

Abstract

The diagnosis occupational asthma implicates serious consequences for both affected individuals and their employers, such as long-time medical treatment and unfitness for the job. In chapter 2 some background information has been presented. Aluminium potroom asthma is a specific form of occupational asthma. In course of time many workers in the primary aluminium industry in the Netherlands have developed asthma. Very little is known about the factors that can affect the onset of symptoms and the prognosis of aluminium potroom asthma. Therefore, we have carried out a retrospective study in the primary aluminium industry in the Netherlands in order to provide tools for occupational physicians to prevent the development of occupational asthma and to contend aggravation of asthma. A more specific aim of the present study was to gain more insight in patient characteristics predicting the onset and course of the disease. We have formulated five specific questions in this thesis:

- Which risk indicators can be identified in aluminium potroom workers who developed asthma?
- Did preventive measures such as exposure reduction and the introduction of the histamine provocation test as a pre-employment selection instrument result in lower incidence of potroom asthma or a longer latency time between starting employment and the occurrence of potroom asthma?
- Which factors are determining for the prognosis in transferred workers with potroom asthma?
- Which factors are determining for the medical outcome in workers with potroom asthma currently employed?
- What is the effectiveness of screening at pre-employment examination to prevent occupational asthma in this industry?

Chapter 3, eosinophils as risk indicator

Occupational asthma still occurs in aluminium potroom workers despite of pre-employment medical selection. The purpose of this part of the study was to identify workers with an increased risk developing potroom asthma (PA). A nested case control study has been carried out in two Dutch aluminium producing plants. Pre-employment data of 364 potroom workers (182 cases and 182 controls) were analysed. Cases were workers unable to work in the potroom because of work-related respiratory disease, meeting the criteria for PA. The selected controls were potroom workers matched for age, year of starting employment. The matching implies that cases and controls have been working under the same conditions. Pre-employment eosinophil count was

time (the time interval between start of exposure and diagnosis). To correct for confounding factors, we included age, pre-employment FEV_1 -%pred, allergy, medical treatment, and smoking in the analysis. The mean FEV_1 -%pred at follow-up was within the normal range (90.3, SD 13.5). Long exposure time was significantly associated with a low FEV_1 -%pred at follow-up ($p=0.005$). Adjustment was necessary for pre-employment FEV_1 -%pred and current smoking as confounding factors. We concluded that a long duration of exposure is a factor affecting FEV_1 in workers with PA. The results of this study point to the importance of early recognition of work-related respiratory complaints and repeated education.

Chapter 6, medical outcome in workers with potroom asthma

In this follow-up study, we investigated which factors are related with bronchial hyperresponsiveness, lung function (FEV_1 percent predicted), and sickness absence during the last five years of employment, in workers with PA still working at the company after transfer from exposure to exposure-free departments. Between 1970 and 1990 in a Dutch aluminium production plant, 179 workers had been diagnosed as having PA. From this population, 39 workers are still working in the plant (current workers). Within this population, histamine provocation tests and spirometry have been performed to measure bronchial responsiveness and lung function. Workers with persistent bronchial hyperresponsiveness were compared with the non-responsive workers concerning pre-employment FEV_1 percent predicted (FEV_1 -%pred), smoking habits, atopic history and eosinophil count. As potential risk indicators exposure time and current smoking were analysed. As the manner of case detection is relevant for the evaluation of occupational health care activities, this factor has been explored.

In 46% of the current workers with PA increased bronchial responsiveness was found. All potroom asthma patients with an atopic history ($n=6$) had increased bronchial responsiveness at follow-up. The mean FEV_1 -%pred was in the normal range (92.9 %). Current employees with PA with longer exposure time tended to have lower mean FEV_1 -%pred at follow-up. Cases who were detected by means of consulting hours have a statistically significant higher mean FEV_1 -%pred as compared with cases detected by periodic medical examination (94.4% versus 82.9%). Sickness absence in the patients was slightly higher as compared with the whole plant population. PA patients with bronchial hyperresponsiveness had no more sickness absence compared with PA patients with normal responsiveness.

We concluded that in many patients with PA transferred to exposure-free departments bronchial hyperresponsiveness persisted. This negative medical outcome depends on prolonged exposure especially in workers with an atopic

history. Once diagnosed, patients with potroom asthma were re-located and need to be carefully followed up and educated to prevent more negative health impairments.

Chapter 7, screening on risk indicators

The occurrence of PA has been described due to exposure to fluorides in gaseous form or as dust. Potroom exposure can affect employees, mediated by work methods, personal behaviour and personal risk indicators. In the primary aluminium industry, pre-employment screening may be relevant to protect susceptible applicants. Aim of our study was to compute the predictive value of a positive test result (PPV), the number of medical assessments needed to reduce the number of new cases by one (NNT) and the number of rejections for the job needed to reduce the number of new cases by one (NNR).

We used the diagnostic model in 2x2 table format as the basis for a pre-employment medical table. Data were derived from a nested case-control study in the Netherlands. FEV₁ percent predicted lower than 80%, atopic history and blood eosinophil count above 220 cells/mm³ were analysed as risk indicators. We computed PPV, NNT and NNR at high and low incidence rate of potroom asthma. At high incidence rate defined as 0.04 (40 new cases per 1000 workers per year), the results for low FEV₁, atopic history and high eosinophil count were respectively: PPV 5%, 6.7% and 21.4%; NNT 667, 222 and 116; NNR 20, 15, and 5. At low incidence rate defined as 0.005 (5 new cases per 1000 workers per year), the results for low FEV₁, atopic history and high eosinophil count were respectively: PPV 0.6%, 0.9% and 2.7%; NNT 5000, 1667 and 909; NNR 155, 112, and 36.

Our evaluation model shows that the personal risk indicators studied are far from appropriate to incorporate in an effective and not harmful selection instrument, especially when the incidence rate is low. In general, too many unjustified rejections occur to prevent one case. We concluded that personal risk indicators such as a low FEV₁-level in a pre-employment examination, atopic history and high blood eosinophil counts at pre-employment should not be used as a selection instrument. These indicators can be taken into account in further intensive health surveillance, including medical examinations and education.

In chapter 8 the conclusions have been presented:

- Potroom exposure induces asthma. There are some indications that fluoride dust particles are responsible for the induction of asthma. In the pathogenesis, the eosinophil cell plays a role (chapter 3 and 4).
- Increased bronchial hyperresponsiveness is a consequence of exposure (chapter 6).

- Potroom exposure of subjects with pre-existing asthma.
- Negative medical history and atopic history are not sufficient to exclude a worker from employment.
- Current employees with asthma do not recover completely after leaving the potroom.
- Exclusion of asymptomatic workers with allergy and low level of asthma, especially in the primary aluminium industry.

- Potroom exposure may also act as an inciter of asthmatic reactions in subjects with pre-existing asthma (chapter 4).
- Negative medical outcome depends on several factors such as smoking, atopic history and long duration of exposure (chapter 5 and 6).
- Current employees who were transferred because of potroom asthma do not recover completely (chapter 6).
- Exclusion of asymptomatic applicants with personal risk indicators such as allergy and low lung function level is not effective in preventing potroom asthma, especially not when the risk of potroom asthma is low (chapter 7).