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A mortality historical cohort study in the Verona repair workshop of Italian Railways [1]

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INTRODUCTION

Italian Railways run a number of specialized repair workshops for locomotives, where workers may be exposed to asbestos and other noxious materials (Commissione di studio per i problemi relativi alle OGR di Foligno, 1982). Thus, monitoring long-term effects is relevant. A previous study (Magnani *et al.*, 1986) described the mortality experience among workers of the repair workshop of Foligno, where electrical locomotives have been repaired. The present report describes a parallel epidemiological study among workers of the repair workshop of Verona. In this workshop, steam locomotives have been repaired for several decades, until 1976. Repair of electrical locomotives started in 1969 and is still undertaken at present.

MATERIAL AND METHODS

The cohort includes 1248 males who were active in the Verona workshop on January 1, 1967 and 1380 hired subsequently, up to December 31, 1980. The management of the workshop provided us with a nominal list of members of the cohort, including town of residence and dates (day, month, year) of: *a*) birth; *b*) hiring by Italian Railways; *c*) starting work in the Verona workshop, and *d*) (where applicable) retiring, quitting work with Italian Railways for other reasons or transfer to other plants of Italian Railways.

Living status on April 1, 1984 of members of the cohort who had stopped employment at Italian Railways before that date was assessed through the registrars of the towns of residence. For each subject, the latter were asked to certify that he was either alive and resident, or had died (indicating date of death and causes as reported in the death certificate) or had moved to another town (in the latter case, the same request was addressed to the registrar of the town of immigration). For a small number of ex-workers who could not be traced through this procedure, living status was provided by the Intercompartmental

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Medical Center of Italian Railways, on the basis of their individual records.

The expected number of deaths (total and some specific causes) was estimated on the basis of quinquennial age-specific mortality rates among male residents in the province of Verona during 1969-81 (Rapporti ISS, 1981; Capocaccia and Scipione, 1984).

Initial causes of death were coded by two of us (C.M. and B.T.) according to the 8th Revision of the International Classification of Diseases (Classificazione delle malattie e cause di morte, 1972).

The numbers of person-years observation and of expected deaths, as well as the Standardized Mortality Ratios (SMR) were estimated with modification of Hill's programme (1972). Ninety-five per cent confidence intervals (CI) were estimated on the basis of a Poisson distribution of events.

No information on asbestos (or other material) atmospheric concentration in the workplace was available. Documents provided by Italian Railways indicate that boilers of steam locomotives had not been insulated up to 1950 and that, subsequently, they were insulated with glassfibers by subcontracted firms. According to the same source, the boilers contained steam pipes covered with asbestos and asbestos gaskets.

RESULTS

Living status could be established for all members of the cohort. At the end of follow-up, 2313 (88%) men were alive and 315 (12%) had died.

Table 1 reports the number of person-years observation by age class and period of hiring. Observed and expected number of deaths from main causes are given in Table 2. For no SMR the lowest limit of the confidence interval is greater than 100. Among «Other cancers of the G.I. tract», 7 were pancreatic (vs. 4.0 expected) and 6 death certificates indicated primary liver cancer as the initial cause of death (vs. 3.4 expected). Cancer sites for which 5 or less deaths were reported, are listed in Table 3.

Table 4 compares death experience among workers hired by Italian Railways before and after age 40. For both total number of deaths and specific causes, SMRs were consistently higher among men hired after aged 40. Observed and expected deaths from all causes, respiratory (lung, pleura and larynx) cancers and cardiovascular diseases, broken down both by age at hiring by Italian Railways and by length of follow-up are given in Table 5. In both groups of age at hiring, a healthy worker effect is obvious, but within each class of length of follow-up, SMRs for total deaths are higher among those hired after age 40. The correlation between length of follow-up and SMRs for respiratory cancer and cardiovascular diseases is less clearcut.

Length of working period in the Verona repair shop was analyzed only among workers hired before age 40. In order to detect, if any, an effect of repairing steam locomotives, analyses were carried out considering as «exposure» either any calendar period of work in the plant, or exclusively periods before 1969. No trend related to the length of working period in the shop was observed in either analysis. SMRs based on working periods up to 1969 are reported in Table 6.

