A Follow-up Study of a Ten-Percent Sample of the Canadian Labor Force. I. Cancer Mortality in Males, 1965–73[1,2]

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ABSTRACT—A system is described for monitoring the mortality experience of an approximately 10% sample of the Canadian Labor Force with the use of computerized record linkage to the Canadian mortality data base. Results are presented for the 4,203 cancer deaths that occurred between 1965 and 1973 in 415,201 males with known occupational histories from 1965 to 1969. A number of previously suggested associations between certain occupations and cancers have been confirmed in these results, and a number of new associations also have been observed. The system provides a powerful tool for both generating and testing hypotheses, and this power will increase as further mortality experience is accumulated by the cohort.—JNCI 1983; 70:37–44.

Many associations between certain occupations and increased risk of various cancers have been reported (*1*). Estimates of the percentage of cancer attributable to occupational exposure have ranged as high as 40% (*2*), though this figure is a matter of some dispute *(3)*. Most of the known occupation–cancer associations initially developed from anecdotal observations, and little work has been done in the area of systematic monitoring of large samples of the labor force to detect new possible associations.

There are two major problems in attempting to establish such a monitoring system: 1) the cost of assembling a sufficiently large cohort of individuals with known occupational history and 2) the difficulty and cost in following such a cohort for a sufficient period of time to obtain data on a large enough number of cancer cases or deaths. The closest approach to such a system is that of the U.K. Registrar General who issues a decennial supplement *(4)*. Associations between occupation and cancer or other causes of death are estimated as follows: The number of deaths reported by occupation as recorded on the death certificate is used as the numerator, and the estimated number of individuals working in that occupation during the time in question is used as the denominator. This method, of course, has a drawback. Because of the time lag involved, the observed deaths are not necessarily occurring in the working population that constitutes the denominator.

This paper reports the establishment of a monitoring system based on individuals (forming an ≈10% sample of the Canadian labor force) for whom occupational histories between 1965 and 1971 are available. Computerized record linkage *(5)* is being used in conjunction with the Canadian mortality data base maintained by Statistics Canada (formerly Dominion Bureau of Statistics) to determine the mortality experience of the cohort. Initial findings of the study are reported for cancer mortality occurring in male members of the cohort between 1965 and 1973. The plan is to continue mortality monitoring in the future, and the system should thus provide a very powerful tool for both generating and testing hypotheses concerning associations between occupation and cancer risk.

MATERIALS AND METHODS

Occupational histories.—Between 1965 and 1968, the Canadian UIC collected data from all employers in Canada for all employees whose SI number ended in the digit 4. The data consisted of the individual's SI number, surname, sex, year of birth, and occupation and industry in which the individual was currently employed. For 1969 and 1971, only those persons whose SI number terminated in the digit 4 preceded by an odd-numbered digit were included in the sample. The data for 1970 were not available for the purposes of the present study. The occupations were coded with the use of the three-digit 1961 Canadian census occupation codes (6) for the data from 1965 to 1969 and the four-digit 1971 Canadian census codes *(7)* for the 1971 occupations. Industries were coded with the use of corresponding versions of the 1961 and 1971 three-digit Canadian census industry codes (8, 9). The data were converted to machine-readable form and were originally used to examine employment patterns in Canada (*10*) and thus originally were not intended for use in epidemiologic research.

The file of approximately 3 million records was sorted by SI number to bring together records referring to the same individual, thereby forming composite occupational histories. Records that had the same SI number but differed in surname, sex, or year of birth were inspected, and as a consequence less than 0.1% of the records were sufficiently discrepant to indicate that they referred to different individuals. The discrepant records were dropped from the file, leaving 700,335 individuals. To obtain further identifying information for the purposes of record linkage, a list of the SI numbers was given to the Canadian UIC, the agency responsible for the issuing of SI numbers. The UIC added identifying data for all members of the cohort, so that the items available for linkage were surname: first and second given names; sex; day, month, and year of birth: mother's

Abbreviations used: ICD=International Classification of Diseases: ICD-7=7th revision of ICD: ICD-8=8th revision of ICD: SI=social insurance; SMR=standard mortality ratio(s): UIC=Unemployment Insurance Commission.

