

**Identification of Non-Smokers for the Workers' Compensation
Board of Manitoba Lung Cancer and Fire Fighting Policy**

Submitted by

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Introduction.

The Province of Manitoba has recently agreed to amend The Worker's Compensation Act to accept lung cancer in "non-smoking" firefighters who have worked as a firefighter for fifteen years as an occupational disease. The Workers Compensation Board of Manitoba (WCB) has been asked to facilitate implementation of the legislation. The purpose of this paper is to provide information for the WCB to help create a definition of a "non-smoking" firefighter.

The association between lung cancer and smoking is strong and well established. Smoking of cigarettes (1-4), cigars(5) and pipes (6) have all been associated with increased risks of lung cancer. The risk of lung cancer increases with both the number of cigarettes smoked and the duration of smoking (4;7). Summary measures like "pack years" (number of packs/day smoked X number of years smoked) do not accurately reflect the association between smoking and lung cancer because duration of smoking is a stronger predictor of lung cancer risk than amount smoked(4;7). Other factors including, age starting smoking (2), age (4), stopping smoking(1;2), and the amount inhaled(5;6) also influence the association between lung cancer and smoking. Although all of the above variables influence the association between smoking and the development of lung cancer, the WCB will need an evidence based, practical, and easily applicable standard to identify non-smokers.

To obtain the appropriate data, the medical literature was reviewed and studies comparing the lung cancer risk of smokers, never smokers and former smokers were identified. Although a large number of studies touch on aspects of the association of smoking and lung cancer, four large studies have been repeatedly cited in this area and are the largest available to address the questions at hand. These studies are the American Cancer Society Cancer Prevention Study I (CPS-I)(1) and II (CPS-II)(4-6), The Veteran's study (2) and the British Doctor's study (3;7). Although each of these studies have looked at the association between smoking and lung cancer and other conditions, not all of them have published information in a way that can be easily used to address all of the questions posed by the proposed legislation. The basic methodology of these studies will be presented prior to summarizing the appropriate data. The results for cigarette smoking will be discussed first, followed by information on cigar and pipe smoking.

The American Cancer Society CPS-I (1;8) was a 12-year follow up study of 1 million men and women. The study began in 1959 and continued through to 1972. The CPS-I used 68,116 volunteers to enroll 1,078,894 men and women in the study. The 12-year follow up of this study included over 11 million person years of follow up. Mortality for cigarette smoking(1) was reported by cause of death based on the number of cigarettes smoked per day and the duration of smoking habit in years. This group also reported on the mortality for lung cancer according to number of cigarettes smoked per day and duration of cessation of smoking. According to this study, never smokers were individuals who indicated at the time of the initial survey that they never smoked cigarettes regularly. Current smokers were individuals who indicated current cigarette smoking at the time of initial survey and former smokers were individuals who indicated at the time of the survey that they were former cigarette smokers and did not indicate current smoking at any subsequent follow up. Follow up time for former smokers began to accrue after they had quit for at least 2 years.

The second large study was the mortality follow-up of 300,00 US veterans whose tobacco use was surveyed in a questionnaire in the 1950's(2). Follow up was performed for 26 years from 1954-1980. This study included 5,429,000 person years of follow up during which time almost 2/3 of the initial 300,000 veterans had died. Smoking status was assessed at the reply to the original questionnaire. Never smokers were those that reported never regularly smoking cigarettes, cigars or pipes. Regular smokers were those that had a lifetime consumption of more than 5-10 packs of cigarettes. Amongst other investigations, this study compared the lung cancer rates of former smokers to never smokers based on amounts smoked and years since stopping smoking.

The third large study in this area is the British doctor's study (3;7). The study has been updated a number of times, the most recent update in 2004 reported on 50 years of observation of 34,439 male British doctors(3). In this study a never smoker referred to individuals that had not smoked on most days for most of one year. Although this study reported on a large number of men for many years, specific data on mortality for lung cancer for former smokers by number of cigarettes smoked and duration since stopping smoking could not be located. Baseline lung

cancer rates for non-smokers were taken from the CPS-I study(1) reported above. Thus data from this study proved difficult to use to provide the answers required by the WCB.

The fourth study is the CPS-II. This study had a similar methodology to CPS-I and followed 1,185,000 individuals for six years(9). At enrollment participants were asked the question “ Do you now or have you ever smoked cigarettes, cigars or pipes at least one a day for one year’s time”(6). Current and former smokers were asked additional questions to quantify the amount they smoked. Follow-up was for 6 years and was over 98% complete(4). This study has provided the most detailed information identified on the lung cancer risks of current cigarette (4), pipe(6) and cigar(5) smoking.