Two deaths were certified as caused by cancer of the pleura, vs. 1.0 expected for ICD-VIII 163, i.e., the total of cancer of the pleura and mediastinum (SMR 210, 95% CI 25.4-758.5). A search for occupational histories and clinical information revealed that the diagnosis was histologically confirmed for one of the two men. He was born in 1924, had been working in the workshop as a coppersmith

Table 1

DISTRIBUTION OF PERSON-YEARS AT RISK BY AGE CLASS

Ages	Total
15-19	12.24
20-24	1,226.40
25-29	3,588.16
30-34	4,317.21
35-39	3,047.52
40-44	3,148.76
45-49	4,122.14
50-54	4,635.97
55-59	4,545.35
60-64	2,811.92
65-69	1,549.04
70-74	522.58
75-79	48.07
80-84	0.00
≥85	0.00
Total	33,575.35

Table 2

OBSERVED AND EXPECTED NUMBERS OF DEATHS FROM MAIN CAUSES. SMRS AND 95% CONFIDENCE INTERVALS

Causes of death		YEAR START WORK IN VERONA WORKSHOP								
		≤1969			≥1970			Total		
	ICD-VIII	Obs	Exp	SMRs (Conf. Int. 95%)	Obs	Exp	SMRs (Conf. Int. 95%)	Obs	Exp	SMRs (Conf. Int. 95%)
All deaths	0-999	284	306.4	92.7 (82.2-104.1)	16	27.4	58.5 (33.4-94.9)	300	333.7	89.9 (80.0-100.7)
All cancers	140-209	105	94.0	111.7 (91.3-135.2)	2	6.2	32.1 (3.9-115.9)	107	100.3	106.7 (84.5-129.0)
Cancer of the stomach	151	8	8.8	90.9 (39.3-179.1)	0	0.4	–	8	9.2	86.9 (37.5-171.3)
Cancer of the gross intestine	153-154	11	7.1	154.7 (77.0-276.8)	0	0.4	–	11	7.5	146.1 (72.9-261.3)
Other cancers of the digestive tract	150,152, 155-159	17	12.5	136.0 (79.3-217.6)	0	0.8	–	17	13.3	127.8 (74.5-204.5)
Cancer of the larynx	161	9	5.8	159.9 (73.1-303.6)	0	0.3	–	9	5.9	152.2 (69.6-288.9)
Cancer of the lung	162	27	30.4	88.9 (58.6-129.3)	0	1.6	–	27	32.0	84.4 (55.6-122.8)
Cancer of the kidney	189	6	2.2	271.0 (99.5-589.9)	0	0.1	–	6	2.3	257.7 (94.6-560.9)
Leukaemias	204-207	6	2.9	209.6 (76.9-456.2)	0	0.5	–	6	3.4	177.0 (65.0-385.3)
Cardiovascular diseases	390-458	113	117.5	96.2 (79.3-115.6)	6	7.0	85.7 (31.5-186.6)	119	124.5	95.6 (79.2-114.4)
Respiratory diseases	460-519	13	17.0	76.6 (40.8-130.9)	0	0.8	–	13	17.8	73.0 (38.9-124.8)
Liver cirrhosis	571	21	23.3	90.2 (55.8-137.9)	1	2.0	50.2 (1.3-279.7)	22	25.3	87.0 (54.6-131.8)
Violent deaths	800-999	12	24.5	49.1 (25.4-85.7)	7	8.3	84.3 (33.9-173.7)	19	32.8	58.0 (34.9-90.6)

repairing steam boilers during 1956-76, as a mechanical engineer for three more years and died in 1983. The other man, born in 1916, had worked as a technician (foreman) between 1949 and 1967 and died in 1982.

All 6 workers dying from cancer of the kidney had been hired before age 40, before 1969 and had worked at least 20 years in the shop. Of the 6 leukaemias certified as cause of death, 2 were not further specified while 1, 1 and 2 were specified respectively as chronic lymphatic, acute myeloid and chronic leukaemia.

Table 3
NUMBERS OF DEATHS FROM CANCER AT SITES WHERE LESS THAN 5 CASES HAVE BEEN OBSERVED

Cancer site	ICD-VIII	Cases
Oral/oropharyngeal	(140)	1
Pharynx	(146-147)	3
Esophagus	(150)	4
Soft tissue sarcomas	(171)	2
Skin melanoma	(172)	1
Prostate	(185)	2
Bladder	(188)	3
Brain	(191)	2
Lymphomas	(200-202)	3
Myelofibrosis	(209)	1
Ill-defined sites	(195,199)	3

DISCUSSION

Information on exposure to asbestos by the workers included in the cohort is very scanty. Italian Railways have reported that, in steam locomotives, boilers were not insulated until 1950 and later with glassfiber mattresses. Asbestos was used for insulating pipes and for gaskets. In the seventies, in the Foligno workshop (Magnani *et al.*, 1986), atmospheric asbestos concentration ranged between 0 and 1.2 ff/ml in the area where electrical materials were repaired but there were peaks up to 43 ff/ml in the area where asbestos-insulated plates were cut. It can be argued that the cohort described in the present study had been less exposed to asbestos than cohorts described in studies carried out in the US and in Sweden (Mancuso, 1983; Ohlson, Klaesson and Hogstedt, 1984). Nothing can be inferred on exposure to oils, solvent and soot. Finally, no information was available on individual smoking habits.