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maiden name; and most recent province in which the individual worked.[6]

Mortality fillow-up.—Statistics Canada maintains a mortality data base that contains records for all deaths registered in Canada since 1950 (*11*). These data are supplied to Statistics Canada by the vital statistics registrars in the various provinces and territories. The data also include the deaths of Canadian residents that occurred in the United States, which probably account for most of the extraterritorial deaths, To determine the mortality of the occupational cohort, records from the cohort were linked to the mortality data base for the years 1965–73 (the latest years for which data were available at the time the linkage was performed). .Methods for the computerized linkage of records on the basis of such identifying characteristics as surname and date of birth originally were developed in Canada by Newcombe (*12*) and his associates. These methods were developed further by Howe and Lindsay (5) to form a generalized iterative record linkage system. which is now being used routinely by Statistics Canada for a number of medical follow-up studies *(13)*.

Record linkage involves the comparison of all records in one file (the occupational cohort) with all records in another file (the mortality data base) and the calculation of a score (weight) that is a measure of the relative probability that two records, one from each file, refer to the same person. The weights are calculated by comparison of the individual identifying items, such as given names, surname, or day, month, and year of birth, and assignment of a positive or negative component to the weight depending on whether the items in question agree, partially agree, or disagree. The components of the weight are based on the relative frequency of the value of the identifying item and on an estimate of how frequently the item in question is misrecorded. The methods and computer system that were used have been described in detail (5).When a match occurred between a member of the cohort and a death record, the date and cause of death [coded to the appropriate revision of the ICD (*14, 15*)] were abstracted from the death record and added to the occupational information for that individual.

The data for analysis, therefore, consisted of records for 415,201 males who entered the cohort between 1965 and 1969. Those who entered in 1971 (42,135) were excluded because the 1961 and 1971 census occupation codes are not readily compatible. Thus 1971 occupations were not considered in the present analysis. Females also were excluded because of the relatively small number of deaths that occurred during the period in question. A more meaningful analysis of the data for females will be possible when further years of mortality data are available.

Statistical *analysis.*—SMR were computed for various subgroups of the cohort (as defined below) for all causes of death combined, for all cancer deaths, and for deaths according to 19 cancer categories (table 1). Expected numbers of deaths were calculated by application of the age-specific rate for the particular cause of death for the reference group to the person-years of observation of the exposed group for 15 age categories (0–19, 20–24, . . . 80–84, ≥85). The SMR for a particular cause of death and for a particular exposure group was then calculated in the usual way as the ratio of the observed number of deaths in the group to the expected number. It was not necessary to control for calendar year of observation inasmuch as mortality rates were stable during the time period under study. A member of the cohort was defined as entering the study (i.e., contributing person-years of observation) at the midpoint of the year in which occupational information was first recorded for him and exiting the study either in the year of death or at the end of 1973 if still alive.

SMR were computed with respect both to Canadian population death rates (*16*) and to death rates for the occupational cohort as a whole. Because Canadian population death rates reflect the expected "healthy worker" effect (*17*) (*see* below), and because it is preferable when mortality data are ascertained by record linkage that both the group of interest and the referent group have their mortality determined by record linkage (*18*), the SMRs presented are generally those with respect to the entire cohort. Tests of significance and interval estimation were performed by treatment of the observed number of deaths as a Poisson variable and with the use of standard techniques based on the Poisson distribution. In interpreting the statistical significance of the results presented, however, the problems of confounding the multiple comparisons must be taken into account, as discussed subsequently.

RESULTS

Table 1 shows (in terms of ICD codes) the various cancer causes of death considered and the number of deaths ascribed to those causes that occurred in the cohort. Table 2 gives results of comparison of the mortality experience of the entire cohort with that expected from comparison with Canadian population rates. The mortality rate for the cohort from all causes combined is approximately 20% lower than that occurring in the general population, the size of the reduction being very similar to that reported in other general occupational cohorts and presumably accounted for by the healthy worker effect. The death rates from all cancers and for lung and bladder cancers (two sites that have a number of postulated occupational associations) are not reduced to the same extent from the population rates. This finding indicates a larger (age-adjusted) proportion of deaths due to lung and bladder diseases in the cohort as compared to the number of deaths from these causes in the general population—again a not unexpected result.

