Noteworthy Decision Summary

Decision: WCAT-2004-05368 **Panel**: Randy Lane **Decision Date:** October 18, 2004

Firefighter case – Upon review of epidemiological studies, the panel found that, under section 6(1) of the Workers Compensation Act, the firefighter's death from stomach cancer was not due to the nature of his employment

The worker commenced employment as a firefighter in 1976, and in 1992 he was promoted to fire captain and then in 1999 to assistant fire chief - safety and training. In 2003 he was diagnosed with adenocarcinoma of the stomach. Even after his promotions, his work included attending fires and engaging in fire suppression activities. The issue was whether his death from stomach cancer was due to the nature of his employment.

Although the worker was exposed to asbestos, the duration requirement in Schedule B had not been met, hence the panel examined whether, under section 6(1) of the *Workers Compensation Act*, his stomach cancer was due to the nature of his employment. Epidemiological evidence is not mandatory before a claim may be accepted and cannot prove or disprove causation in an individual case; its usefulness relates more directly to the issues of risk than of actual occurrence. Nevertheless, cancer cases are rarely resolved by opinions that merely canvass the case of a particular worker, and in most cases epidemiological evidence is used to provide a relevant background for any opinion specific to the particular worker. The panel reviewed numerous studies and noted that there are very few studies which established that firefighters were at a greatly increased significant risk for stomach cancer. There was only one study which showed several relative risks over 2.0 that were statistically significant, but numerous studies with data that point away from a link between firefighting and stomach cancer. Strength of association in the studies was rarely close to 2.0 and often below 1.0; also the data did not persuasively establish a dose-response relationship or show a consistent increasing risk associated with duration of employment. The worker's exposure would have to have been extraordinary, when compared to a cohort of firefighters with a similar number of years of employment, to elevate his personal risk to 2.0 or more, and the panel considered that it would be speculative to make such a finding. The worker's death was not due to the nature of his employment.

Workers' Compensation Appeal Tribunal 150, 4600 Jacombs Road, Richmond, B.C. V6V 3B1
Telephone: (604) 664-7800; 1-800-663-2782; Fax (604) 664-7898

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Panel: Randy Lane, Vice Chair

Introduction

The worker, a firefighter, died of adenocarcinoma of the stomach in March 2003. His widow, Ms. A (not her real initial), applied to the Workers' Compensation Board (Board) for dependant's benefits.

By decision of August 18, 2003 a case manager of the Board denied Ms. A's application, as he was unable find that the worker's exposure as a firefighter was of causative significance with respect to his cancer. By decision of January 16, 2004 a review officer with the Review Division of the Board confirmed the August 18, 2003 decision (*Review Reference #7736* which may be viewed on the Internet at the Board's website at http://www.worksafebc.com).

Ms. A appealed the January 16, 2004 decision to the Workers' Compensation Appeal Tribunal (WCAT). She provided a February 4, 2004 notice of appeal which was accompanied by a February 4, 2004 letter and, among other documents, several pages concerning occupational diseases excerpted from the report of the Royal Commission on Workers' Compensation in British Columbia and a copy of her submission to the Review Division. She then provided an April 5, 2004 letter accompanied by her submission to WCAT and, among other materials, numerous documents concerning formaldehyde, asbestos, lead, and benzene; carcinogenicity database information (including materials from the Carcinogenicity Potency Project); a report concerning occupational cancers in New York City firefighters; an abstract concerning an article regarding multiple organ carcinogenicity of certain substances in mice and rats; materials concerning the investigation of fire cases; a copy of a newspaper article concerning a fire attended by the worker; a list of occupational cancer cases accepted by the Board in 2000; information concerning fire incidents between 1976 and 2003 in the area served by the fire department to which the worker belonged; and an article regarding stomach cancer and rubber industry workers. She then provided an April 26, 2004 letter which was accompanied by a copy of an article regarding exposure to occupational dust and an article concerning the risk of cancer in firefighters, and information from the National Toxicology Program.

The worker's employer provided a May 31, 2004 submission to which Ms. A provided a June 8, 2004 response. While Ms. A was advised by June 11, 2004 letter that submissions were considered closed, she then sent a June 14, 2004 letter in which she asked that the employer and the Board provide WCAT with the results of air quality studies performed at fire scenes of every nature.