Thus, findings of the present study are

Table 4
OBSERVED AND EXPECTED NUMBERS OF DEATHS FROM MAIN CAUSES. SMRS AND 95% CI BY AGE AT HIRING IN THE VERONA WORKSHOP

Causes of death	AGE AT HIRING					
	≤40			>40		
	Obs	Exp.	SMRs (Conf. Int. 95%)	Obs	Exp.	SMRs (Conf. Int. 95%)
All deaths	258	299.1	86.2 (76.0-97.4)	42	34.6	121.4 (87.5-164.0)
All cancers	91	89.7	101.4 (81.7-124.5)	16	10.5	151.9 (86.8-246.7)
Respiratory cancers	30	35.0	85.8 (57.9-122.5)	8	4.0	200.2 (86.4-394.5)
Cardiovascular diseases	103	110.5	93.2 (76.1-113.1)	16	14.0	114.0 (65.1-185.1)
Respiratory diseases	10	15.6	64.1 (30.7-118.9)	3	2.2	135.7 (28.0-396.4)
Cirrhosis	18	22.9	78.5 (46.5-124.0)	4	2.3	171.1 (46.6-438.0)
Violent deaths	17	30.7	55.4 (32.3-88.7)	2	2.1	97.3 (11.8-351.6)

Table 5
OBSERVED AND EXPECTED NUMBERS OF DEATHS FROM MAIN CAUSES. SMRS AND 95% CI BY LENGTH OF FOLLOW-UP AND AGE AT HIRING IN THE VERONA WORKSHOP

Causes of death	Age at hiring	LENGTH OF FOLLOW-UP (YEARS)											
		0-9			10-19			20-29			≥30		
		Obs	Exp	SMRs	Obs	Exp	SMRs	Obs	Exp	SMRs	Obs	Exp	SMRs
All deaths	≤40	17	27.8	61.2 (35.6-97.8)	21	27.7	75.8 (46.9-115.8)	63	72.6	86.8 (66.7-111.0)	157	171.0	91.8 (78.0-107.3)
	>40	7	9.1	76.9 (30.9-158.5)	24	18.1	132.4 (84.8-197.0)	11	7.4	149.6 (74.7-267.8)	–	–	–
Respiratory cancers	≤40	0	1.8	–	2	3.1	63.9 (7.7-230.8)	9	8.8	102.4 (46.8-194.4)	19	21.3	89.3 (53.8-139.4)
	>40	1	1.1	90.9 (2.3-506.4)	6	2.1	286.8 (105.2-624.2)	1	0.8	–	–	–	–
Cardiovascular diseases	≤40	4	6.6	60.6 (16.6-155.2)	11	9.1	121.4 (60.6-217.1)	31	25.4	122.2 (83.0-173.4)	57	69.4	82.1 (62.2-106.4)
	>40	4	3.3	121.2 (33.1-310.3)	7	7.5	93.9 (37.8-193.5)	5	3.3	152.9 (46.7-356.9)	–	–	–

Table 6
OBSERVED AND EXPECTED NUMBERS OF DEATHS FROM MAIN CAUSES. SMRS AND 95% CI BY LENGTH OF WORKING PERIOD IN THE VERONA WORKSHOP (TRUNCATED AT DECEMBER 31, 1969)

Causes of death	LENGTH OF WORKING PERIOD IN VERONA WORKSHOP														
	0-4			5-9			10-19			20-29			≥30		
	Obs	Exp	SMRs	Obs	Exp	SMRs	Obs	Exp	SMRs	Obs	Exp	SMRs	Obs	Exp	SMRs
All deaths	6	14.0	42.8 (15.7-93.2)	9	9.8	91.9 (42.0-174.5)	30	28.6	104.7 (70.7-149.5)	177	192.7	91.8 (78.8-106.4)	21	29.9	70.3 (43.6-107.5)
All cancers	2	3.8	52.6 (6.4-189.9)	4	3.1	129.6 (35.3-331.7)	13	9.0	142.7 (76.5-245.7)	82	59.8	103.8 (79.5-133.0)	8	8.9	90.2 (38.9-177.7)
Respiratory cancers	0	1.4	–	3	1.3	237.4 (49.0-693.8)	5	3.7	133.8 (43.4-312.2)	18	23.8	75.7 (44.8-119.6)	4	3.3	122.2 (33.3-312.8)

mainly descriptive. The low SMRs among workers hired after 1970 are likely to reflect a healthy worker effect (McMichael, 1976) rather than a change in environmental exposures. The statistically significant low SMR for violent deaths is consistent with previous findings among other groups of workers of Italian Railways (Menotti and Puddu, 1976; Magnani *et al.*, 1986).

