

Work-exacerbated asthma in a workers' compensation population

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Background	Asthma is becoming more prevalent with large numbers of individuals suffering from work-exacerbated asthma.
Aims	To examine the characteristics of workplace exposures and working days lost in relation to work-exacerbated asthma (WEA) in a workers' compensation population.
Methods	An analysis of accepted workers' compensation asthma claims in Ontario over a 5-year period. Claims among the top three industry groups were categorized based on working time lost of 1 day or less, 2–5 days and 6 days or more. Attributable agents were subdivided into dusts, smoke, chemicals and sensitizers.
Results	Among the asthma claims, 72% (645) fulfilled criteria for WEA from their history. The commonest industry groups were services, education and health care, with 270 claims that met our analysis requirements. Within these industry groups, education had a lower proportion of workers with short exacerbations (missing 1 day or less: 27%) while the health care industry had a higher than expected proportion of short exacerbations (55%). The agents to which WEA was attributed differed across the groups, with dusts having the highest proportion in the education group (65%), smoke in the service industry (34%) and sensitizers in health care (41%). Those agents more commonly attributed to exacerbations tended to have lower rates of prolonged exacerbation compared with less commonly involved agents.
Conclusions	The morbidity of WEA and the type of agents to which it was attributed varied between industry groups.
Key words	Asthma; education; health care; industry; occupational; service; work-exacerbated asthma.

Introduction

Asthma is becoming more prevalent and is a worldwide problem [1,2]. Up to 25% of individuals with asthma have symptoms that are exacerbated by the workplace environment [3]. Work-exacerbated asthma (WEA) is defined as pre-existing or concurrent asthma that is worsened by workplace conditions [3]. WEA has been described as being more prevalent in particular industries such as health care than in others such as administration [4]. Characterizing these environments has remained a challenge for those involved in the workplace and for health

care professionals. Asthma is estimated to cost up to \$56 billion annually in the USA [5]. It is also the fourth leading cause of sickness absence with over 14½ million work days lost per year in the USA [6] and is also thought to be a significant contributor to 'presenteeism' (suboptimal performance at work due to ill-health). Worldwide, asthma exacerbations cause a large proportion of asthmatic individuals to miss work each year, for example, 17% in Western Europe, 23% in Central and Eastern Europe, 27% in Asia-Pacific and 30% in Japan [7]. WEA is known to be more prevalent in particular industries, but the range of exposures among each industry and the

duration of illness related to exacerbations have been little studied [8]. Within each industry, the exact nature of the exposure and the resulting duration of time off work is unclear. There is likely to be a spectrum of WEA, ranging from transient occasional worsening at work, which is difficult to identify objectively and is managed in primary care or the emergency room at one end, to frequent or daily worsening at work, leading to specialist evaluation, potentially more time off and consideration of a possible diagnosis of occupational asthma (OA) at the other extreme. To date, the relative prevalence of each of these has not been reported.

Having a profile of the severity of workplace asthma exacerbations within industry groups would be valuable in designing industry strategies for managing workplace safety and welfare. Similarly, an analysis of the various exposures that can exacerbate asthma would aid prevention of future cases. The purpose of this paper is to help identify trends and patterns of short duration versus prolonged WEA. Identifying industries or agents attributable could help to formulate cost-effective strategies to reduce workplace asthma.

Methods

We first identified claims from the occupational disease database of the Ontario Workplace Safety and Insurance Board (WSIB) that contained primarily diseases that included asthma for which the 'date of accident' was between January 1998 and December 2002 (five consecutive years). The point estimates of reported exposures causing WEA and duration of symptoms were generated from a cross-sectional analysis of data collected over this period. The 'date of accident' was the date identified in the WSIB file as the onset of the work-associated symptom exacerbation or, in the case of OA, the date asthma started. This initial sample was then screened to exclude claims that were not allowed, were still pending WSIB decision or were abandoned by the claimants, and subsequently screened for duplicate entries or erroneously entered date of accident outside the study period. A single trained reviewer abstracted information from each claim file using a standardized form adapted from our previously published studies [9–11].

