

Cancer risk among workers of a secondary aluminium smelter

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Background	Cancer risk in secondary aluminium production is not well described. Workers in this industry are exposed to potentially carcinogenic agents from secondary smelters that reprocess aluminium scrap.
Aims	To evaluate cancer risk in workers in a secondary aluminium plant in Spain.
Methods	Retrospective cohort study of male workers employed at an aluminium secondary smelter (1960–92). Exposure histories and vital status through 2011 were obtained through personal interviews and hospital records, respectively. Standardized mortality (SMRs) and incidence ratios (SIRs) were calculated.
Results	The study group consisted of 98 workers. We found increased incidence and mortality from bladder cancer [SIR = 2.85, 95% confidence interval (CI) 1.23–5.62; SMR = 5.90, 95% CI 1.58–15.11]. Increased incidence was also observed for prostate cancer and all other cancers but neither were statistically significant. No increased risk was observed for lung cancer.
Conclusions	Results of this study suggest that work at secondary aluminium smelters is associated with bladder cancer risk. Identification of occupational carcinogens in this industry is needed.
Key words	Cancer; occupation; secondary aluminium smelter; urinary bladder.

Introduction

Cancer risk in the secondary aluminium production industry, which reprocesses scrap containing aluminium, has been little investigated. Exposures during aluminium production are associated with bladder and lung cancer [1,2]. A higher incidence of lung cancer has been reported in workers in secondary aluminium smelters [3]. Workers employed in secondary smelters may be exposed to a complex mixture of agents that include thermal degradation products of polyvinyl chloride, lubricants and petrol modifiers [4]. Exposures in secondary aluminium processing only partially resemble those in primary aluminium production [3]. Details on processes, exposures and protective measures used in the industry [5] are shown in Table S1, available as Supplementary data at *Occupational Medicine* Online.

Following a report by a trade union and complaints of residents around a secondary aluminium smelter, we initiated a retrospective cohort study to evaluate cancer

risk among workers. The plant had ceased production in 1992.

Methods

We examined a retrospective cohort of male workers in a secondary aluminium smelter in Catalonia, Spain, employed for at least 6 months between 1960 and 1992. A roster of workers was obtained from the Spanish National Institute of Social Insurance. Vital status of workers was followed from April 1960, when the first workers were hired, until December 2011. Workers or their family members were contacted by telephone, confirming their vital status, smoking history and presence of cancer diagnosis. An exposure questionnaire was developed from an earlier study on bladder cancer and completed by the contact [6]. Information about industrial exposures was obtained through semi-structured interviews with the most experienced company workers.

We contacted personally or by telephone 90% of workers and/or their family members to identify cancer cases in this population and request information on the hospitals where workers were treated. Diagnoses were verified through hospital medical records and coded following ICD 10 by a medical doctor (A.M.).

All-cause standardized mortality ratios (SMRs) were calculated using age, sex and period-specific all-cause mortality from Catalonia from 1981 to 2007 [7]. Cancer incidence and mortality rates for the same period were provided by the regional cancer registry for the population of the Tarragona province in Catalonia where the smelter was located [8] and used to calculate SMR and standardized incidence ratios (SIR) for cancer diagnosis.

To evaluate the potential confounding effect of smoking on lung and bladder cancer risk, we estimated the prevalence of smoking in the study population through interviews and applied Axelson's technique [9] that indirectly estimates the degree of confounding of a factor (in this case smoking). We used the smoking-related cancer rates from previous studies [10,11] and smoking prevalence for the Catalan population [12]. We used the statistical package PAMCOMP 1.41 [13]. Procedures were approved by the Ethics Committee of the Hospital (IMIM-Hospital del Mar Research Institute), and signed informed consent was obtained from participating subjects or next of kin.

Results

The study group consisted of 98 male workers. Nine women were excluded from the analysis as most were working in the administrative office. We could not verify the vital status of 11 workers lost to follow up, for whom the last day of employment was used to calculate person-time.