Mortality experience among workers hired at age >40, albeit based on small numbers, is interesting. A lower than expected total number of deaths was limited to the first ten years of follow-up while it was observed in the whole period of follow-up for workers hired before age 40. It can be argued that for this subcohort, selective phenomena underlying the healthy worker effect had been either relatively weak and/or operating before hiring by Italian Railways. Among these men, 108/119

were hired in 4 calendar years (57 in 1960, 25 in 1965, 10 in 1972 and 16 in 1974): this unusual distribution suggests some administrative reasons for these hirings, and the possibility that they had been previously working in the same shop as workers of firms subcontracted by Italian Railways cannot be ruled out. This subcohort also experienced an excess mortality from lung cancer, the interpretation of which is uncertain, due to borderline statistical significance and lack of information on smoking habits. Finally, there was no low SMR for violent deaths among workers hired after age 40, but this was based on very small numbers.

In the whole cohort, an excess of deaths from renal cancer of borderline significance was found. The interest of this observation relies on previous suggestions that renal cancer may be associated with coke production (IARC, 1987). It can be hypothesized that repair of steam locomotives might have entailed exposure to products formed during incomplete combustion of coke. In the Foligno workshop, where only electrical locomotives had been repaired, there was no excess of renal cancer (Magnani *et al.*, 1986).

Two deaths certified as caused by pleural cancer were identified, one of which was histologically confirmed. Dying or incident cases of pleural cancer, with or without histological confirmation, have been reported also from other repair workshops of Italian Railways: i.e. 1 in Foligno (Magnani *et al.*, 1986), 1 in Florence (Paci and Seniori Costantini, 1987), 1 in Torino (AA.VV., 1985), 8 in Bologna (Maltoni *et al.*, 1986; Perino *et al.*, 1987; Maltoni *et al.*, 1988) and 1 in Rimini (Maltoni *et al.*, 1986). With the exception of the workshop in Foligno (where the only reported case was exclusively identified on the death certificate), these workshops also repaired passenger coaches, and this might have entailed higher exposures to asbestos. The need for unraveling associations of pleural cancer among workers of Italian Railways with past environmental exposures in the workplace is obvious.

SUMMARY

A historical prospective study was carried out on the mortality experience of a cohort of 2628 male workers employed in the Verona repair workshop of Italian Railways, either at work on January 1, 1967 (1248 men) or hired subsequently (1380 men). The main activity in the plant was locomotive repair (exclusively steam locomotives up to 1969, both steam and electric locomotives during 1969-75 and exclusively the latter thereafter). Activities carried out in the plant entailed some exposure to asbestos, but no data were available on environmental exposure.

Follow-up ended in 1984, for a total of 33575 men-year observation. Mortality rates in the male population of the province of Verona in 1969-81 were used as reference population for estimating SMRs.

Deaths from lung cancer were 27 vs. 30.4 expected. Two deaths were certified as caused by pleural cancer vs. 1.0 expected for the total of pleural and mediastinal cancer. There were 6 deaths from renal cancer and 6 from leukaemias vs. respectively 2.2 and 3.4 expected. The SMR for death from violent causes was 58, based on 19 cases observed.

Within each class of length of follow-up, SMRs for all deaths among workers hired by Italian Railways after age 40 were higher than among other workers. In the same subgroup, deaths from respiratory cancer were 8 vs. 4.0 expected.

RIASSUNTO

Viene descritto uno studio prospettico storico di mortalità in una coorte di 2628 uomini, dipendenti dell'Officina Grandi Riparazioni (OGR) di Verona delle Ferrovie dello Stato, in pianta nel 1967 (1248) o assunti successivamente (1380). La OGR ha riparato solo locomotive a vapore fino al 1969, a vapore ed elettriche nel 1969-75 e solo elettriche successivamente. L'attività comportava esposizione ad amianto, ma non erano disponibili risultati di determinazioni ambientali.

La coorte è stata seguita fino al 1984 per un totale di 33575 anni uomo di osservazione. I Rapporti Standardizzati di Mortalità (RSM) sono stati stimati in riferimento ai tassi di mortalità nella popolazione maschile della provincia di Verona nel 1969-81.

I morti per cancro polmonare sono stati 27 (atteso 30,4). Due morti erano certificate come causate da tumore maligno della pleura (contro 1,0 atteso per l'insieme dei tumori maligni della pleura e del mediastino). Le morti per tumore renale sono state 6 e altrettante quelle per leucemia, contro rispettivamente 2,2 e 3,4 attese. Il RSM per cause violente era 58, basato su 19 casi osservati.

All'interno di ogni classe di durata del follow-up, i RSM per tutte le cause erano più bassi tra i lavoratori assunti dalle Ferrovie dello Stato prima di 40 anni di età che tra quelli assunti successivamente nel corso della loro vita. Tra questi ultimi, sono state osservate 8 morti per tumore maligno delle vie respiratorie contro 4.0 attese.

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