As in our previous studies, we obtained data on the following if available: demographics (date of birth, gender, smoking status if available and occupation); exposure history including agents and duration; occupation; documented history of previous asthma before starting the job for which the claim had been initiated; history of nasal, eye and lower respiratory symptoms and their frequency; clinical diagnosis made by the most specialized assessing physician; WSIB decision and any objective tests (spirometry, peak flow studies, methacholine challenge tests, skin tests to common allergens and workplace substances, if available). The files were

reviewed and abstracted by the research assistant, with subsequent discussion with the investigators for consensus as needed. The outcome categorization in this study (i.e. final decision presented here after review and discussion) was different in some cases from that originally coded by the WSIB.

For this study, we analysed all allowed asthma claims which we considered on file review to be probable WEA. The WSIB does not have written criteria for this decision but bases decisions on the probability of work-related worsening of asthma with the information available. In some cases, our decision differed from the claim decision, especially for cases with no preceding history of asthma. The criteria we used are the following: (i) data indicating a pre-existing asthma diagnosis (i.e. present before starting the job or exposure event for which the WSIB claim had been initiated), with or without objective documentation of asthma, and (ii) exacerbation of symptoms at work which was not identified as being due to new specific sensitization to a workplace agent. Exposures were self-identified by the claimant and were not chosen from a predefined list. In a few cases, claimants were considered to have WEA without a documented history of preceding asthma symptoms if there was evidence of asthma (from history and pulmonary function tests), and symptoms had worsened at work without massive workplace exposures to irritants and with no identified workplace exposure to a sensitizer. We excluded from this diagnosis accepted claims for which there were new-onset asthma symptoms concurrent with workplace exposures when symptoms lasted 4 weeks or less and had not been objectively confirmed as asthma (classified by us as 'asthma-like reactions' and not included in this report). These cases did not have objective testing to confirm asthma and as a result were excluded from the study. We also excluded cases of reactive airways dysfunction syndrome or irritant-induced asthma. Other extracted data on OA claims are reported elsewhere [12].

We then analysed data from the three industries in which claimants were most frequently employed and subdivided the attributed exposure agents into dusts, smokes, chemicals and potential respiratory sensitizers. Cases were divided into shorter exacerbations (0–1 days off work), 2–5 days off work and longer periods (6 or more days off work) for the top three industry groups. Individuals thought to have WEA rather than OA, despite exposure to potential respiratory sensitizers, had tests for OA that were negative, had exposures at irritant levels, continued to work with the sensitizer without continued worsening or had active pre-existing asthma made worse by the exposure. The categories for specific exposures were subdivided. Categories of dust included airborne dust, other dust, construction dust and renovation dust. The smoke category included welding fumes, exhaust fumes, other fumes/odours, fire/smoke, second-hand smoke and other smoke. Chemicals included toxic chemical fumes,

perfumes, chlorine, insecticides, pesticides, aromatic hydrocarbons, acids, ammonia products, chemicals not specified, minerals and carpet glue fumes. Sensitizers included organic compounds, epoxy resins, amines, phenol formaldehyde, formaldehydes, moulds, paint fumes, cleaning agents, glutaraldehyde and oil/coolants.

Data analyses were performed in SAS, version 9.1 (SAS Institute, Cary, NC) and Graph Pad Prism 4. The outcome variables are expressed as crude prevalence rates or proportions. Continuous variables are expressed as mean $\pm$ SD, and categorical variables are expressed as frequencies or percentages. Comparisons of continuous variables and categorical variables were conducted via two-tailed *t*-tests (Wilcoxon test for non-parametric analysis) and chi-square tests (Fisher's exact test when appropriate), respectively. The study protocol was reviewed and approved by the Research Ethics Board of the University of Toronto (IRB# 21679).

Results

Of the 1825 WSIB claims submitted for asthma between January 1998 and December 2002, 281 claims were rejected as not being work related and 589 were not processed due to lack of follow-up from the applicants. Twenty-nine claims with an accident date between 1998 and 2002 had not received a compensation decision by January 2006 when the study population was extracted from the WSIB database and were not formally abstracted. (When the WSIB decision was subsequently reached, 11 were allowed as OA and 8 as work-exacerbated/aggravated asthma but they are not included here.) After excluding duplicate claims, 893 accepted claims underwent file abstraction. This report analyses the data from 643 of the 645 claimants categorized by us as WEA (in contrast to only 99 with sensitizer-induced OA [12]). The top three industries were health care (115