To do asystematic examination of the data, it is necessary, of course, to define the "exposure" groups. A number of options are available since for each individual in the cohort potentially 10 variables are available that define the occupational history, i.e., the occupation and industry codes for up to 5 years. For this study, an individual was categorized as exposed to a particular occupation or industry if he had been recorded as being employed in that occupation

[6] All data processing involving individual records containing identifying data was done in Statistics Canada under the auspices of the Canadian Federal Statistics Act. Analyses were performed after the identifying information had been removed from the records. thus preserving the privacy of individuals in the rcudv.

TABLE 1.—*Number of cancer deaths, by site, in* cohort, *1965–73*

Cancer site	ICD-7 code[a]	ICD-8 code[b]	No. of deaths
ac. _, bronchus, and lung	162–163	162	1,336
)mach	151	151	408
estine except rectum	152–153	152–153	359
ıcreas	157	157	253
ner neoplasms of lymphatic ınd hematopoietictissue	200-205	200-203	245
)state gland	177	185	207
ıdder plus other *urinary*)rgans[c]	181	188–189	194
:tum and rectosigmoid unction	154	154	162
ıkemia and aleukemia	204	204–207	154
ecal cavity and pharynx xcept lip	141–148	141–149	138
!in	193.0	191–192.0	128
)phagus	150	150	87
er	155	155–156	81
ynx	161	161	56
n	190–191	172–173	52
ne	196	170	30
	140	140	7
east	170	174	3
ıer and unspecified sites			303
Total	140–205	140–209	4.203

[a] ICD-7 code applies to deaths that occurred from 1965 *to* 1968.
[b] ICD-8 code applies to deaths that occurred from 1969 to 1973.
[c] In subsequent tables, bladder cancers (ICD-7 code 181.0 and ICD-de 188) and other *urinary* organ cancers are listed both separately combined.

ustry for at least 1 year between 1965 and 1969; thus he ·b cluded in more than one exposure group. Analysis) w _ade of the data for individuals who to be listed as osed had to have 2, 3, 4, or 5 years of recorded employ-ıt in the particular occupation or industry. Analyses of records for these individuals inevitably yielded smaller ıbers for the various exposure groups, but the results ıined were essentially similar to those reported here. ıough in many cases a degree of overlap exists between ıain occupations and industries, for the present analyses ıpation and industry were examined independently.

able 3 shows the SMR for the 13 major occupational sions into which the 1961 census codes are grouped (*6*), ıll causes of death combined, for all cancers, and for the ·ading individual cancer causes of death. Bladder cancer other urinary tract cancers are listed both separately combined. Table 4 gives the corresponding data for the najor industry divisions. Tables 5 and 6 show results ·ing to individual three-digit occupation and industry ·s. An association was included when the SMR was ated. with at least five observed deaths and the nominal ificance level was ≤0.05 (one-sided).

CUSSION

)ur primary purpose in preparing the present paper was eport on the establishment of the monitoring system. refore, extensive results and comparisons with results ı other similar monitoring systems are not presented .in ·uch as such data will be more meaningful when ·r ı. .bers of deaths are available for analysis.

Inevitably, limitations become apparent in performing the type of monitoring exercise described in this paper: 1) We had to assume that among individuals employed in a particular occupation or industry there would be those who had been in that occupation or industry, or a similar one, for a number of years. This assumption was necessary primarily because of the latent period effect, since the present data related to mortality occurring within at most 8 years of the first recorded exposure to a particular occupation or industry. Also, a minimum number of years of exposure may be necessary for a person to be at increased risk. although numerous studies indicate that for many occupation–cancer associations the minimum period of exposure necessary is very small (*1*). Inclusion in an exposure group of individuals who had not achieved any necessary latent period or minimum time of exposure would, of course, lead to a misclassification bias. Such bias would lead to an underestimation of risk, and the estimate thus would be conservative. *2)* Lack of data concerning possible confounders as smoking or socioeconomic factors makes it impossible to distinguish indirect from direct associations. 3) With 274 different occupation codes, 274 industry codes. and 19 different cancer causes of death, a problem with multiple comparisons inevitably arises, in the sense that at least 1 in 20 of the associations recorded (tables 5, 6) may be due to chance.

