

Fifteen-year trends in occupational asthma: data from the Shield surveillance scheme

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Background	Trends of occupational asthma (OA) differ between regions depending on local industries, provisions for health and safety at the workplace and the availability of a reporting scheme to help in data collection and interpretation.
Aim	To assess trends in OA in an industrialized part of the UK over a 15-year period.
Methods	Occupational and chest physicians in the West Midlands were invited to submit details of newly diagnosed cases with OA. Data were then transferred to the regional centre for occupational lung diseases for analysis.
Results	A total of 1461 cases were reported to the scheme. Sixty-eight per cent were males with mean (standard deviation) age of 44 (12) years. The annual incidence of OA was 42 per million of working population (95% CI = 37–45). OA was most frequently reported in welders (9%) and health care-related professions (9%) while <1% of cases were reported in farmers. Isocyanates were the commonest offending agents responsible for 21% of reports followed by metal working fluids (MWFs) (11%), adhesives (7%), chrome (7%), latex (6%) and glutaraldehyde (6%). Flour was suspected in 5% of cases while laboratory animals only in 1%.
Conclusions	Our data confirm a high annual incidence of OA in this part of the UK. MWFs are an emerging problem, while isocyanates remain the commonest cause. Incidence remained at a fairly stable background level with many small and a few large epidemics superimposed. Schemes like Midland Thoracic Society's Rare Respiratory Disease Registry Surveillance Scheme of Occupational Asthma could help in identifying outbreaks by linking cases at the workplace.
Key words	Metal working fluid; occupational asthma; prevalence; isocyanates; shield; welders.

Introduction

Occupational asthma (OA) accounts for 9–15% of asthma in adults of working age [1,2]. Moreover, it is the most reported occupation-related lung disease in many countries including the UK [3]. The UK's Health & Safety Executive estimates the annual incidence of OA between 1500 and 3000 cases [4]. The condition is similar to non-occupational asthma with the presence of airway inflammation and bronchospasm [5]; however, symptoms are work related and cure may be possible if an affected individual is removed from the causative agent. On the other hand, the condition is preventable

with the effective control of respiratory sensitizers in the workplace [4].

Different mechanisms are available world wide to report new cases of OA. Most of these are voluntary surveillance schemes (Box 1). This paper aims to report the incidence of OA in the West Midlands area, which has the highest proportion of people working in the manufacturing industry in the UK (20.8% of people of working age between 16 and 74 compared to a national average of 14.8%) [6], and to identify changes over a 15-year period from January 1991 to December 2005.

Methods

The Midland Thoracic Society's Rare Respiratory Disease Registry Surveillance Scheme of Occupational Asthma (Shield) is a voluntary reporting scheme for OA in the West Midlands, UK, with an average working population of 2.3 million over the 15-year period [6]. It is a joint project between the West Midlands branch of the Society of Occupational Medicine and the Midlands Thoracic

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Box 1. Reporting programmes for occupational lung diseases in various parts of the world.

Programme name	Country/region	
Surveillance of Work-related Occupational Respiratory Diseases (SWORD)	United Kingdom	Voluntary
Midland Thoracic Society's Rare Respiratory Disease Registry Surveillance Scheme of Occupational Asthma (Shield)	West Midlands	Voluntary
Swedish Register of Reported Occupational Disease (SRROD)	Sweden	Voluntary
Physician Based Surveillance System of Occupational Respiratory Disease (PROPULSE)	Quebec	Voluntary
Finnish Register of Occupational Diseases (FROD)	Finland	Statutory
Norwegian Reporting	Norway	Statutory
Surveillance of Australian Workplace-Based Respiratory Events (SABRE)	Australia	Voluntary
Surveillance of Work-related and Occupational Respiratory Diseases in South Africa (SORDSA)	South Africa	Voluntary
Observatoire National des Asthmes Professionnels in South Africa (ONAP)	France	Voluntary
Notifiable Occupational Disease System (NODS)	New Zealand	Voluntary

Society. Suspected cases are reported by occupational and chest physicians, although most reports come through the regional centre for occupational lung diseases based at Birmingham, UK. Workers from outside the West Midlands region, but seen within it are included, but those workers from inside the West Midlands region, but seen clinically outside the region are not included in the reporting scheme. The programme was initiated in 1989 and included new cases only from 1990; we have reported results from this scheme in previous years [7–9]. New cases are reported if the diagnosis of OA is thought more likely than not, on an easy-to-fill reporting card. The record includes suspected agent, clinical data, pathophysiology (allergic, irritant, pharmacological or unknown) and the name and address of the workplace, allowing linkage of cases from the same workplace. Since the advent of the Data Protection Act, the workers consent has been required for the inclusion of personal identifiable items such as name, age or sex. No specific tests are required before notification, but validation is encouraged.