cases; 18% of total), education (102; 16%) and service industry (83 cases; 13% of total). The commonest occupations (cases and percentage of total) included production workers (116; 18%), government office workers (111; 17%), health care workers (87; 14%), other indoor workers (81; 13%) and teachers (80; 12%). Common exposures to which exacerbations were attributed (number of cases) included airborne dust (74), construction/renovation dust (61), cleaning agents (60), paint fumes (57), other fumes (49), fire/smoke (42), moulds (29), chemicals not otherwise specified (27), environmental factors (26), perfumes (26), exhaust fumes (20), other dust (18), organic solvents (16), second-hand smoke (15), toxic chemical fumes (13) and welding fumes (13). The range of time lost from work due to an exacerbation and available descriptive features according to time lost are displayed in Table 1. Overall, there were 270 claims with information about days off work that fit within the described exposure categories (103 in health care, 99 in education and 68 in service). Among claimants in education, there was a significantly greater proportion requiring 2–5 days off work at 37%. In health care, there was significant difference between prolonged and short exacerbations (21 versus 55%). Service industries demonstrated less than expected morbidity, requiring 2–5 days off work at 12%. Between the industry groups, there were differences in the attributed agents, with dust causing a higher proportion of cases in education at 65%. In health care, sensitizers caused a higher proportion of claims (41%), while in the service industry, smoke was the attributed cause of the greatest proportion of claims (34%) (Table 2).

A further analysis of the attributed agents associated with our three categories of days off work revealed that a greater proportion of claimants with chemicals, dusts or sensitizers as the attributed exacerbating exposures in education and service industries required 6 or more days off work compared with health care (Table 3). We also

Table 1. Demographic characteristics of the WEA subgroups by time off work due to symptoms (*n* = 643)

Variable	Group 1 (<i>n</i> = 248)	Group 2 (<i>n</i> = 59)	Group 3 (<i>n</i> = 150)	Group 4 (<i>n</i> = 114)	Group 5 (<i>n</i> = 72)	<i>P</i> value*
Mean age (years) ^a	39 $\pm$ 11	40 $\pm$ 12	40 $\pm$ 11	43 $\pm$ 10 ^b	42 $\pm$ 10	<0.01
History of previous asthma, %	99	100	100	98	96	NS
Smoking status						
Never smoked, %	15	14	13	21	47	<0.001
Ex-smoker, %	8	2	11	12	15	
Current smoker, %	6	8	6	9	11	
Missing data on smoking, %	71	76	70	58	27	
Mean pack-years of current and ex-smokers ^a	4 $\pm$ 10	2 $\pm$ 4	7 $\pm$ 16	6 $\pm$ 11	7 $\pm$ 20	NS

Group 1 = no time off; Group 2 = 1 day off; Group 3 = 2–5 days off; Group 4 = more than 5 but less than 21 days off; Group 5 = 21 or more days off. ANOVA for continuous variables and Chi square for categorical variables; NS = non-significant.

^aMean and standard deviation.

^bGroups 4 and 1 were statistically different for age, *P* < 0.01.

**P* value given for differences across groups.

Table 2. Attributed agents and duration of asthma exacerbations by industry group

	Health care					Service					Education				
	Total cases (%)	Time off (days)			% with ≥6 days off	Total cases (%)	Time off (days)			% with ≥6 days off	Total cases (%)	Time off (days)			% with ≥6 days off
		≤1	2–5	≥6			≤1	2–5	≥6			≤1	2–5	≥6	
Dusts	21 (20)*	8	5	8	35	17 (25)	4	2	11	65	64 (65)*	10	31	23	36
Smoke	19 (18)	11	4	4	21	23 (34)*	18	1	4	17	10 (10)	8	1	1	10
Chemicals	21 (20)	13	5	3	14	9 (13)	4	2	3	33	7 (7)	2	1	4	57
Sensitizers	42 (41)*	25	10	7	17	19 (28)	9	3	7	37	18 (18)	7	4	7	39

Cells with significantly greater than expected percentages of attributed agents are shown in bold font. *Chi square statistically significant for differences between cells, $P < 0.001$.

Table 3. Industry groups and duration of time off work

Industry	Days off work—1 or less (%)	Days off work—2–5 (%)	Days off work—6 or more (%)
Education*	27 (27)	37 (37)	35 (35)
Service	35 (51)	8 (12)	25 (37)
Health care*	57 (55)	24 (23)	22 (21)

*Chi square statistically significant between cells, $P < 0.001$.

found that dust was more common as an exacerbating agent in education (65%) than the other two industry groups. Smoke was significantly more common in the service industry at 34%, and sensitizers were more prevalent in health care at 41%.

