

Longitudinal study of respiratory function in aluminum smelter workers.

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FINAL PROGRESS REPORT

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A. Specific Aims: The specific aims of this K01 remain unchanged and are briefly reviewed below:

Specific Aim 1a and 1b: Delineate two cohorts, an overall (1a) and an inception cohort (1b), of exposed smelter workers for whom basic demographic data as well as data concerning date of hire, job tasks and exposures, medical claims information and spirometric function tests are available.

Specific Aim 2a & 2b: Determine the change over time, or slope, of the principle parameters of spirometric function including forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), and maximal midexpiratory flow rates (MMEF) among workers in the overall cohort (2a) and inception subcohort (2b)

Specific Aim 3a & 3b: Using insurance claims data, measure the incidence and prevalence of obstructive lung disease (OLD) and of subgroups of asthma and COPD among the overall cohort (3a) and inception subcohort (3b).

Specific Aim 4a & 4b: Determine the concordance between change over time, or slope, in the principle parameters of spirometric function and the diagnosis of OLD and of subgroups of asthma and COPD in the overall cohort and inception subcohort.

Specific Aim 5a & 5b: Measure the association between exposure to total and respirable particulate matter and change over time in spirometric function (5a) and the diagnosis of OLD (5b) in the overall cohort and inception subcohort.

Specific Aim 6a & 6b: Measure the association between each of the principle exposures commonly found in aluminum smelters, including fluorides (gaseous, particulate and total), sulfur dioxide, oil mist and coal tar pitch volatiles, and change over time in spirometric function (6a) and the diagnosis of OLD (6b) in the overall cohort and inception subcohort.

Specific Aim 7a & 7b: Explore the role of smoking as an effect modifier of longitudinal changes in spirometric function (7a) and the diagnosis of OLD (7b) in the overall cohort and inception subcohort.

Specific Aim 8a & 8b: Develop a multivariate model including demographic predictors, smoking status and the exposures to predict change over time in spirometric function (8a) and the incidence of OLD diagnosis (8b)

B. Studies and Results

1. Prevalence of OLD Diagnosis Among Workers with Spirometric Obstruction (Specific Aims 1, 3, 8) In an initial cross sectional analysis, the concordance between spirometric obstruction and the presence of OLD diagnosis using insurance claims, both medical and pharmacy claims, was examined. First, a cohort was identified (Specific Aim 1). 6821 workers from 13 U.S. Alcoa locations with at least 1 spirometry during the 2 year period 1996-1997 and with available insurance claims for any contiguous period between 1996 and 2002 were identified. Over 85% of workers were Caucasian males and had an average duration of employment of over 20 years. The prevalence of obstruction was then determined in this cohort. 11.7% (Specific Aim 3) of the cohort had spirometric evidence of obstruction. Workers with spirometric obstruction were older (49.3 years vs. 46.5 years, $p < 0.0001$) and had a longer duration of employment (21.3 years versus 18.8 years, $p < 0.0001$).

771 workers had 3013 claims for an OLD diagnosis. 61.1% of claims were for asthma (ICD9 code 493) while 26.2% of claims were for chronic airflow obstruction (ICD9 code 496). 14% of workers with an asthma claim also had a claim for another OLD diagnosis. Workers with obstruction were more likely to have an OLD claim (35.8% vs 14.5%, $p < 0.001$); however 59.3% of workers with obstruction did not have any claim. Workers with more severe obstruction were more likely to have a claim ($p < 0.001$): no obstruction: 18.6% (1122/6024); borderline obstruction 30.0 (136/454); mild 42.8% (98/229); moderate 75.3% (67/89); severe 84.0% (21/25)

In the multivariate model (Specific Aim 8), age, sex (female vs. male), and employment type (hourly versus salary) were associated with an increased likelihood of an OLD claim. Increasing severity of obstruction was associated with an increasing hazards ratio for having a claim: borderline 1.91; mild 3.20; moderate 5.86 and severe 11.54. Duration of employment and current smoking status were not significantly associated with having an OLD claim (Gulati M, Slade M et al, J Occup Environ Med. 2009; 51:336-342).

2. Validation Study of Medical Insurance Claims for Obstructive Lung Disease (submitted): While administrative data are increasingly used in health studies, the sensitivity and specificity of insurance claims for the diagnosis of OLD is unclear particularly in outpatient populations such as in healthy workers with chronic stable diseases. In a study of a subset of approximately 4000 workers, we explored the sensitivity and specificity for claims for OLD. Specificity, as expected, was higher for medical claims than pharmacy claims.

Specificity was highest using 5 years of claims data: 90.4%. Sensitivity even at 5 years was modest at 60% for the use of medical/pharmacy claims combined.

3. Longitudinal Analysis of Spirometry (Specific Aim 2) (presented ATS poster 2009) The natural history of obstructive lung disease is unclear. The clinical significance of mild or borderline obstruction in asymptomatic healthy workers is unknown. In a study of a subset of 232 workers with obstruction, workers with mild and obstruction had accelerated decline (50.1cc/yr) compared to workers with no obstruction ($p<0.001$) suggesting that early detection of lung function loss may have clinical significance at later stages.

4. Exposure Assessment in Aluminum Industry: (Specific Aim 5): In order to explore associations between exposures, exposure levels need to be assigned to individual workers and cumulative exposure levels for individual exposure levels were calculated. Geometric means were assigned for coal tar pitch volatiles, respirable dust, total dust, total fluoride, oil mist and sulfur dioxide. Geometric means were calculated using all exposure measurements for a specific job regardless of year unless a historical trend was identified. For example, historical trends in total dust exposure were found in workers employed in the green anode and potroom departments. In a multivariate mixed effects model with total dust as the only exposure, total dust was significantly associated with accelerated declines in FEV1; however the magnitude of effect was quite small and the clinical significance is unknown.

C & D. SIGNIFICANCE AND PLANS: The results of these early studies will have significant impact on future studies. The demographic characteristics, prevalence of airflow obstruction and exposure matrix for relevant exposures have now been established. Further exploration of associations between exposures and longitudinal lung function loss can be explored in further detail. The clinical significance or longitudinal lung function loss can be further explored by linking such analyses to the insurance claims databases.

E. PUBLICATIONS: (ABSTRACTS)

Gulati M, Slade M, Fiellin M, Cullen M. Healthcare for Obstructive of Lung Disease in an Industrial Spirometry Surveillance Program. J Occup Environ Med. 2009; 51: 336-342

Gulati M, Galusha D, Slade M, Redlich C, Cullen M. Association between Insurance Claims for Obstructive Lung Disease and Spirometric Airflow Obstruction. (submitted)

Gulati M, Slade M, Galusha D, Redlich C, Cullen M. Longitudinal Decline in FEV1 by GOLD Stage in Workers in a Spirometry Surveillance Program. Am J Respir Crit Care Med 2009; 179: A4078).