

Cancer incidence among Finnish cobalt production workers 1969-2013: a cohort study

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Aim of the study

To assess the risk of cancer among workers employed in the Finnish cobalt plant since the beginning of production in 1968.

Background of the study

- There are conflicting data on carcinogenicity of cobalt in epidemiological studies.
- A Swedish study (Högstedt and Alexandersson, 1990):
 - Non-significant excess mortality from lung cancer (SMR 1.34, 95%CI 0.77-2.13)
 - Among employees with >10 years employment who had died more than 20 years after the end of exposure, there was a significant excess mortality from lung cancer (SMR 2.78, 95%CI 1.11-5.72)

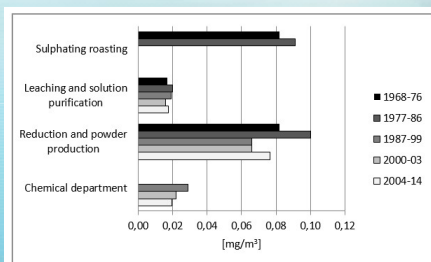
Background of the study

- A French study of mortality at an electrochemical plant
 - relative increase in deaths from cancers of the trachea, lung and bronchus (SMR 4.66; 95%CI 1.46-10.64 based on four cases) (Mur et al. 1987)
 - a follow-up study could not confirm the findings (Moulin et al. 1993). SMRs were 0.85 (95%CI 0.18-2.50, 3 cases).
- IARC: there is inadequate evidence in humans for the carcinogenicity of cobalt metal without tungsten carbide (Group 2B) (IARC 2006)

Subjects and methods

- The study cohort consisted of all male persons employed by the Finnish cobalt plant 1968-2004 (n= 995, 26 083 person-years).
- Follow-up for cancer through the files of the Finnish Cancer Registry was performed using the personal identity code as key.
- The cohort was divided into subcohorts by exposure levels.
- Standardised incidence ratios (SIRs) and 95% confidence intervals were calculated as the ratios of observed numbers of cancer cases and numbers expected on the basis of incidence rates in the population of the same region.

Mean cobalt exposure levels in Kokkola cobalt plant in 1968-2014



Exposure groups 1-4 according to the departments

Group	Definition	Departments
1	High exposure	Sulfatizing roasting, Reduction and powder production
2	Moderate exposure	Chemical department, test plant
3	Low exposure	Leaching and solution purification
4	Variable exposure with peak exposures	Factory maintenance

Primary site	Employment > 1 year			Employment > 5 years		
	Obs	Exp	SIR 95%CI	Obs	Exp	SIR 95%CI
All sites	92	91.9	1.00 0.81-1.22	77	71.6	1.08 0.85-1.34
Tongue	3	0.41	7.39 1.52-21.6	3	0.30	10.0 2.06-29.2
Oesophagus	2	1.15	1.74 0.21-6.28	2	0.89	2.24 0.27-8.08
Stomach	7	3.47	2.01 0.81-4.15	5	2.73	1.83 0.59-4.26
Colon	4	4.36	0.92 0.25-2.34	4	3.46	1.16 0.32-2.96
Rectum, rectosigmoid	4	3.80	1.05 0.29-2.69	3	2.93	1.03 0.21-2.99
Pancreas	2	3.44	0.58 0.07-2.09	1	2.69	0.37 0.01-2.07
Larynx, epiglottis	2	0.81	2.46 0.30-8.86	2	0.85	3.09 0.37-11.2
Lung, trachea	6	12.0	0.50 0.16-1.08	5	9.55	0.62 0.17-1.22
Melanoma of the skin	1	3.29	0.30 0.01-1.69	1	2.53	0.39 0.01-2.20
Skin, non-melanoma	3	2.78	1.08 0.22-3.15	3	2.22	1.35 0.28-3.94
Basal cell carcinoma of the skin	18	19.2	0.94 0.56-1.48	12	15.1	0.80 0.41-1.38
Prostate	33	24.4	1.35 0.93-1.89	26	19.4	1.34 0.87-1.96
Kidney	2	3.91	0.52 0.06-1.89	2	3.00	0.67 0.08-2.40
Bladder and urinary tract	9	4.79	1.88 0.86-3.56	6	3.76	1.60 0.59-3.47
Brain, central nervous system	2	2.82	0.71 0.09-2.56	2	2.87	0.87 0.12-3.49
Thyroid gland	2	0.99	2.01 0.24-7.26	2	0.72	2.78 0.34-10.0
Non-Hodgkin lymphoma	3	4.44	0.68 0.14-1.97	3	3.42	0.88 0.19-2.56