Because of the limited number of years of death records available for study and the low mortality of the cohort as a whole, several established occupation–cancer associations are not yet apparent for this cohort. However, some significantly high SMR correspond with findings in other occupational studies: High mortality due to cancer of the brain in occupation division 2 (professional and technical occupations: table 3) corresponds with the findings of the 1971 U.K. occupational mortality decennial supplement *(4)*. In occupation division 5 (service and recreation occupations), an elevated SMR for cancer of the buccal cavity and pharynx except lip is similar to the U.K. cancer registrations data, which show high rates of tongue and mouth cancer *(4)*. Industry division 10 (community, business, and personal service industries: table 4) also has a high rate of cancer of the buccal cavity and pharynx except lip. reflecting the fact that many of the same individuals had jobs classified in occupation division 5 (table 3). In addition. two separate occupations in division 5, bartenders and waiters (table 5), show elevated SMR for buccal cavity and pharynx except lip.

Both the data presented here and the U.K. data *(4)* show high mortality from all cancers in transport and communi-

TABLE 2.—SMR *for various causes of death in males in cohort, 1965–73*

Cause of death	No. of deaths		SMR[a]	90% confidence interval
	Observed	Expected		
All causes	19,374	23,399	0.83	0.82–0.84
All cancers	4,315	4,881	0.68	0.86–0.90
Lung cancer	1,370	1,443	0.95	0.91–0.99
Bladder cancer	124	139	0.89	0.76–1.03

[a] Computed with reference to Canadian population rates, 1965–73.

TABLE 3.—*SMR and number of observed deaths for males, by occupation division*

Occupation division		SMR[a,b] and observed deaths (No.) for:															
				Specific cancer site													
No.	Type	All causes	All malignant neoplasms	Trachea, bronchus, and lung	Stomach	Intestine except rectum	Pancreas	Other neoplasms of lymphatic and hematopoietic tissue	Prostate gland	Bladder and other urinary organs	Bladder	Other urinary organs	Rectum and rectosigmoid junction	Leukemia and aleukemia	Buccal cavity and pharynx except lip	Brain	Esophagus
1	Managerial	0.81***	0.87*	0.75*	0.86	0.90	0.73	0.77	1.26	1.76*	1.70	1.86	0.94	0.69	0.70	0.65	1.52
