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WHAT PROPORTION OF CANCER IS  
OCCUPATIONAL IN ORIGIN?

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#### ABSTRACT

The identification of any occupational causes for cancer is a matter of great importance as such cancers are--at least in theory--wholly preventable. The question of what proportion of all cancers is occupational is also a matter of great interest since this gives indication of what element of the whole cancer problem can be looked on to have been solved from the point of view of prevention. This latter question has become a matter of considerable controversy in recent years and has become charged with political overtones. This paper will briefly review the history leading up to the present status, the occupational exposures known to cause cancer and present new evidence that bears on the likely true frequency, derived from data from an agency that has made extensive efforts to locate individual cases. In the context of this paper, occupational cancer is defined as "any cancer that would not have developed in the absence of some defined occupational exposure." This is a somewhat negative definition which does not aid in identifying individual cases, but it takes cognizance of the importance of recognizing that any preventable exposure, no matter what part it plays in the involved process of carcinogenesis, if it is critical to the occurrence of the cancer, should be considered a cause.

## HISTORY

The original occupational cancer described by Percival Pott in 1775 in child chimney sweeps disappeared with the abolition of the use of children for this chore and is now only a matter of historic curiosity. Lung cancer was identified as the cause of excess deaths in the Schneeberg miners in the late 19th Century and coal tars as a source of skin cancer around the same time, but it was the identification in 1895 of aniline dyes as a source of bladder cancer which seems to have aroused fears of epidemics of cancer due to new organic chemicals. These epidemics have never materialized. Over the next decades a number of other sources of occupational cancer were identified, but the numbers of workers involved were small and, in epidemiologic terms, they largely could be considered "point sources."

Proof of cause and effect relationship in occupational cancer is never easy. It has to rely largely on cohort epidemiology which is hardly an exact science. Opinions always differ on how strong the evidence should be before a relationship is accepted. The International Agency for Research on Cancer--which can be looked on as a reasonably authoritative scientific body--reviewed the data on 54 suspect compounds or processes, but could only conclude that there was adequate evidence of carcinogenicity for 18 substances or processes listed.<sup>(1)</sup>

In the light of probable multiple elements ("causes") being involved in the process of carcinogenesis, it is desirable to clarify the definition of what is meant by "Occupational Cancer." It can be reasonably defined as any cancer that would not have developed in the absence of a specific occupational exposure. This is essentially an epidemiologic concept and does not permit identification of individual cases. It does, however, recognize the fact that any agent essential to the process--no matter how or at what stage it acts--can be considered a carcinogen.

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In the mid-'70s there were epidemiologic indications of a rather sharp increase in cancer mortality. This--as shown in Figure 1--was essentially limited to males and wholly due to the increase in lung cancer which has resulted from cigarette smoking. Other cancers did not increase. There are those, however, who preferred to talk of an epidemic of all sorts of cancer attributable to the nefarious activities of the chemical industry and "big business." This helped promote and sensationalize sales of some paperback quasi-scientific literature.<sup>(2)</sup> In 1978, a document originated in the National Cancer Institute and was circulated--but never published--indicating that 18% of cancer was due to occupational exposure to asbestos and that 30% or more of all cancer was caused by industrial exposures.<sup>(3)</sup> Incredibly the authors had naively taken the risks for the high exposures of identified point sources as risks for all workers who might be exposed at any level. Responsible epidemiologists rapidly responded to ridicule this document and may have been responsible for the fact that it was never published. Unfortunately it was early the subject of very high level political comment and has been widely quoted ever since by those who wish to attribute the cancer problem to industry.

There is a considerable body of serious studies in the literature concerning the porportion of cancer attributable to various occupational exposures.<sup>(4,5,6)</sup>

This has been largely based on consideration of the differences in incidence between sexes and between various countries for certain cancers. Most estimates are in the range of 1-5% for the proportion of cancer which has an occupational cause in industrialized Western society. What presumably was intended as the final word in this argument is a massive study--commissioned by the U.S. government--from Doll & Peto in 1981 which also concludes that the true figure is almost certainly less than 4% overall (8% for men). (7)

#### EXPERIENCE

When one reviews the literature on identified causes (Table 1) of occupational cancer it becomes evident that almost all have been identified as "point source" exposures with essentially no suggestion of occurrence beyond the specific industry--with the exception of asbestos. There is a noticeable site specificity for most of the substances, again with the possible exception of asbestos. Figure 2 illustrates the occurrence of cases of lung and sinus cancer in a work force of less than 500 from a single plant in a nickel refinery using a particular sintering process which operated from 1948-62. These cases were limited to one specific operation and no excess was noted in the rest of this large mining, milling and refining operation.