Since 1992, a computer-assisted system [Occupational Asthma SYStem (OASYS)] has been used to provide a simple and validated method for interpretation of serial measurements of peak expiratory flow [10]. We excluded workers with acute irritant-induced asthma after a single large exposure, often called reactive airways dysfunction syndrome (RADS), unless this resulted in sensitization with subsequent responses to low-level exposure; workers with regular deterioration following usual workplace exposures with a symptomless latent interval were included even if the mechanism was thought to be irritant (irritant-induced OA). Information has also been added from the case notes and workplace visits to augment the Shield reports for some of the outbreaks.

Reporting cards were collected centrally and data were entered on a central database for analysis. Occupations were grouped in preparation for analysis as per the classification of occupations 1991 standard occupational classification [11]. Reported cases were aggregated by region within the West Midlands.

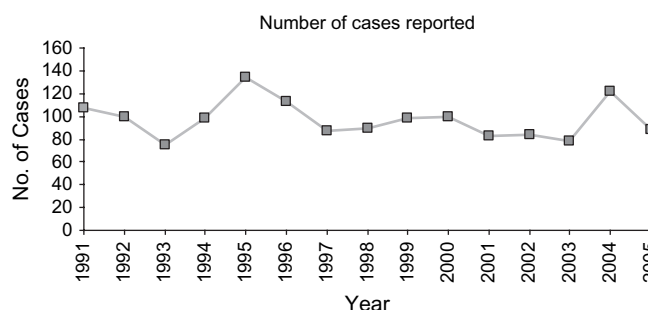


Figure 1. Number of new cases reported annually to Shield 1991–2005.

Results

A total of 1461 cases were reported to the Shield scheme during the period 1991–2005 (Figure 1). At least one confirmatory test was sought to aid the diagnosis of OA in 85% of cases and 94% of workers were reported as improving on holidays or on days away from work. Serial peak flow measurements were the most utilized confirmatory test, with 66% of workers having completed them; specific IgE was measured in 48%. Only 9% of workers had specific bronchial challenge tests.

All reports were from workers with a latent interval between first exposure and onset of disease having regular deterioration with ordinary exposure, fulfilling the criteria for hypersensitivity OA. This excludes acute irritant-induced asthma (RADS).

The majority of patients were males (68%) with mean age of 44 years (SD 12). The amount of current, ex- and non-smokers on the database was similar accounting for 27, 28 and 32% of reports, respectively.

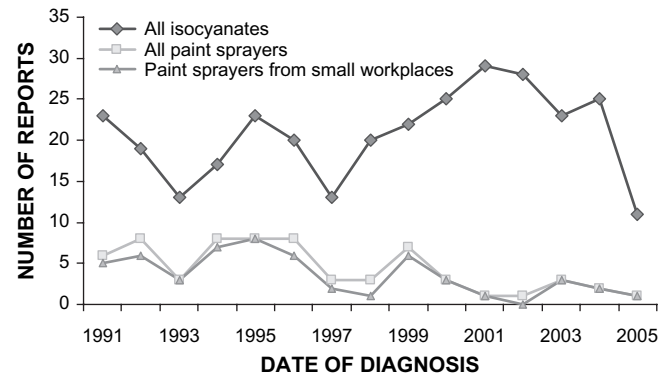
The annual incidence of OA was 42 (95% CI = 37–45) per million working population. Approximately 20% of reported cases were working outside the West Midlands region, but have been seen clinically within the region. There were no consistent trends in incidence over time. Welders and occupations related to health care (doctors, nurses and allied health professionals) were