		(888)	(218)	(60)	(21)	(19)	(11)	(11)	(14)	(20)	(12)	(8)	(9)	(6)	(6)	(5)	(6)
2	Professional and technical	0.82***	1.00	0.66*	1.21	1.00	1.36	1.37	1.31	0.50	0.54	0.44	1.15	0.94	1.12	1.95*	1.46
		(580)	(141)	(28)	(16)	(12)	(11)	(13)	(8)	(3)	(2)	(1)	(6)	(6)	(5)	(10)	(4)
3	Clerical	0.99	1.03	1.02	0.69*	1.25	0.85	1.24	1.17	1.38*	1.18	1.73*	0.95	1.01	1.67**	0.77	0.75
		(2,330)	(529)	(163)	(34)	(55)	(26)	(38)	(32)	(33)	(18)	(15)	(19)	(20)	(27)	(12)	(8)
4	Sales	0.95*	0.98	0.81*	0.70	1.41*	0.96	1.14	1.58*	1.34	1.38	1.28	1.30	0.51*	1.10	1.16	1.39
		(1,292)	(277)	(71)	(19)	(34)	(16)	(20)	(21)	(17)	(11)	(6)	(14)	(6)	(10)	(11)	(8)
5	Service and recreation	1.06***	1.02	1.10	1.11	0.88	0.94	0.91	1.05	0.98	1.01	0.93	0.79	0.95	1.66**	0.73	0.95
		(3,254)	(749)	(254)	(81)	(58)	(43)	(36)	(53)	(37)	(25)	(12)	(24)	(23)	(36)	(12)	(15)
6	Transport and communication	1.04*	1.12*	1.06	1.10	1.26	0.60*	1.03	1.09	1.42	1.25	1.69	1.46	1.68**	0.90	1.01	1.53
		(2,059)	(473)	(143)	(45)	(45)	(15)	(27)	(18)	(26)	(14)	(12)	(23)	(28)	(13)	(15)	(13)
7	Farmers and farm workers	0.88**	0.87	0.69	1.77*	0.53	0.57	0.62	1.16	—	—	—	1.16	0.33	0.37	1.77	1.10
		(331)	(75)	(19)	(15)	(4)	(3)	(3)	(6)	—	—	—	(4)	(1)	(1)	(4)	(2)
8	Loggers and related workers	1.02	0.82*	0.64*	1.62*	1.17	1.47	0.32	0.74	0.67	0.73	0.57	1.05	0.25	1.13	0.84	—
		(491)	(84)	(21)	(16)	(10)	(9)	(2)	(3)	(3)	(2)	(1)	(4)	(1)	(4)	(3)	—
9	Fishermen, trappers, and hunters	0.87*	0.65**	0.55*	1.28	0.84	0.59	0.65	—	0.38	—	1.02	0.46	—	—	1.27	—
		(208)	(36)	(10)	(7)	(4)	(2)	(2)	—	(1)	—	(1)	(1)	—	—	(2)	—
10	Miners, quarrymen, and related workers	1.07	0.84	1.00	1.07	0.75	1.04	0.67	0.28	0.48	0.39	0.61	0.56	1.05	0.59	1.15	0.51
		(490)	(82)	(31)	(10)	(6)	(6)	(4)	(1)	(2)	(1)	(1)	(2)	(4)	(2)	(4)	(1)
11	Craftsmen, production processors, and related workers	0.92***	0.94**	0.99	0.85*	0.91	1.00	0.92	0.93	0.93	0.91	0.96	0.94	0.98	0.86	0.89	0.92
		(8,381)	(1,904)	(637)	(167)	(154)	(121)	(109)	(82)	(84)	(51)	(33)	(72)	(72)	(59)	(58)	(38)
12	Laborers not elsewhere specified[c]	0.93***	0.91**	0.93	1.12	0.73**	1.10	0.96	0.75*	0.61**	0.72	0.44**	1.07	1.09	0.84	0.92	0.77
		(4,640)	(986)	(320)	(116)	(66)	(71)	(62)	(38)	(30)	(22)	(8)	(44)	(45)	(30)	(32)	(17)
13	Unspecified occupations	0.86***	0.89*	0.93	0.82	0.92	0.59	1.39	0.86	0.51*	0.53	0.46	1.02	1.55	0.76	0.28*	0.77
		(957)	(224)	(74)	(20)	(20)	(9)	(20)	(12)	(6)	(4)	(2)	(10)	(14)	(6)	(2)	(4)