Workers reported that they were exposed to high temperatures, gases, vapours, oils, combustion products and gasoline. Interviewed workers also reported inhalation exposure to metal dust, silica, potassium, magnesium, manganese, copper, iron and titanium.

During the follow-up period (1960–2011), 31 workers died, 16 of those from cancer. All-cause mortality was lower than the general population [SMR = 0.62, 95% confidence interval (CI) 0.01–6.96]. Mortality from bladder cancer was nearly six times higher (SMR = 5.90, 95% CI 1.58–15.11) while no increase was observed for lung cancer (Table 1). Mortality from all cancers did not increase with duration of exposure (SMR for <10 years employment: 1.42, 95% CI 0.79–2.34; SMR for >10 years: 1.25, 95% CI 0.01–6.96). Cancer incidence was slightly higher than expected for all types of cancer (Table 1), and a 3-fold increase was observed for bladder cancer (SIR = 2.85, 95% CI 1.23–5.62). An increased incidence of prostate cancer was observed, while the incidence of lung cancer was lower than expected.

Prevalence of smoking among workers was 70%. Smoking could explain an SMR of 1.14 for mortality from all cancers, compared with the SMR of 1.41 observed. For bladder cancer, cigarette smoking could explain an SMR of 1.25 and contrasts with the observed SMR of 5.90.

Discussion

In this study of workers in a secondary aluminium smelter, we found increased incidence and mortality from bladder cancer. There are no exposure measurements in this plant but reports by workers in the plant indicated that they were exposed to a variety of chemicals that could contribute to the observed cancer risk.

The use of ad hoc sources of data could have affected the comparability of cohort mortality and incidence data with reference rates used for comparison. However, the use of hospital cancer diagnoses makes the presence of serious biases unlikely. Lower mortality from all causes compared to the general population, termed the healthy worker effect, is frequently observed in occupational studies.

To reduce reporting bias, all identified cancer diagnoses and deaths were verified through medical records.

Table 1. Standardized cancer mortality and cancer incidence ratios (SMR and SIR) in a cohort of workers of a secondary aluminium smelter from 1961 to 2011

		Observed	Expected	SMR/SIR ^b	95% CI
Cancer mortality	All cancers ^a	16	11.34	1.41	0.80, 2.28
	Lung cancer	3	3.09	0.97	0.19, 2.83
	Bladder cancer	4	0.67	5.90*	1.58, 15.11
Cancer incidence	All cancers	26	21.22	1.22	0.80, 1.79
	Lung cancer	3	3.8	0.77	0.15, 2.26
	Bladder cancer	8	2.8	2.85*	1.23, 5.62
	Prostate cancer	6	2.96	2.02	0.74, 4.41

^aComparing to cancer mortality and incidence rates of the population of Tarragona province.

^bMortality from all cancers did not increase with duration of exposure.

* $P < 0.05$.

Level of exposure was not analysed for association with cancer diagnosis, as detailed information on exposure to specific chemicals could not be identified with a high degree of certainty. The relatively small size of the cohort did not allow a lagged-time analysis and reduced the statistical precision of estimates as indicated by wide CIs for specific outcomes.

Our observed increase in bladder cancer incidence and mortality differs from Selden's past negative findings for this disease [3]. One possible difference is the predominance of primary aluminium smelters in Selden's study, with only 3 of 10 companies in secondary production.

In contrast to a previous study, we did not find an excess risk for lung cancer [3] possibly because exposures in the secondary smelter are different from those in primary smelters, although numbers of cases we observed are small [2]. This also indicates that potential confounding by smoking is probably not significant in this population.

In conclusion, we found an increased bladder cancer risk among workers in the secondary aluminum industry cohort that were exposed to a variety of chemicals, including ones not present in the primary aluminum smelting industry.

Key points

- Cancer risk in the secondary aluminium production industry has not been well described to date.
- Workers employed in secondary smelters may be exposed to a variety of agents that only partially resemble exposures in primary aluminium production.
- Work at secondary aluminium smelters is associated with increased bladder cancer risk in this cohort of workers.

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Conflicts of interest

None declared.

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