I consider a fair and thorough decision may be reached on this appeal without holding an oral hearing.

Issue(s)

At issue is whether the worker's death from stomach cancer was due to the nature of his employment.

Jurisdiction

WCAT may consider all questions of fact and law arising in an appeal, but is not bound by legal precedent (section 250(1) of the *Workers Compensation Act* (Act)). WCAT must make its decision on the merits and justice of the case, but, in so doing, it must apply a policy of the board of directors of the Board that is applicable in the case. WCAT has exclusive jurisdiction to inquire into, hear and determine all those matters and questions of fact and law arising or required to be determined in an appeal before it (section 254).

This is an appeal by way of rehearing, rather than a hearing *de novo* or an appeal on the record. WCAT has jurisdiction to consider new evidence, and to substitute its own decision for the decision under appeal.

Background and Evidence

The worker commenced employment as a firefighter in August 1976. In 1992 he was promoted to fire captain. In February 1995 he was appointed as the acting chief training officer. In July 1999 he was promoted to assistant fire chief - safety and training. The worker was admitted to hospital in January 2003; it was discovered that he had adenocarcinoma of the stomach.

I accept that even after his promotions, the worker's work included attending fires and engaging in fire suppression activities.

In a July 8, 2003 memorandum a case manager noted Ms. A's information regarding the worker. No one in the worker's family had died of cancer. The worker was an outdoorsman who loved hunting, fishing, and camping. He was a very healthy eater. Ms. A and the worker "farmed" their own beef and chicken, as well as grew their own vegetables. The worker smoked in his early 20s, but he had stopped smoking 20 years prior to 2003. The case manager estimated the worker had a five to ten pack-year history of smoking. Ms. A considered that the worker's cancer was employment-related because he had attended many fires involving chemicals and other carcinogenic agents prior to a time when firefighters were equipped with respiratory protection. He had been exposed to asbestos that was part of some of the buildings that were on fire and that was used in firefighting equipment.

In his August 15, 2003 opinion Dr. G, the Board's medicine consultant and a specialist in internal medicine, indicated that gastric cancer was a disease with significant morbidity and mortality that had been increasing in incidence over the past few decades. Occupational exposures had been implicated in the increasing incidence of the disease, and there had been many recent studies evaluating occupational risks which indicated that there was evidence that occupations in coal and tin mining, metal processing (particularly steel and iron), and rubber manufacturing industries led to an increased risk of gastric cancer. Increased risks were noted in miners, quarrymen, construction and metal processing workers, gas station workers, and administrative support positions in the financial, insurance, and real estate industries. He noted that there was a very weak association with other "dusty" occupations, but the evidence was inconclusive.

Dr. G observed that studies had evaluated the cancer risk associated with fire fighting; increased risks for leukemia, non-Hodgkin's lymphoma, multiple myeloma, and cancer of the brain and bladder had been suggested epidemiologically. He indicated gastric adenocarcinoma had not been demonstrated epidemiologically to have associations with fighting. He concluded that the worker's adenocarcinoma of the stomach was not related to his occupation as a firefighter.

By decision on August 18, 2003 the case manager denied Ms. A's claim. He found that none of the worker's interests or lifestyle led to the development of stomach cancer. He indicated that information from the assistant fire chief and acting fire chief indicated that records kept by the Fire Department, from the time when the worker was in active service, were fairly sketchy. He considered that it was not possible to identify particular risks to which the worker was exposed in his career. He considered that it would be safe to assume that the worker had the average exposure of the average firefighter involved in fighting residential, commercial, and industrial fires. He cited the opinion of the Board's internal medicine consultant.

In his January 16, 2004 decision the review officer denied Ms. A's appeal. He noted that gastro-intestinal cancer was listed in Schedule B of the Act. He found that the Schedule was not applicable because, while the worker was exposed to airborne asbestos, the worker's exposure did not meet the duration of exposure requirement set out in Schedule B:

> Where there is exposure to asbestos dust if during the period between the first exposure to asbestos dust and the diagnosis of gastro-intestinal cancer there has been a period of, or periods adding up to, 20 years of continuous exposure to asbestos dust and such exposure represents or is a manifestation of the major component of the occupational activity in which it occurred.