Table 1. Cases of OA by profession

Profession	No. of cases	Per cent
Veterinary nurses and assistants and veterinary surgeons	4	<1
Sales and customer service	4	<1
Biological scientist	5	<1
Agricultural workers	6	<1
Hairdressers and beauticians	10	1
Building trade	10	1
Administrative occupations	13	1
Manager and senior officials	14	1
Laboratory technicians	14	1
Forklift truck drivers	18	1
Professional occupation	22	2
Metal machine setters	25	2
Assemblers (electrical)	27	2
Food processors (not bakers)	28	2
Chemical-related process operatives	32	2
Wood workers	33	2
Metal working production and maintenance fitters	38	3
Metal working machine operatives	45	3
Assemblers (vehicle and metal goods)	51	3
Bakers and flour confectioners	53	4
Not clear	55	4
Labourers and cleaners	58	4
Associate professional and technical occupation	62	4
Metal making and treating process operatives	64	4
Vehicle spray painters	78	5
Moulders	94	6
Skilled workers	103	7
Nurses, health professionals and doctors	125	9
Welders	126	9
Other	244	17

the two most frequently reported occupations with 126 (9%) and 125 (9%) reports, respectively (Table 1). The incidence of new cases was least reported in veterinary nurses and veterinary surgeons, customer service advisors, biological scientists and farmers (<1% each).

Isocyanates were the commonest cause for OA being responsible for 300 (21%) reports. Table 2 (available as Supplementary data at *Occupational Medicine Online*) illustrates the most commonly reported jobs where isocyanates were suspected as the offending agents. The highest incidence was in paint sprayers. Figure 2 shows reports of paint sprayers from large and small businesses. Most reports were from small businesses with a single affected employee. These were the targets of a health and safety campaign which was associated with reduced reports. There are several large employers in the region with large numbers of paint sprayers. Only one of the four large workplaces with multiple reports has continuing identified cases suggesting that when OA occurs, most are able to introduce or tighten control avoiding further reports. Figure 3 shows the incidence in 15 workplaces with more

**Figure 2.** Total numbers of OA from isocyanates per year over the 15 years by job category.

than two reports of isocyanate-related asthma. Foundries were a prominent source, where diphenylmethane diisocyanate is used as part of the 'cold box' system to bind the sand used to form the cores that make cavities in castings. Exposure occurs both in the core-making and knock-out sections. From case notes, it was found that one outbreak of isocyanate-adhesive asthma was stopped by using a roller rather than spray application. Other areas with previous reports included mending of gas mains, and the use of isocyanate lacquers to protect silver-plated items (lacquering was subsequently stopped). Polyurethane foam manufacture, mostly of car seats, has been a continuing problem. One of the problem plants transferred work (and reports) to another location.

OA related to metal working fluid (MWF) was responsible for 163 (11%) Shield reports (see supplementary Figure 1, available as Supplementary data at *Occupational Medicine Online*). There were two sizable outbreaks, the largest was in a car factory in 2003 and 2004 when MWF was responsible for 48 and 37% of the total new cases of OA, respectively, overtaking isocyanates as the number one offending agent in the previous years; used MWF was the most likely cause [12]. There were isolated Shield reports from another 16 workplaces suggesting a more general problem.

The other large outbreak was in a company manufacturing valves for engines which were welded with stellite, a cobalt-containing alloy. Cases notified to Shield were detected from this company over many years (Figure 4). The first two cases were in a stellite welder and a maintenance electrician. A worksite visit was carried out in this instance which found that following enclosure of the stellite welding machine, further cases from stellite welding were prevented. However, further cases were notified when the subsequent machining of the stellite weld resulted in the MWF being distributed to other machines, which then became the source of cobalt exposure (as the MWF was contaminated with it). The problem was worse on night shifts when external exhaust extraction had to be turned off due to noise pollution affecting neighbouring houses. The Shield data showed

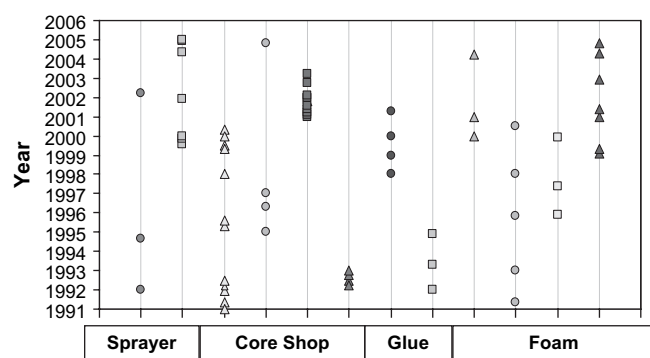


Figure 3. Workplaces with more than two notifications of OA from isocyanate by date of diagnosis.