If cases occurring in workers exposed in the known hazardous industries can be identified, it would seem that the large bulk of occupational cases will be accounted for. This has been attempted under the programs of the Workmen's Compensation Board of Ontario.

Administration of workmen's compensation in Ontario differs somewhat from that in most U.S. states in that there is no involvement of private insurance companies and the Board functions both in an adjudicative and appellate role as a U.S. compensation board or industrial commission might, as well as an insuring agency such as a state fund in the U.S. The Ontario Board has a strong paternalistic tradition towards workers and it has been policy that it has the responsibility of identifying workers who may have entitlement to benefits, rather than just waiting for claims to be submitted. As a result, as the causes of occupational cancer have been identified in the Province, efforts have been made to locate exposed workers who might have developed the disease. Guidelines have been developed for acceptance of claims based on the duration of exposure and latency that fitted their epidemiology. Table 2 lists the source and type of cancer for accepted compensation claims. This illustrates well the diversity of sources and cancer types involved. The problem is to relate the number of cases identified to the overall incidence of cancer in the Province.

The question must arise as to how complete the ascertainment of cases has been. Techniques for ascertainment have included: search of death certificate data, company records, union records, and appeals to physicians in practice to report cases. As well there has been considerable general media publicity about the subject in recent years. The author's personal experience in undertaking epidemiologic studies where all cases were identified by searching death records, indicated that for the uranium miners, of a potential 135 cases, 21 (16%) had not resulted in claims. In a similar study of the nickel sinter workers, only 3 out of 60 (5%) did not have claims. The usual reason in that claims had not been established was that workers had succumbed to the disease and left no survivors interested in pursuing benefits. Case ascertainment for other industries should be comparable.

Table 3 lists the total deaths identified for specific sites and exposures for the period 1975-9. Table 4 compares the occupational total for lung, sinus and all sites with those for the Province (population, 8.5 million; workforce, 4.3 million). It might be suggested that unreasonably tough criteria for claims acceptance, may have resulted in artificially depressing these totals, but it should be noted that these totals include both accepted and rejected claims. (The fate of those with rejected claims was not always known so it has been assumed that mortality equalled incidence.)

#### DISCUSSION

The ascertainment of cancer cases from known occupational hazards is probably reasonably complete. A possible exception is for cases of bladder cancer in workers exposed to aniline dyes. These are likely under-reported as there is some doubt that urologists are oriented to probing remote industrial exposures. As these tumors are usually curable, this would tend to be reflected more in incidence data and not affect mortality data greatly. The number of workers exposed in Ontario has probably never been great.

It can be suggested that there is a pool of cases of cancer due to unidentified occupational expositors. No cancers other than lung cancer (and mesothelioma) seem to have increased over the recent past. There may be sporadic cases of lung cancer occurring in workers who smoke, where the addition of an unidentified exposure to some agent might be postulated as the "last straw" in the causation of the tumor. This has been suggested as a reason for the high lung cancer rates in lower socio-economic groups. However, Adelstein's<sup>(8)</sup> work would suggest that occupation plays only a very small part in this difference. This makes it seem unlikely that there are many cases attributable to unidentified sources.

#### CONCLUSION

This data suggests that taking all factors into consideration, it is likely that the proportions of cancer mortality attributable to occupational hazards are in the order of 1% for all sites and 2% for lung cancer. Analysis has been limited to mortality data. The W.C.B.O. claims experience cannot be meaningfully related to the population at large for incident cases of nonfatal cancers such as skin and bladder due to the lack of availability of incidence rates for the Province.

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TABLE 1

| <u>SUBSTANCE/OCCUPATION</u>                    | <u>CANCER SITE</u>                    |
|------------------------------------------------|---------------------------------------|
| Soots, tars, mineral oils (P.A.H.)             | Skin, lung                            |
| Arsenic                                        | Skin, lung                            |
| Nickel Refining                                | Lung, nasal sinus                     |
| Chromates                                      | Lung                                  |
| Asbestos                                       | Lung, Mesothelioma,<br>?G.I., ?Larynx |
| Mustard gas                                    | Lung, larynx, sinus                   |
| Isopropyl alcohol manufacture                  | Larynx, sinus                         |
| Bischloromethyl ether                          | Lung                                  |
| Uranium and Haematite mining (Radon daughters) | Lung                                  |
| Shoe manufacture                               | Sinus                                 |
| Furniture manufacture                          | Sinus                                 |
| 4 Aminobiphenyl                                | Bladder                               |
| Auramine manufacture                           | Bladder                               |
| Benzidine                                      | Bladder.                              |
| Naphthylamines                                 | Bladder                               |
| Radium                                         | Osteogenic sarcoma                    |
| Cadmium                                        | Prostate                              |
| Benzene                                        | Leukemia                              |
| Vinyl Chloride                                 | Angio sarcoma                         |
| Ionizing radiation                             | All                                   |