The following paragraphs set out his reasons for determining that the worker's stomach cancer was not due to the nature of his employment as set out in subsection 6(1) of the Act:

> It is reasonable to assume that as a firefighter, the worker was likely exposed to a variety of toxic substances throughout the years when he was directly engaged in fire suppression. I further acknowledge that there is epidemiological evidence to support a relationship between certain kinds of cancer and firefighting. There is, however, no general presumption that firefighters are at higher risk for all types of cancer and, therefore, each claim must be considered on its individual merits.
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> I do not find the epidemiological evidence on the claim file or in the applicant's submission to be compelling with respect to a possible connection between stomach cancer and firefighting. The applicant's submission contains a summary of a number of studies on the more general topic of incidents of all cancers among firefighters. Some of the information is missing but there are complete summaries of 13 studies. Of these, two indicate some evidence of increased risk of stomach cancer for firefighters. One study showed an increased risk for firefighters whose exposure began 40 years before diagnosis (not relevant to this claim) and one study showed "non-significant" findings on such an association. While most of the remaining nine studies do show increased risks of various other forms of cancer among firefighters, stomach cancer is not included in this list.
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> In addition to the above, the Board Internal Medicine Consultant has provided a clear opinion, with references, on the lack of evidence supporting a relationship between stomach cancer and the worker's occupation. I find his opinion compelling given the lack of any opinion or evidence to the contrary. I find, therefore, that the evidence does not support a connection between the worker's occupation and the diagnosed stomach cancer. As a result, I deny the applicant's request.

Reasons and Findings

Ms. A indicates that she tried to obtain an opinion from an epidemiologist, but she was unsuccessful. She asks that such an opinion be obtained.

I do not consider that I require an assessment by an independent health professional under section 249 of the Act, or an opinion from an epidemiologist, to resolve the issue on appeal. The file contains Dr. G's opinion. While he is not an epidemiologist, he is a medical doctor with a specialty in internal medicine. Many epidemiologists are not medical doctors, and that limits their ability to provide opinions specific to individual

workers. Dr. G's opinion does not cite all of the articles that may be relevant to the issue of firefighting and stomach cancer, but he does cite some of the relevant literature.

I also do not consider that I require the Board to provide air quality studies. As indicated below, I accept that firefighters are exposed to a number of dangerous substances. I question whether data which confirmed that would add to the analysis of the issue on appeal.

I agree with the review officer that the evidence is not sufficient to establish that the terms of Schedule B regarding gastro-intestinal cancer have been satisfied. I accept that the worker was exposed to asbestos, but I do not consider that the duration requirement has been met. Thus, there is no rebuttable presumption, pursuant to the terms of subsection 6(3) of the Act, that the worker's cancer was due to the nature of his employment. The next step is to examine whether, under subsection 6(1) of the Act, it was due to the nature of his employment.

Ms. A uses a process of elimination to point to the worker's occupation as a cause of his cancer. Ms. A observes that the worker's grandfathers, uncles, and his father lived and/or are living in good health into their mid 80s and 90s, and there was no history of stomach cancer in the family. She comments that the worker's cancer did not appear to be of a genetic nature, and since it was recognized by the case manager that the worker's lifestyle did not contribute to his cancer development, by process of elimination, his occupation appears to have been a cause of his condition and death.

I do not consider that the adjudication of the appeal is that simple.

Dr. G cited several articles concerning studies dealing with the risk of stomach cancer and occupations generally. I have obtained and read the articles cited: Burns *et al*.[1], Cocco *et al*. (1998)[2], Cocco *et al*. (1999)[3], Simán *et al*.[4], Engel *et al*.[5], Aragonés *et al*.[6], and Raj[7]. Ms. A also supplied articles by Wright *et al*.[8] and Straif *et al*.[9] Those articles