[a] Computed with reference to entire cohort.

[b] *=$0.01 \leq P \leq 0.05$, **=$0.001 \leq P \leq 0.01$, ***=$P \leq 0.001$.

[c] Excludes laborers engaged in agricultural, logging, fishing, and mining operations.

TABLE 4.—*SMR and number of observed deaths for males, by industry division*

Industry division		SMR[a,b] and observed deaths (No.) for:															
				Specific cancer site													
No.	Type	All causes	All malignant neoplasms	Trachea, bronchus, and lung	Stomach	Intestine except rectum	Pancreas	Other neoplasms of lymphatic and hematopoietic tissue	Prostate gland	Bladder and other urinary organs	Bladder	Other urinary organs	Rectum and rectosigmoid junction	Leukemia and aleukemia	Buccal cavity and pharynx except lip	Brain	Esophagus
1	Agriculture	0.95	1.03	0.60	2.93***	0.66	0.94	0.99	1.36	—	—	—	0.49	1.04	—	2.68	—
		(222)	(54)	(10)	(15)	(3)	(3)	(3)	(4)	—	—	—	(1)	(2)	—	(4)	—
2	Forestry	1.05	0.78**	0.64**	1.25	1.19	1.19	0.59	0.66	0.48	0.52	0.42	0.94	0.76	0.83	1.08	0.35
		(679)	(110)	(29)	(17)	(14)	(10)	(5)	(4)	(3)	(2)	(1)	(5)	(4)	(4)	(5)	(1)
3	Fishing and trapping	0.86*	0.69**	0.54*	1.26	0.83	0.58	0.64	—	0.37	—	1.00	0.45	0.52	—	1.24	—
		(210)	(39)	(10)	(7)	(4)	(2)	(2)	—	(1)	—	(1)	(1)	(1)	—	(2)	—
4	Mines (including milling quarries and oil wells)	1.07*	0.91	1.13	1.11	0.73	0.79	0.55	0.87	0.93	1.01	0.79	0.54	1.21	0.77	0.57	0.66
		(745)	(136)	(54)	(16)	(9)	(7)	(5)	(5)	(6)	(4)	(2)	(3)	(7)	(4)	(3)	(2)
5	Manufacturing	0.96***	0.99	1.02	0.88	1.08	1.05	1.10	0.94	0.80*	0.74*	0.90	0.97	0.90	0.96	0.93	0.93
		(7,149)	(1,620)	(533)	(139)	(150)	(103)	(107)	(69)	(59)	(34)	(25)	(60)	(55)	(53)	(49)	(31)
6	Construction	0.94**	0.90*	1.03	0.89	0.59**	1.13	0.62*	0.89	0.79	0.78	0.80	0.71	0.82	0.90	1.11	1.13
		(2,315)	(472)	(171)	(45)	(26)	(35)	(20)	(19)	(18)	(11)	(7)	(14)	(17)	(16)	(20)	(12)
7	Transportation, communication, and other utilities	1.00	1.02	1.04	1.01	1.03	1.12	0.84	1.04	1.04	0.81	1.40	1.15	1.36	0.56*	1.04	1.19
		(2,811)	(638)	(209)	(61)	(54)	(42)	(31)	(28)	(29)	(14)	(15)	(27)	(31)	(12)	(21)	(15)
8	Trade	0.95**	0.99	0.86*	0.90	1.01	0.72*	1.16	1.44*	1.14	1.30	0.88	1.35	1.06	1.04	1.06	1.44
		(3,112)	(678)	(182)	(59)	(59)	(29)	(49)	(47)	(35)	(25)	(10)	(35)	(30)	(23)	(24)	(20)
9	Finance, insurance, and real estate	0.87***	0.92	0.84	1.19	1.65*	0.59	0.37*	0.35*	1.62	1.58	1.68	0.54	0.39	0.72	1.10	0.69
		(534)	(127)	(36)	(16)	(20)	(5)	(3)	(3)	(11)	(7)	(4)	(3)	(2)	(3)	(4)	(2)
10	Community, business, and personal service	1.02	1.06	1.11	1.08	0.91	0.81	1.05	1.00	1.26	1.09	1.58	0.90	1.05	2.27***	0.77	0.81
		(2,631)	(624)	(205)	(62)	(47)	(29)	(35)	(35)	(36)	(20)	(16)	(21)	(22)	(41)	(12)	(10)
11	Public administration and defense	1.00	0.96	0.97	1.14	0.97	1.13	0.78	0.82	0.96	1.33	0.33	0.81	1.21	0.87	0.62	0.68
		(1,501)	(335)	(109)	(39)	(29)	(24)	(15)	(15)	(16)	(14)	(2)	(11)	(14)	(10)	(6)	(5)
12	Unspecified or undefined industries	0.96	0.86*	0.86	0.96	0.75	0.94	0.77	0.86	0.60	0.47	0.83	0.91	1.66	1.61	0.81	1.04
		(583)	(119)	(38)	(13)	(9)	(8)	(6)	(7)	(4)	(2)	(2)	(5)	(8)	(7)	(3)	(3)

[a]Computed with reference to entire cohort.
[b]*=$0.01 \leq P \leq 0.05$, **=$0.001 \leq P \leq 0.01$, ***=$P \leq 0.001$.

TABLE 5.—SMR *and number of observed deaths for males, by three-digit occupation* code

