



Welders are at increased risk for invasive pneumococcal disease

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SUMMARY

Background: Welders are at increased risk of pulmonary infection and lobar pneumonia, likely due to significant occupational exposure to metal fumes. We hypothesized that welders would be at increased risk for invasive pneumococcal disease (IPD) compared to the general population.

Methods: A retrospective chart review of all patients with IPD in the province of Alberta, Canada (population approx. 3.3 million) was conducted from 2000 to 2004 to study the epidemiology of IPD.

Results: There were 18 cases identified in welders, giving an attack rate of 22.7 cases per 100 000 population per year (95% confidence interval (CI) 12.23–33.23). Compared with an attack rate of 8.7 cases per 100 000 population per year (95% CI 8.10–9.26) for the general adult population between ages 18 and 65 years, there was a 2.7-fold greater incidence of IPD in welders (95% CI 1.67–4.22, $p < 0.001$). There was an increased prevalence of serotypes 4 and 8 compared to the general population. Eight of 18 cases were caused by serotypes in the 7-valent pneumococcal conjugate vaccine, 11 of 18 cases by serotypes in the 13-valent pneumococcal conjugate vaccine, and 18 of 18 cases by serotypes in the 23-valent pneumococcal polysaccharide vaccine. Seventeen patients had bacteremic pneumococcal pneumonia and one had meningitis; one person died due to infection. Fifteen of 18 patients were either current or former smokers, which was a higher rate than the general population adjusted for age and gender (odds ratio 2.976, 95% CI 0.908–9.729, $p = 0.084$).

Conclusions: Welders, particularly those who smoke, are at increased risk of IPD and should be considered for routine administration of the pneumococcal polysaccharide vaccine. Ongoing workplace measures to reduce exposure to metal fumes and promote smoking cessation should be reinforced.

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Introduction

Streptococcus pneumoniae is an important cause of community-acquired pneumonia and bacteremia. Invasive pneumococcal disease (IPD) is defined as isolation of *S. pneumoniae* from a normally sterile body site (typically blood or cerebrospinal fluid), and carries with it significant morbidity and mortality. Numerous risk factors for IPD have been identified, which include extremes of age, various medical co-morbidities including congestive heart failure and diabetes mellitus, alcohol abuse, smoking, solid-organ or hematological transplant, and immunosuppression.^{1–4} Vaccination of adults with the 23-valent pneumococcal polysaccharide vaccine offers a protective benefit against IPD, and is recommended for adults in high-risk groups.^{5,6}

In the context of a large five-year retrospective study of all patients with IPD in the province of Alberta, we sought to clarify the relationship between occupation and IPD, particularly in 'high-risk' occupations where routine work exposures could predispose individuals to IPD. For the purposes of our study, the occupations considered included welding, farming, day care workers, and electricians.

Methods

Demographics and definitions

The study encompassed the province of Alberta from 2000 to 2004, which at the time of the study was divided into nine health regions. The provincial population was 2 967 755 in 2000 and 3 179 036 in 2004.⁷ Cases of IPD were defined as the isolation of *S. pneumoniae* from any normally sterile body site, including blood, cerebrospinal fluid, pleural fluid, biopsy tissue, synovial fluid,

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pericardial fluid, and peritoneal fluid.⁸ In Alberta, IPD is considered a notifiable disease reportable to the Provincial Health Office. *S. pneumoniae* isolates recovered from patients with IPD are submitted to the National Centre for Streptococcus (NCS) located in Edmonton, Alberta, for capsular serotyping and antimicrobial resistance profiling for trending analysis. Isolates were submitted to the NCS prospectively from acute diagnostic microbiology laboratories in Alberta during the study period.

To ensure as complete as possible the capture of all patients with IPD in Alberta during the study period, a number of databases were utilized. These included all patients identified by identification of *S. pneumoniae* isolates sent to the NCS, all patients reported to the Provincial Health Office, and all patients captured in both the Calgary Area *S. pneumoniae* Epidemiology Research (CASPER) database (Calgary, AB) and the Community Acquired Pneumonia Study database (Edmonton, AB). All four databases were combined to form the final dataset, and duplicate patients were counted only once. An extensive retrospective chart review of all identified patients was then performed for all identified cases of IPD occurring during the survey period. Current occupations were recorded as self-reported by patients, including whether they were unemployed or retired.

In the laboratory, upon receipt of *S. pneumoniae* isolates, bacteria were stored at -70°C until serotyping and susceptibility assays were performed. Only one isolate from each IPD case was included in the review unless the isolates were collected one month or more apart in time, or were of a different serotype if less than one month had elapsed between episodes of IPD.