[1] Burns, PB et al. Stomach cancer risk among black and white men and women: the role of occupation and cigarette smoking. *Journal of Occupational and Environmental Medicine*. 1995 Oct;37(10):1218-23.
[2] Cocco, P et al. Occupational risk factors for cancer of the gastric cardia. Analysis of death certificates from 24 US states. *Journal of Occupational and Environmental Medicine*. 1998 Oct;40(10):855-61
[3] Cocco, P et al. Risk of stomach cancer associated with 12 workplace hazards: analysis of death certificates from 24 states of the United States with the aid of job exposure matrices. *Occupational and Environmental Medicine*. 1999 Nov;56(11):781-7.
[4] Simán, JH et al. Tobacco smoking increases the risk for gastric adenocarcinoma among Helicobacter pylori-infected individuals. *Scandinavian Journal of Gastroenterology*. 2001 Feb;36(2):208-13.
[5] Engel, LS et al. Occupation and risk of esophageal and gastric cardia adenocarcinoma. *American Journal of Industrial Medicine*. 2002 Jul;42(1):11-22.
[6] Aragonés, N et al. Stomach cancer and occupation in Sweden: 1971-89. *Occupational and Environmental Medicine*. 2002 May;59(5):329-37.
[7] Raj, A et al. Occupation and gastric cancer. *Postgraduate Medicine Journal*. 2003 May;79(931):252-8
[8] Wright, WE et al. Adenocarcinoma of the stomach and exposure to occupational dust. *American Journal of Epidemiology*. 1988 Jul;128(1):64-73.

concerning stomach cancer and occupation generally and stomach cancer and exposure to dust are of interest.

However, I consider that there is a significant collection of information dealing with firefighters and cancer that should be the primary focus of the analysis in this case. I have read the following articles published in peer-reviewed journals which I have listed by year of publication and name(s) of author(s): Musk *et al*.[10], Eliopulos *et al*.[11], Feuer *et al*.[12], Vena and Fiedler[13], Hansen[14], Heyer *et al*.[15], Sama *et al*.[16], Howe and Burch[17], Beaumont *et al*.[18], Demers *et al*. (1992)[19], Guidotti (1993)[20], Burnett *et al*.[21], Tornling *et al*.[22], Aronson *et al*.[23], Demers *et al*. (1994)[24], Guidotti (1995)[25], Golden *et al*.[26], Ma *et al*.[27], Baris *et al*.[28], Bates *et al*.[29], and

[9] Straif, K et al. Occupational risk factors for mortality from stomach and lung cancer among rubber workers: an analysis using internal controls and refined exposure assessment. *International Journal of Epidemiology*. 1999 Dec;28(6):1037-43.
[10] Musk, AW et al. Mortality among Boston firefighters, 1915-1975. *British Journal of Industrial Medicine*. 1978 May;35(2):104-8
[11] Eliopulos, E et al. Mortality of fire fighters in Western Australia. *British Journal of Industrial Medicine*. 1984 May;41(2):183-7.
[12] Feuer, E et al. Mortality in police and firefighters in New Jersey. *American Journal of Industrial Medicine.* 1986;9(6):517-27.
[13] Vena, JE and Fiedler, RC. Mortality of a Municipal-Worker Cohort: IV. Fire Fighters. *American Journal of Industrial Medicine*. 1987 11:671-684.
[14] Hansen, ES. A cohort study on the mortality of firefighters. *British Journal of Industrial Medicine*. 1990 Dec;47(12):805-9.
[15] Heyer, N et al. Cohort mortality study of Seattle fire fighters: 1945-1983. *American Journal of Industrial Medicine*. 1990 17(4):493-504.
[16] Sama, SR et al. Cancer incidence among Massachusetts firefighters, 1982-1986. *American Journal of Industrial Medicine*. 1990 18(1):47-54.
[17] Howe, GR and Burch, JD. Fire fighters and risk of cancer: an assessment and overview of the epidemiologic evidence. *American Journal of Epidemiology*. 1990 Dec;132(6):1039-50.
[18] Beaumont, JJ et al. An epidemiologic study of cancer and other causes of mortality in San Francisco firefighters. *American Journal of Industrial Medicine*. 1991 19: 357-372.
[19] Demers PA et al. Mortality among firefighters from three Northwestern United States Cities. *British Journal of Industrial Medicine*. 1992 49:664-670
[20] Guidotti, TL. Mortality of urban firefighters in Alberta, 1927-1987. *American Journal of Industrial Medicine.* 1993 23 (6): 921-40
[21] Burnett, CA et al. Mortality among firefighters: A 27 State survey. *American Journal of Industrial Medicine*. 1994 26:81-833.
[22] Tornling, G et al. Mortality and Cancer incidence in Stockholm firefighters. *American Journal of Industrial Medicine*. 1994 25: 219-228
[23] Aronson, KJ et al Mortality among fire fighters in metropolitan Toronto. *American Journal of Industrial Medicine*. 1994 Jul;26(1):89-101.
[24] Demers, PA et al. Cancer incidence among firefighters in Seattle and Tacoma Washington (United States). *Cancer Causes and Control.* 1994 5(2): 129-35.
[25] Guidotti, TL Occupational Mortality among Firefighters: Assessing the Association. *Journal of Occupational and Environmental Medicine.* 1995 37:1348-1356.
[26] Golden, AL et al. The Risk of Cancer in Firefighters. *Occupational Medicine: State of the Art Reviews*. 1995 10(4) 803-820.
[27] Ma, F et al. Race-specific cancer mortality in US firefighters: 1984-1993.*Journal of Occupational and Environmental Medicine*. 1998 Dec;40(12):1134-8.
[28] Baris, D et al. Cohort mortality study of Philadelphia firefighters. *American Journal of Industrial Medicine*. 2001 39: 463-476.
[29] Bates, MN et al. Is Testicular Cancer an Occupational Disease of Fire Fighters? *American Journal of Industrial Medicine*. 2001 40:263-270.

