common effect.

Risk: The probability that an event will occur (e.g., that an individual will develop disease within a stated period of time or by a certain age).

Incidence rate or incidence: The rate of occurrence of a new event of interest (e.g. cancer) in a given population over a given time period. (The rate is often expressed in terms of cases per year of 'person-time', and so incorporates the numbers at risk of the event, the time for which they are at risk and the numbers that go on to develop that event.)

Confidence Interval (CI): The **Relative Risk** reported in a study is only an estimate of the true value of relative risk in the underlying population; a different sample may give a somewhat different estimate. The CI defines a plausible range in which the true population value lies, given the extent of statistical uncertainty in the data. The commonly chosen 95% CIs give a range in which there is a 95% chance that the true value will be found (in the absence of bias and confounding). Small studies generate much uncertainty and a wide range, whereas very large studies provide a narrower band of compatible values.

Bias: A systematic tendency to over- or under-estimate the size of a measure of interest in a study.

Confounding: Arises when the association between exposure and disease is explained in whole or part by a third factor (confounder), itself a cause of the disease, that occurs to a different extent in the groups being compared.

Department for Work and Pensions
www.gov.uk

ISBN 978-1-5286-0025-5
CCS0917931116