Discussion

This study found significant differences in the agents to which workplace asthma exacerbations were attributed and in the duration of time off work due to WEA between the education, health and service industries. Dust was listed as causing 65% of accepted claims for asthma exacerbations in the education group while causing only 25 and 20% of accepted claims in the service and health care industries, respectively.

As this was a retrospective cross-sectional study, data analysis was limited by the information provided upon initial assessment and data on the quantity and quality of exposure are difficult to determine. Although there were substantial numbers of claimants in the top three industry groups, other groups had insufficient numbers for analysis. We observed that the accepted claims in the service industry involved a higher proportion of individuals suffering from exacerbations attributed to smoke exposure. A survey of the attributed exposures revealed that many involved machinery or office equipment malfunctioning and exposures to smoke from cooking or cleaning. The health care population had relatively less

use of machinery and office equipment although there was a strong emphasis on cleaning. A large proportion of asthma exacerbations caused by cleaning agents in health care were classified as chemical exposure. In contrast there was a relatively higher proportion of smoke-related WEA in the service industry than in health care and education.

The difference in the proportions of attributed agents between the top three industry groups may provide insights into causes of WEA. Within service industries, smoke is listed as the top causative agent. This may be explained by the large variety of occupations within this sector; many of the claims were in industries where exposure to smoke is commonplace, such as the automotive service industry, drivers and cashiers (in smoking environments). The high proportion of attributed potential sensitizer exposures causing WEA in health care may be due to the frequent presence of such agents in health care facilities. Many are used during regular cleaning to maintain sterile facilities and many are respiratory irritants as well as possible sensitizers. Despite the frequent identification of sensitizing agents among the health care workers with WEA, during the study period only five cases of sensitizer-induced OA were identified among health care workers.

Subdividing the actual proportion of prolonged exacerbations between the causative agents within each industry group provides an indication of which agents are more likely to cause a prolonged exacerbation. Attributing agents causing most exacerbations within an industry tended to cause a lower proportion of prolonged exacerbations. This was seen in health care where potential sensitizers were associated with the greatest number of exacerbations but were far less often associated with prolonged exacerbations compared with dust (17 versus 35%). Although health care has a larger proportion of sensitizer and chemical exposures, the majority of these exposures were associated with short exacerbations during the study period. Within the service industry, smoke was the most frequent attributed agent but was the least likely of all four agents to be associated with prolonged exacerbations. This suggests that by targeting both less common as well as common WEA

triggers, policy makers and industries may reduce both the duration and the frequency of WEA.

Limitations of this study include its retrospective nature. We were limited to the documentation present in the compensation file, both for the diagnosis and for the causative exposure agents, which in many cases was based on history without objective verification. It is therefore possible that some cases with identified sensitizer exposure or new onset of asthma may have been cases of OA. However, these would have accounted for a small proportion of this population and are unlikely to have changed our results. Exposures were also not confirmed objectively, and the diagnosis and clinical assessment were dependent on the independent physician involved in assessing each case.

Interpreting the data on WEA between industry groups will assist future preventive strategies for specific industries. With more data, it might be possible to identify and reduce or prevent the number and duration of WEA episodes in education. Within health care, a large number of preventive strategies to reduce exposure to OA sensitizers have already been implemented but there is still a large difference between the prevalence of WEA attributed to exposure to potential sensitizers in health care versus other industries.

Key points

- Work-exacerbated asthma was frequent in a workers' compensation claim population.
- Most cases were transient with almost 50% leading to no days or 1 day away from work.
- The most common industry groups were health care, education and service, and some differences were seen between these groups in time loss and types of agents responsible.

Funding

Ontario Workplace Safety and Insurance Board Research Advisory Council.

Acknowledgements

Supported in part by the Research Advisory Council of the Ontario Workplace Safety and Insurance Board (WSIB). The authors thank Ms Carol Luce, WSIB for assistance in identifying asthma claim files for our review.

Conflicts of interest

S.M.T. performs clinical assessments at the request of the Ontario Workplace Safety and Insurance Board. The other authors have no declared conflicts of interest.

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