Criteria used to identify non-smokers who develop lung cancer for the WCB firefighters regulation.

Non-smokers can be defined as either never smokers or former smokers. Although it is reasonable to assume that lung cancer arising in a never smoking firefighter may be work related, many former smokers who develop lung cancer do so because of their previous smoking habit (1;2). The risk of lung cancer in former smokers decreases with time, but for heavy smokers it never returns to the same level as never smokers(1;2). Thus it is important to identify what period of time a firefighter who smoked has to stop smoking so that their risk of lung cancer would be low enough that an occupational causation could be presumed and compensation awarded.

The definition of occupational diseases used by the Workers Compensation Board of Manitoba requires that occupational factors be deemed the dominant cause of the development of the disease. In order for occupational factors to be dominant, it has to be shown that they are more likely than not to have caused the disease. Provincial adjudication criteria require, on balance, that workplace factors outweigh non-workplace factors and that workplace factors account for at least 50.1% of the cause of the disease for it to be deemed occupational. The 50.1% standard implies that there has to be at least a doubling of the risk due to the occupational factor for that factor to be considered the dominant cause. Doubling of risk means that the rate of disease in the observed population is twice that in the control population. A doubling of risk is equivalent to a

Rate Ratio (RR) in an epidemiologic study of 2.0. RR above 2.0 suggest more than doubling of risk and RR below 2.0 but above 1.0 suggest an increase risk that is not double. A level of 1.0 suggests that there is no difference in the rates in the observed and control populations. Levels below 1.0 suggest a decreased risk in the exposed as compared to the control population. In order to better interpret the RR, 95% confidence intervals (95% CI) are presented. These numbers can be used to determine if the result is statistically significant. If the 95% confidence intervals do not include 1.0 the finding is statistically significant.

In order to show that smoking is not the “dominant” cause of the development of lung cancer in a former smoking firefighter, data was sought to identify when the risk of dying of lung cancer for former smokers fell to less than twice the baseline risk in never smokers. This is the level of risk used to argue that non-smoking firefighters should receive compensation in previous submissions to the WCB. If the risk from smoking was shown to be below this level, then it could be assumed that smoking is a less important factor than occupational exposures in the development of disease.

Data provided by the CPS-I (1) and the Veteran’s(2) studies were examined to determine when the RR of dying of lung cancer for former cigarette smokers fell to less 2.0 compared to never smokers. Published data from the British physician’s study and CPS-II could not be identified to address the issue of the declining risk of lung cancer in former cigarette smokers. The former smoking time period when the RR was closest to 2.0 in the CPS-I (1) and Veteran’s (2) studies was recorded in Table 1. In cases where the RR did not closely approximate 2 the RR above and below 2.0 were both presented. Both the CPS-I (1) and Veteran’s (2) study show a gradual increase in the duration of time a former smoker had to have quit smoking for their risk of dying of lung cancer to decrease to approximately 2.0 as the number of cigarettes per day they smoked increased. In the Veteran’s study (2) the number of years is consistently higher than the CPS-I (1) study. Overall, a doubling of risk was still present between 20-25 years after stopping smoking in the CPS-I study (1) and after 30-39 years in the Veteran’s study (2).

Proposed definitions of never and former cigarette smokers for the WCB firefighters regulation.

The WCB legislation proposes granting compensation to non-smoking firefighters who develop lung cancer. Non-smokers include both never smokers and former smokers. A reasonable definition of a never smoker would be an individual who smoked less than one cigarette a day for one year (3;4). The WCB could consider a definition of a never smoker as an individual who smoked less than 365 cigarettes in their life time.

Data as summarized in Table 1 is the best information that could be located on the risk in former cigarette smokers. Since the risk of lung cancer in former smokers is dependent on the amount smoked, the used of a single time period of not smoking in adjudication decisions for all former smokers would penalized lighter smokers as their risk would be lower than average, and reward heavy smokers since their risk would be greater than average. In order to avoid this problem, a table based on the information in Table 1 (Table 2) was developed, so that varying periods of former smoking would qualify based of the extent of the former smoking habit. The time periods in Table 2 were selected by identifying the time period for the RR of dying of lung cancer to fall to just below 2.0 in each study (1;2). The period selected placed more weight on the CPS-I study (1) than the Veterans (2) as the former study had twice the person years of follow up. Time periods were rounded to the nearest year.