Observed and expected numbers of cancer cases among male workers at the Kokkola cobalt plant during 1969-2013

The overall cancer incidence was not increased

	Employment > 1 year				Employment > 5 years			
	Obs	Exp	SIR	95%CI	Obs	Exp	SIR	95%CI
All sites	92	91.9	1.00	0.81-1.22	77	71.6	1.08	0.85-1.34

The lung cancer risk seemed to be decreased

	Employment > 1 year				Employment > 5 years			
	Obs	Exp	SIR	95%CI	Obs	Exp	SIR	95%CI
Lung, trachea	6	12.0	0.50	0.18-1.08	5	9.55	0.52	0.17-1.22

Only the incidence of tongue cancer was significantly increased

	Employment > 1 year				Employment > 5 years			
	Obs	Exp	SIR	95%CI	Obs	Exp	SIR	95%CI
Tongue	3	0.41	7.39	1.52-21.6	3	0.30	10.0	2.06-29.2

Observed (Obs) numbers of cancer cases were not related to the exposure groups

Exposure group	All sites				Lung, trachea				Tongue				Larynx, epiglottis				Bladder			
	Obs	Exp	SIR	95%CI	Obs	Exp	SIR	95%CI	Obs	Exp	SIR	95%CI	Obs	Exp	SIR	95%CI	Obs	Exp	SIR	95%CI
Variable	7	5.02	1.39	0.56-2.87	-	0.55	0.00	0.00-6.68	1	0.04	26.4	0.67-14.0	-	0.05	0.00	0.00-77.9	-	0.25	0.00	0.00-15.0
Low	42	37.8	1.11	0.80-1.50	2	4.89	0.41	0.05-1.47	1	0.15	6.48	0.16-36.1	-	0.33	0.00	0.00-11.2	6	1.96	3.07	1.12-6.67
Medium	4	6.02	0.66	0.18-1.70	-	0.66	0.00	0.00-5.56	-	0.06	0.00	0.00-0.00	-	0.05	0.00	0.00-67.1	-	0.30	0.00	0.00-12.2
High	39	43.6	0.90	0.64-1.22	4	5.95	0.67	0.18-1.72	1	0.16	6.12	0.15-34.1	2	0.39	5.15	0.62-18.6	3	2.32	1.30	0.27-3.78
Total	92	91.9	1.00	0.81-1.22	6	12.0	0.50	0.18-1.08	3	0.41	7.39	1.52-21.6	2	0.81	2.45	0.30-8.86	9	4.79	1.88	0.86-3.56

Discussion (1)

- The reference group was the population of Central Ostrobothnia, Finland, which is located around the cobalt plant.
- Cobalt exposure had been monitored with exceptional accuracy from the early days of the studied plant.
- The working history of the patients was verified from the registers which minimizes the recall and information bias.
- This was not the case in the previous epidemiological studies where exposure levels of cobalt were not reported neither the simultaneous co-exposures (Mur et al. 1987).

Discussion (2)

- In the previous epidemiological studies on the carcinogenicity of cobalt the standardised mortality ratio (SMR) was used as a measure of cancer risk
- As majority of cancer patients die from non-cancer causes of death, the SIR is a more sensitive way to analyze the effects of cobalt than SMR.
- Registration of cancer in Finland and other Nordic countries is on a high level (Engholm et al. 2010).
- When it comes to cancer incidence in other countries, or cancer mortality statistics in any country, the possibility of incomplete registration and inaccurate disease classification increases.

Discussion (3)

- The increase of tongue cancer was unexpected.
- There are no previous data either from animal or human studies that could support the association of cobalt and tongue cancer.
- According to the literature, the most remarkable risk factors for oral cancer are smoking and alcohol consumption (Bagnardi et al. 2001; Weikert et al. 2009; Schütze et al. 2011).
- In addition, HPV infections (Syrjänen et al. 2011) have been shown to increase the risk of oral cancer.
- All three cases of tongue cancer in our cohort were smokers.

Conclusions

- The results suggest that occupational exposure to cobalt is not associated with an increased overall cancer risk or lung cancer risk among cobalt workers.
- Unexpectedly we found a significant increase in the incidence of tongue cancer.
- There are no previous data from either animal or human studies to support an association between cobalt and tongue cancer.
- Because of the small number of cancer cases the results must be interpreted with caution.

THANK YOU FOR YOUR ATTENTION!

Read more:
Sauni R, Oksa P, Uitti J, Linna A, Kerttula R, Pukkala E. Cancer incidence among Finnish male cobalt production workers in 1969-2013: a cohort study. BMC Cancer (2017) 17:340