## IDENTIFIED SOURCES OF OCCUPATIONAL CANCER

(Modified from Doll)<sup>(7)</sup>

TABLE 2

CRITERIA FOR W.C.B.O.  
ALLOWANCE

| <u>CRITERIA FOR W.C.B.O.</u><br><u>ALLOWANCE</u> | <u>SOURCE</u>                                                                                           | <u>CANCER SITE</u>               |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------|----------------------------------|
| Guidelines based on exposure and latency         | Asbestos--any exposure                                                                                  | Lung, Mesothelioma, G.I., Larynx |
|                                                  | Arsenic--(metal refinery, pesticide manufacture)                                                        | Lung, skin                       |
|                                                  | Nickel refining (2 refineries)                                                                          | Lung, sinus, larynx              |
|                                                  | Uranium Mining (Radon daughters)                                                                        | Lung                             |
|                                                  | Coal tar pitch volatiles/ Polycyclic aromatic Hydrocarbons--(Coal gas plant, coke ovens, steel foundry) | Lung                             |
| Individual consideration                         | X-rays and other radiation                                                                              | Leukaemia, skin                  |
|                                                  | Oils, soots and tars                                                                                    | Skin                             |
|                                                  | Aniline dyes                                                                                            | Bladder                          |

SOURCES OF OCCUPATIONAL CANCER IDENTIFIED IN  
ONTARIO BY WORKMENS COMPENSATION BOARD

TABLE 3

| <u>Cause</u>    | <u>Site</u>                      | <u>Total</u> |
|-----------------|----------------------------------|--------------|
| Asbestos        | Lung 20, Mesothelioma 22, G.I. 8 | 50           |
| Arsenic         | Lung 2                           | 2            |
| Nickel refining | Lung 37, Sinus 9                 | 46           |
| Uranium mining  | Lung 28                          | 28           |
| CTV/PAH         | Lung 13                          | 13           |

Deaths from cancer associated with specific occupational hazards identified by W.C.B.O. 1975-1979 (male). (Total consists of known deaths among those with "accepted" claims plus number of incident-"rejected" cases which were assumed to be all fatal.)

TABLE 4

| <u>SITE</u> | <u>POSSIBLE OCCUPATIONAL<br/>EXPOSURE<br/>IDENTIFIED BY WCBO</u> | <u>TOTAL CASES<br/>ONTARIO</u> | <u>PERCENTAGE<br/>OCCUPATIONAL</u> |
|-------------|------------------------------------------------------------------|--------------------------------|------------------------------------|
| Lung        | 100                                                              | 11092                          | 0.90%                              |
| Sinus       | 9                                                                | 77                             | 11%                                |
| All Sites   | 139                                                              | 36011                          | 0.39%                              |

Deaths from cancer (males) 1975-79. Cases identified by  
W.C.B.O. (up to January 1981) with possible occupational exposure  
and totals for all Ontario.

Figure 1

# RESPIRATORY CANCER FROM NICKEL SINTER PLANT OPERATING 1948-1962

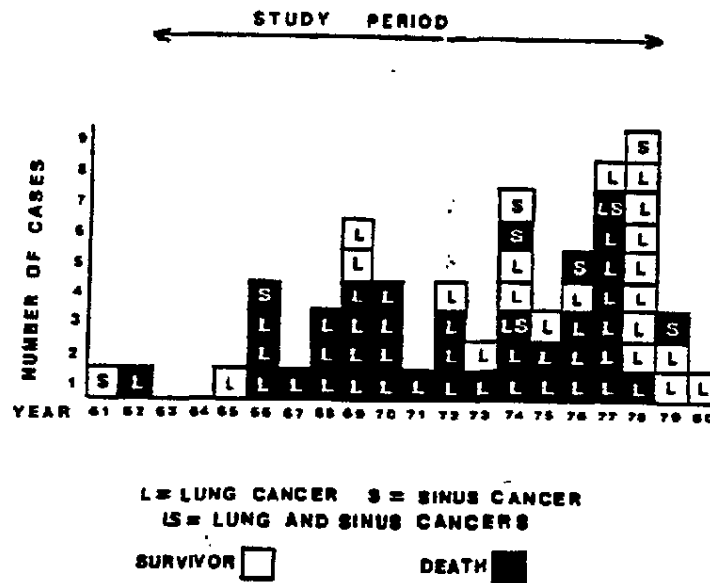


Figure 2

AGE-STANDARDIZED (25-74) MORTALITY RATE  
CANADA