As only data based on the amount smoked and not the duration smoked could be identified to create Table 2, the time presented is a summary value for all individuals who smoked this amount. It is likely that this number would over estimate the time period required for the risk of lung cancer to fall for individuals who smoked shorter periods of time and underestimate it for individuals who smoked longer periods of time. As well, this table identifies the risk of dying of lung cancer and not of being diagnosed with lung cancer. Since the median survival of lung cancer from diagnosis is one to two years, one to two years should be subtracted from these times to account for the fact that people live with the diagnosis of lung cancer for a period of time prior to dying from the disease.

There may be fire fighters who develop lung cancer who have smoked cigarettes slightly more than the amount needed to be considered a never smoker and not stopped long enough to be qualify as a former smoker according to the legislation. It is possible that in such cases of “minimal smokers” occupational exposures and not cigarette smoking led to the development of lung cancer. In such cases, a case by case adjudication should still be performed prior to deciding if the case is compensable or not.

Proposed definitions of never and former pipe smokers for the WCB firefighters regulation.

Pipe smoking is much less common than cigarette smoking and many studies of pipe smoking are limited by relatively small number of exclusive pipe smokers(6). The relative risk of lung cancer mortality amongst current pipe smokers was 5.00 (95%CI 4.16 – 6.00) in the CPS–I dataset(6). Individuals who only smoked 1 – 3 pipe bowls per day still had twice the likelihood of dying from lung cancer and the risk of lung cancer went up from this level with the amount smoked. Individuals who quit pipe smoking for less than 10 years had about 2.5 times the risk of dying from lung cancer. The risk was the same as never smokers for those who stopped smoking a pipe for more than ten years.

Similar to cigarette smokers a useful definition of a never pipe smoker would be an individual who did not smoke more than one pipe a day for a year, or 365 bowls in their life time. With respect to former pipe smoking, it appears that there is no excess risk of dying of lung cancer compared to never smokers in the group that had stopped smoking for more than ten years. Since this information is based on lung cancer mortality and individuals live with the diagnosis of lung cancer typically between one and two years prior to dying of this condition, the WCB should consider fire fighters for compensation under the Act if they stopped smoking a pipe 8 years prior to the diagnosis of lung cancer.

Proposed definitions of never and former cigar smokers for the WCB firefighters regulation.

Cigar smoking is different than cigarette smoking as individuals tend to smoke smaller number of cigars than cigarettes and inhale less deeply(8). However cigar smokers are still at an elevated risk of developing lung cancer(5;8). Their risk of developing lung cancer is similar to that of cigarette smokers after adjusting for the level of inhalation and the amount of tobacco smoked per day(8).

Cigar smokers who smoke one or two or cigars per day did not have an increased risk of dying of lung cancer compared to never smokers in either the CPS-I (8) or CPS-II data sets(5). Current cigar smokers of three or more cigars per day had a lung cancer mortality rate ratio of 7.8 (95% CI 5.9 –10.3) compared to never smokers in CPS-II (5) and between 2.36 and 3.4 in CPS-I(8). Former cigar smokers, likely because this group included individuals who smoked more than two cigars per day had an increased risk of dying of lung cancer (RR 1.6, 95% CI 1.2 –2.4).

Similar to cigarette smokers, a reasonable definition of a never cigar smoker would be an individual who smoked less than one cigar a day for one year (5) or a total of 365 cigars in their life time. With respect to former cigar smokers, individuals who stopped smoking and only smoked one or two cigars per day who develop lung cancer should still be considered non-smokers under the legislation. For former cigar smokers who smoke more than this amount, data on their risk based on amount smoked and duration of not smoking could not be identified. Since the risk of lung cancer due to pipe smoking and cigar smoking are thought to be similar (6), it would be reasonable for the legislation to consider former cigar smokers the same as former pipe smokers.

Table 1. Comparisons of the number of years since smoking cessation for the rate ratio of dying of lung cancer in former smokers to decline to the value closest to double the rate in never smokers.

Cig/day	CPS-I (1)				Veterans (2)			
	Rate Ratio	After yrs of cessation	Rate Ratio	After yrs of cessation	Rate Ratio	After yrs of cessation	Rate Ratio	After yrs of cessation
1-9	2.83	2-4	1.68	5-9	2.2	10-19	1.7	20-29
10-19	2.04	15-19						
20	2.22	15-19	1.86	20-24				
10-20					2.1	30-39	1.6	40+
21-39	2.04	20-24			1.8	40+		
40+	3.99	20-24	0.89	25-29	2.3	40+		
Overall	2.04	20-24			2.0	30-39		

Table 2. Estimated time for the risk of dying of lung cancer to fall to twice that of never smokers in former smokers.

Cigarettes smoked per day	Time in years
1-9	8
10-19	15
20	20
21-39	25
40+	30

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