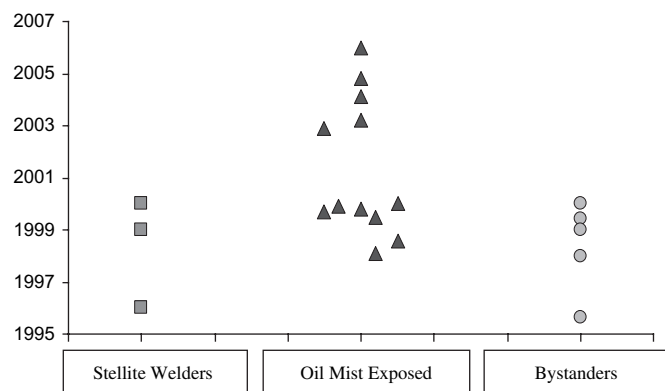


Figure 4. OA from cobalt in a stellite welding company by job category.

that seven workers had specific bronchial challenges, six being positive to cobalt and the other to used MWF, but not to cobalt.

Chrome aerosols and fumes were responsible for 100 (7%) new cases mainly in electroplaters, welders and casters of stainless steel. OA related to chrome maintained a constant level of an average of eight new cases per year; however, there was an outbreak in 2004 which is likely to be related to chrome fumes generated during powder burning, arc air gouging and welding in a stainless steel foundry.

Latex exposure was mainly from powdered gloves used by health care workers. A substantial reduction was detected in the last 2 years with substitution of latex in health care and the use of low-protein, powder-free latex gloves where substitution was difficult (Figure 5). However, reports from prisons and garages increased due to use of powdered latex gloves in these workplaces. In total, latex was responsible for 91 (6%) cases with OA during the period.

Glutaraldehyde is used as a cold sterilant to disinfect and clean heat-sensitive equipment such as dialysis instruments, surgical equipment and in particular endoscopes; in addition, it was part of the developer used in

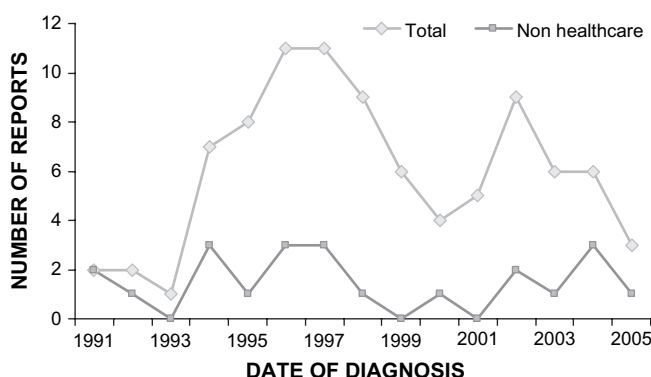


Figure 5. Annual reports of OA from natural rubber latex, with non-health care workers shown separately.

radiology. The highest incidence was seen in endoscopy departments, from which glutaraldehyde has now been withdrawn. Control of glutaraldehyde use in operating theatres was more difficult to manage due to its use in emergencies and the larger numbers with occasional use. Eighty-four (6%) cases with OA were reported to Shield as a result of exposure to glutaraldehyde.

Discussion

Our study found a slightly higher annual incidence of reported cases of OA in the West Midlands (42 per million of working population) compared to the rest of the UK as reported by the Surveillance of Work-related Occupational Respiratory Diseases (SWORD) program with annual incidence of 19 per million of working population in 1989–91 and 38 per million of working population in 1992–97 for the UK as a whole [13]. OA is reported to the Shield scheme when the diagnosis is thought to be more likely than not, similar to other surveillance schemes [3,14–16]. However, confirmatory tests were carried out in 85% of cases. The higher incidence may be related to the presence of a specialist referral centre and reporting system (Shield). However, these data show a relatively stable level of suspected OA cases in contrast to the SWORD data which show a reduction over the last few years despite a slight increase in cases compensated by the industrial injuries benefit scheme over the last 5 years [17]. Our region has a higher proportion of workers exposed to metals and MWF than most accounting for the high proportion of reports from these agents. However, there are low number of reports from other common causes seen elsewhere such as flour (well represented in local industry), as well as animals and pharmaceuticals which are under-represented in the local economy. Similarly, the incidence in France as reported by the Observatoire National des Asthmes Professionnels (ONAP) program [14] was 24 per million of working population (95% CI = 22–25) and varied widely between various regions with an annual incidence of 53