Occupation[a]	Cancer site	SMR[b,c]	No. of observed deaths[d]
Bartenders	Buccal cavity and pharynx except lip	6.35***	6
	Trachea, bronchus, and lung	2.13"	19
	All malignant neoplasms	1.75**	48
Bricklayers, stonemasons, and tile setters	Trachea, bronchus, and lung	1.76*	12
Butchers and meat cutters	Rectum and rectosigmoid junction	4.40' *	5
Canvassers and other door-to-door salesmen	Other neoplasms of lymphatic and hematopoietic tissue	2.72*	5
Carpenters	All malignant neoplasms	0.85*	189
	Other neoplasms of lymphatic and hematopoietic tissue	0.41'	5
Civil engineers	All malignant neoplasms	2.48**	10
Clerical occupations, NES	Buccal cavity and pharynx. except lip	1.79*	18
	Intestine except rectum	1.39'	39
	Stomach	0.67*	21
Commerical travelers	Intestine except rectum	1.91*	12
Cooks	Leukemia and aleukemia	3.24'	6
Driver-salesmen	All malignant neoplasms	1.32**	85
Farm laborers	Stomach	2.61**	9
Fishermen	Trachea, bronchus, and lung	0.55*	10
	All malignant neoplasms	0.65"	36
Fitters and assemblers (metal)	Other neoplasms of lymphatic and hematopoietic tissue	3.22'	5
	Trachea, bronchus. and lung	1.70*	13
Hoistmen, cranemen, and derrickmen	Pancreas	2.60'	5
Inspectors, examiners. and gaugers (metal). NES	Trachea, bronchus, and lung	1.62'	16
Linemen and servicemen (telephone, telegraph, and power)	Intestine except rectum	3.53**	8
	Stomach	2.33'	6
Lumbermen, including logging laborers	All malignant neoplasms	0.74**	67
	Trachea. bronchus, and lung	0.59*	17
Mechanical engineers	All malignant neoplasms	2.39'	8
Mechanics and repairmen, (motor vehicles)	Esophagus	3.59**	7
	Bladder	2.36'	6
	Bladder plus other urinary organs	2.17'	9
Messengers	All malignant neoplasms	1.82***	39
	Trachea, bronchus, and lung	1.82*	12
Metal drawers and extruders	All malignant neoplasms	3.90' *	7
Metalworking machine operators. NES	Leukemia and aleukemia	2.47'	7
Metalworking occupations. NES	Stomach	2.02*	8
Owners and managers. NES	Urinary organs other than bladder	2.21'	8
	Bladder plus other urinary organs	1.67'	16
	All malignant neoplasms	0.85*	179
	Trachea, bronchus, and lung	0.71**	48
Painters (construction and maintenance). paperhangers, and glaziers	Buccal cavity and pharynx except tip	2.85'	5
Plumbers and pipe fitters	Trachea, bronchus, and lung	1.68*	24
Sales clerks	Prostate gland	2.58***	17
	Stomach	0.41*	5
Service station attendants	Bladder plus other urinary organs	5.29***	7
Stationary enginemen	Bladder plus other urinary organs	2.45'	7
Telegraph operators	All malignant neoplasms	1.99'	9
Truck drivers	Leukemia and aleukemia	1.69*	13
Waiters	Buccal cavity and pharynx except lip	7.18***	12
	All malignant neoplasms	1.41**	74
Warehousemen and freighthandlers, NES	Prostate gland	2.35'	10

[a] NES = not elsewhere specified.
[b] Computed with reference to entire cohort.
* = $0.01 \leq P \leq 0.05$, ** = $0.001 \leq P \leq 0.01$, *** = $P \leq 0.001$.
"No. of observed deaths, ≥5. Nominal $P \leq 0.05$ (one-sided).

cation occupations (division 6), although this is not the case for industry division 7 (transporation, communication, and other utilities). Within this occupation division, commercial travelers suffered high mortality rates from cancer of the intestine except rectum, as did commercial travelers in the United Kingdom (1). Both sets of data showed elevated mortality due to cancer of the trachea, bronchus, and lung for messengers. The postulation has been made that

TABLE 6.—*SMR and number of observed deaths for males, by three-digit industry code*