Annual incidence rates for the general population were calculated between 2000 and 2004 using provincial population estimates from Alberta Health and Wellness. Annual occupation-specific incidence rates were calculated between 2000 and 2004 using provincial estimates for various occupations provided by Alberta Employment and Immigration.

The study received approval from the institutional research review committees of all nine health regions in Alberta and also by the University of Alberta and the University of Calgary.

Serotyping of *S. pneumoniae* isolates

Isolates received at the NCS were confirmed as *S. pneumoniae* based on morphology and optochin susceptibility.⁹ Serotyping was performed at the NCS by the Quellung reaction using commercial antisera prepared at the World Health Organization (WHO) Collaborating Center for Reference and Research on Pneumococci, located at the Statens Serum Institut, Copenhagen, Denmark.¹⁰ Strains that failed to type were confirmed as *S. pneumoniae* using Accuprobe™ (Genprobe, San Diego, CA, USA).

Statistical analysis

Incidence rates and serotype prevalence were compared between identified 'high-risk' occupations and the general 'working adult' population between the ages of 18 and 65 years using Fisher's exact test. All statistical analyses were performed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA).

Results

Incidence rates of IPD in 'at-risk' occupations vs. general population

A total of 1768 cases of IPD were identified in Alberta between 2000 and 2004 for which laboratory and clinical data were both complete. Of these, 863 cases (48.8%) occurred in 'working-age' patients aged between 18 and 65 years, for an overall incidence rate of 8.7 cases per 100 000 population per year (95% confidence interval (CI) 8.10–9.26). Within this group, the incidence rate in males (9.7 cases per 100 000 population per year, 95% CI 8.87–10.60, $p < 0.001$) was slightly higher than the incidence rate in females (7.6 cases per 100 000 population per year, 95% CI 6.84–8.38).

The incidence rates of IPD during the study period for each of four identified 'at-risk' occupations are given in Table 1 and compared with rates of IPD in the 'working-age' general adult population between the ages of 18 and 65 years. A total of 18 patients with IPD (1.02%) were identified during the five-year study period in those who reported their current occupation as welding, for an overall occupation-specific incidence rate of 22.7 cases per 100 000 population per year (95% CI 12.23–33.23). Compared with the remainder of the general adult population between ages 18 and 65 years, welders had a 2.7-fold (95% CI 1.67–4.22; $p < 0.0001$) greater incidence of IPD. All of the affected individuals were male, and in comparison with the remainder of males between ages 18 and 65 years, there was still a 2.4-fold increase (95% CI 1.50–3.81, $p = 0.001$) in the rate of IPD.

Electricians (12.2 cases per 100 000 population per year, 95% CI 12.45–22.04, $p = 0.329$) and day care workers (10.5 cases per 100 000 population per year, 95% CI 3.21–17.70, $p = 0.555$) had an increased rate of IPD compared to the remainder of the working-age population, but neither reached statistical significance. Farmers had a lower rate of IPD (3.1 cases per 100 000 population per year, 95% CI 0.81–5.42, $p = 0.002$) compared to the remainder of the working-age population.

Demographic and clinical characteristics of welders with IPD

Selected demographic and clinical information on the IPD cases in welders is provided in Table 2. All of the involved welders were male, with a median age of 39 years. Thirteen (72%) were current smokers and two (11%) were former smokers. Six reported significant alcohol use and four reported the use of illicit drugs. Compared with males aged between 18 and 65 years with IPD, the affected welders had a greater tendency to be either current or former smokers (15/18 (83%) vs. 294/469 (63%), odds ratio (OR) 2.976, 95% CI 0.908–9.729, $p = 0.084$). There was no significant difference in rates of alcohol use between affected welders and males aged between 18 and 65 years with IPD (159/487, 33%). There was no pattern of medical co-morbidities identified, although one patient had a history of recurrent upper respiratory infection and 'metal fume fever', as described by the patient. There was no geographic clustering of cases.

Table 1
Rates of invasive pneumococcal disease in identified 'at-risk' occupations, 2000–2004.

Occupation	IPD cases 2000–2004	Number employed 2000–2004, in person- years	Incidence rate/100 000/year (95% CI)	Odds ratio (95% CI) compared to general population	<i>p</i> -Value ^a
Welder	18	79 200	22.7 (12.23–33.23)	2.653 (1.670–4.215)	<0.001
Electrician	6	49 000	12.2 (2.45–22.04)	1.414 (0.646–3.093)	0.329
Farmer	7	224 700	3.1 (0.81–5.42)	0.354 (0.171–0.732)	0.002
Day care worker	8	76 500	10.5 (3.21–17.70)	1.207 (0.610–2.389)	0.555

CI, confidence interval.

^a Two-tailed Fisher's exact test.

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