per million of working population in Alsace (where the scheme originated) to 4 in Bourgogne. Nevertheless, our annual incidence rate remains much lower than in Finland at 174 per million of working population, where there is a national statutory reporting scheme [18]. Like the French and the SWORD data, the distribution of OA between males and females was similar to ours with 2:1 ratio [13,14], which is likely to be partly explained by different distributions of occupations and exposures between men and women. However, a possible alternative explanation for this may be that OA is more under-diagnosed in women than in men.

In 6%, there was no record on the report sheet of improvement on holidays or days away from work as a result of this part of the data being left blank. This could be due to the worker not having any time away from work such as in maintenance workers and some self-employed professions or occasionally because workers do not perceive symptoms of asthma that can be confirmed objectively (similar to non-occupational asthma).

Serial peak flow measurements were used to assist in the diagnosis in 66% of our cases compared to only 31% of cases from ONAP data [14]. This difference could be related to our use of the OASYS software. Our use of non-specific challenge testing and specific IgE measurement was comparable with the French group, 55 and 48%, respectively, in our data and 56 and 47%, in the French ONAP programme [13,14].

Our results of irritant-induced OA are not directly comparable with others. An irritant mechanism was suspected in 7% of our cases, although those with an acute exposure without subsequent deterioration on re-exposure are excluded from Shield. Acute irritant-induced asthma accounted for 13% of report of occupational respiratory diseases in Catalonia [15]. This was based on history and clinical suspicion. In a report on the inhalation incidents from the SWORD project, acute irritant-induced asthma accounted for 8% of cases, and an enquiry after 1 year found that 5% of patients had developed persistent asthma as a direct consequence to inhalation [19].

Bakers and pastry makers were the most frequently affected worker group reported to the SWORD, ONAP and the Finnish group Finish Register of Occupational Diseases (FROD) [13,14,18]; however, this was not reflected in our scheme as welders closely followed by nurses and health professionals were the most frequently affected. The reasons behind the low number of reports from bakeries are unclear. Isocyanate remains an important causative agent for OA in our region, the UK and Catalonia [13,15], while flour in France and Finland [14,18] and latex in South Africa [16] were the most frequently reported causes for OA (Table 3, available as supplementary data at *Occupational Medicine* online). On the other hand, FROD reported a large number of cases caused by animal epithelia, hairs or secretions (the commonest agent in Finland causing 38% of cases) [18]. This is not reflected

in our sample and may be due to the under-representation of the farming community in the labour market within the West Midlands or possibly due to the lack of good compensatory mechanisms for farmers with the condition.

Reporting new cases of OA to the Shield surveillance programme happened largely through our regional centre for occupational lung diseases, with much less reporting from other centres in the region. A previous capture/recapture exercise between Shield and SWORD in the West Midlands suggested an under-reporting of 43% for Shield.

MWF seems to be an emerging problem in our region. The reasons behind this are unclear as total exposures in general have been decreasing for some years. A recent outbreak may have been associated with greater solubility of hydraulic oil in the MWF, hindering separation of tramp oil and changing the nature of the resulting aerosols [12]. The falling incidence of OA from latex and glutaraldehyde is an encouraging example showing that control measures are feasible to administer and do lead to reduced numbers of new cases. However, the incidence of OA related to other hazards like chrome, cobalt and colophony remained reasonably stable with few significant outbreaks, while isocyanates remain the commonest cause. Schemes like Shield provide the ideal platform to allow a better understanding of the epidemiology and distribution of OA. They can be used for early detection of outbreaks and consequently may improve prevention through control of exposure at the workplace.

Key points

- Isocyanates are the commonest cause of OA in the West Midlands.
- Welders and workers in the health profession were the most commonly affected professions by OA in our region.
- MWF is an emerging problem as a cause of OA in the West Midlands.