Industry	Cancer site	SMR[a,b]	No. of observed deaths[c]
B products	Intestine except rectum	2.63**	10
Beverage manufacturers	Buccal cavity and pharynx except lip	5.50**	5
	All malignant neoplasms	1.40*	37
Bowling alleys and billiard parlors	Trachea: bronchus. and lung	3.01**	7
Building construction	All malignant neoplasms	0.78***	203
	Other neoplasms of lymphatic and hematopoietic tissue	0.40**	6
	Intestine except rectum	0.32***	7
Fish products	All malignant neoplasms	0.62*	19
Fishing	All malignant neoplasms	0.71*	39
	Trachea, bronchus, and lung	0.56*	10
Food stores	Rectum and rectosigmoid junction	2.97*	6
General merchandise stores	Trachea, bronchus, and lung	0.51**	14
Grain elevators	All malignant neoplasms	0.32**	5
Highway and bridge maintenance	Brain	2.94*	5
Hospitals	All malignant neoplasms	1.70*	16
Hotels, restaurants, and taverns	Buccal cavity and pharynx except lip	3.44***	20
	Larynx	2.66*	7
Household furniture	Brain	4.61**	5
Insurance and real estate agencies	Intestine except rectum	2.69*	5
Insurance carriers	Intestine except rectum	3.66**	6
Iron and steel mills	All malignant neoplasms	1.28*	71
Legal service	All malignant neoplasms	2.16*	8
Logging	All malignant neoplasms	0.76**	95
	Trachea, bronchus, and lung	0.62**	25
Machine shops	Trachea. bronchus, and lung	1.85*	12
Manufacturers of major appliances (electric and nonelectric)	Other neoplasms of lymphatic and hematopoietic tissue	5.28**	5
Men's clothing	All malignant neoplasms	0.51**	11
Metal stamping, pressing, and coating	Stomach	2.27*	8
	Intestine except rectum	2.25*	7
	All malignant neoplasms	1.39*	48
Motor vehicle dealers	Esophagus	2.75*	5
	Other neoplasms of lymphatic and hematopoietic tissue	2.31**	13
Motor vehicle manufacturers	Leukemia and aleukemia	2.82*	6
Motor vehicle repair shops	All malignant neoplasms	1.45*	35
Other crop and livestock combination farms	Stomach	2.75*	5
	All malignant neoplasms	0.54*	10
Printing and publishing	Intestine except rectum	3.22**	9
Railway transport	Urinary organs other than bladder	2.68**	11
	Bladder plus other *urinary* organs	1.78*	19
	Other neoplasms of lymphatic and hematopoietic tissue	0.38*	5
Retail stores. NES[d]	Bladder plus other *urinary* organs	7.75.**	5
Savings and credit institutions	Bladder plus other *urinary* organs	2.59*	6
Services incidental to agriculture	Stomach	3.75**	6
	All malignant neoplasms	1.51*	25
Special trade contractors	Stomach	0.48**	10
Taxicab operations	All malignant neoplasms	1.56*	28
Truck transport	Larynx	4.83**	5
	All malignant neoplasms	1.20*	104
Veneer and plywood mills	All malignant neoplasms	0.45**	8
Wholesalers of food	Prostate gland	2.54*	6

[a] Computed with reference to entire cohort.
[b] *=0.01≤*P*≤0.05, **=0.001≤*P*≤0.01, ***=*P*≤0.001.
[c] No. of observed deaths, ≥5. Nominal *P*≤0.05 (one-sided).
[d] NES=not elsewhere specified.

hig rate for messengers in the United Kingdom may be due to self selection by individuals of this kind of work (4). A hig rate of stomach cancer among farmers and farm workers (occupation division 7) was also evident for the males in industry division 1 (agriculture) and for those listed as farm laborers in table 5—clearly due to the overlapping of t categories. A similar observation was reported in studies in Japan and Iceland *(19, 20)* but not in the U.K. (4) decennial supplement.

No significantly elevated mortality levels were found at the divisional level for craftsmen, production processors, and related workers. However, within the division, bricklayers, stonemasons, and tile setters, as well as plumbers and pipe fitters, showed elevated mortality due to trachea, bronchus,

and lung cancer. Similar elevations also were apparent in the U.K. data (4), but the high levels disappeared when controls for social class were instituted, indicating that lifestyle rather than occupational hazards may be responsible for the elevated mortality.

In addition to these observations, which are supported by other studies, other potentially interesting associations in the present results (tables 5, 6) seem worthy of further investigation. The three limitations discussed above imply that the appropriate uses of a monitoring system such as the system described here are twofold: 1) The data may be used to generate hypotheses that then can be tested further in appropriate analytical case–control or cohort studies and 2) the data may be used to test hypotheses generated from other studies. In tests of hypotheses suggested in other studies, it will be possible, of course, to define an exposure group much more specifically in terms of an appropriate combination of occupation and industry codes and years of exposure.

Although a number of interesting results have emerged from the present analysis, the power of the monitoring system to detect associations will increase substantially as further years of death data are accumulated. For this reason, the plan is to continue monitoring the mortality experience of the cohort on a regular basis.

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