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Conflicts of interest

None declared.

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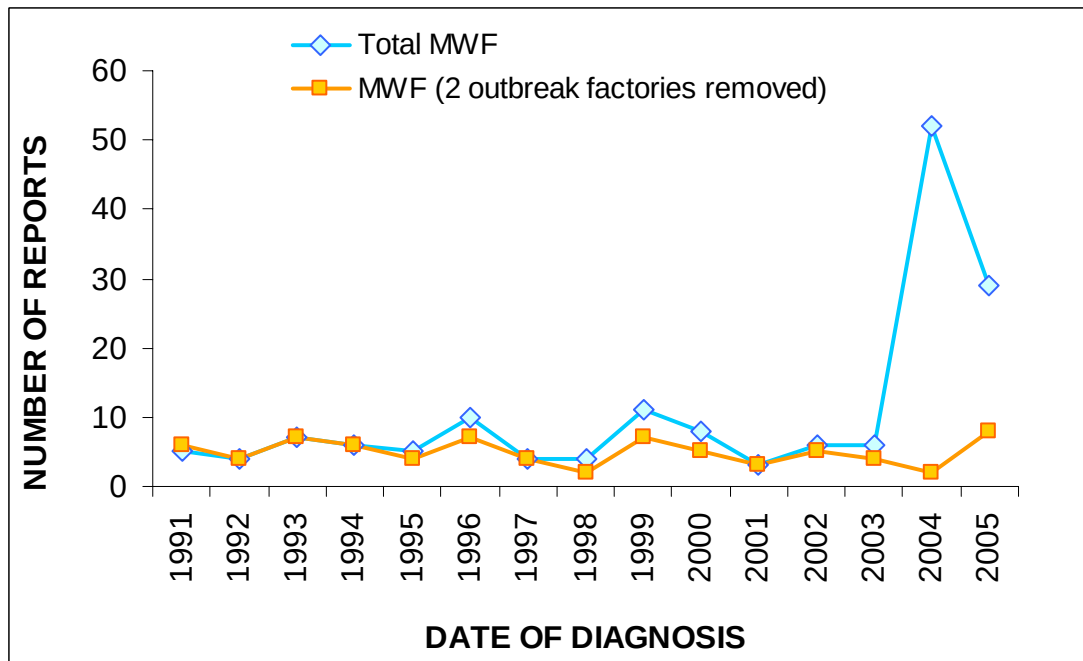


Fig 1 (electronic) Annual reports of occupational asthma from metal working fluid, showing all cases, and those excluding two major outbreaks

Table 1 (electronic). Industries with outbreaks of occupational asthma from isocyanates and associated job titles

Industry Type	Job Titles
Car body manufacturing	Paint sprayer, pattern maker, windscreen fitter, paint shop labourer, lorry driver, paint sander, maintenance engineer, assembler, studio engineer, logistics, designer, primer,
Foundry	Die caster, core maker, cold box operator, injection moulder, grinder, caster, trimmer, hot box core maker, jigger, foundry labourer, maintenance fitter, core blower,
Car seat manufacturing	Packer, maintenance electrician, lab technician, track team worker, assembler, sewing machinist, injection moulder.
Wreath makers	Production engineer, floral tribute producer, wreath maker.
Gas Suppliers	Fitter
Fridge/Freezer manufacturing	Foam injector, assembler

Table 2 (electronic). Suspected causes for occupational asthma cases reported to Shield compared to other similar schemes.

Agent	Shield No of cases (%)	SWORD(13) (%)	ONAP(14) (%)	Catalonia (16) (%)	FROD(15) (%)
Isocyanates	300 (21)	16	14	16	5
MWF/ Cutting oils	163 (11)	2			<1 (oils and lubricants)
Adhesives	104 (7)	3	2	5	1
Chrome	100 (7)				1
Latex	91 (6)	1	7	7	<1
Glutaraldehyde	84 (6)	4	6	2	2 (formaldehyde)
Flour	67 (5)	8	20	8	22
Colophony	65 (4)	4	1	4	

Wood Dust	58 (4)	5	4	8	3
Welding Fumes	40 (3)	2	1		4
Cobalt	31 (2)	<1			<1 (with Nickel)
Lab animals	19 (1)	5	1		
Other	339 (23)				