Haas *et al*.[30] Some of these articles document results of studies undertaken by the authors, and other articles are review articles dealing with the literature generally.

I have also read material prepared by the Industrial Disease Standards Panel (IDSP)[31] and the Michigan Environmental Science Board (MESB)[32]. Those publications concerning firefighting and cancer contain references to other documents that were not published in peer-reviewed publications. Notably, they cite a document prepared by L'Abbe and Tomlinson which was submitted to the IDSP (L'Abbe is the married name of Aronson noted above, and Haas *et al*. indicate that the reports are identical). Documents prepared by Rosenstock *et al*. and Rosenstock and Demers, as part of the Occupational Medicine Program at the University of Washington, appear to be similar to material prepared by Demers *et al*. and Heyer *et al*. noted above. Staples *et al*. dealt with members of the Melbourne Metropolitan Fire Brigade, and it is also cited as Giles *et al*. Lewis *et al*. was prepared by the Institute for Cancer and Blood Research in California. I have not sought out these other documents. They are summarized in the two publications. Ms. A also supplied a report by Landrigan *et al*.[33] concerning New York City firefighters. It does not appear to have been published in a peer-reviewed journal.

Cancer cases are rarely resolved by opinions that merely canvass the case of a particular worker. In most cases, epidemiologic evidence has been gathered and analyzed, and that evidence provides a relevant background for any opinion specific to the particular worker. The increasing number of cases involving such evidence appears to have been one of the main impetuses for the Board's issuance in 1993 of the *Protocol for the Assessment of Medical/Scientific Information - Industrial Diseases Standing Committee, Workers' Compensation Board of British Columbia* (the Protocol), at 9 W.C.R. 429.

I note the following comments from *Appeal Division Decision #93-0163* [9 W.C.R. 151] which I consider are still applicable to many cancer cases and the associated epidemiological issues:

> In considering the standard of proof to be applied, it is important to recognize the limitations in scientific and medical knowledge relating to cancer and its causes. Cancer is a disease whose causes are incompletely understood. Dr. C stated that although there are a number

[30] Haas, NS et al. Latent health effects in firefighters. *International Journal of Occupational and Environmental Health*. 2003 Apr-Jun;9(2):95-103
[31] No. 13: Report To The Workers' Compensation Board On Cardiovascular Disease And Cancer Among Firefighters (September, 1994) which may be viewed on the Internet at: http://www.canoshweb.org/odp/default.htm.
[32] Fischer, LJ, et al. 1999.*Evaluation of the Risk of Cancer among Fire Fighters*. Michigan Environmental Science Board, Lansing, Michigan. This report may be viewed on the Internet at MESB's website at: http://www.michigan.gov/mesb
[33] Landrigan et al. Occupational Cancer in New York City Firefighters. This appears to be a 1996 publication by *The Mount Sinai School of Medicine*

> of known causes of cancer in terms of specific agents which produce cancer, in the majority of cases a specific cause in a specific case cannot be identified. Because of this uncertainty, epidemiology provides the most important *generalized* evidence of whether there is an association between a particular condition existing in the environment, or population, and a particular disease or condition of health.
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> [reproduced as written]

I concur with the Appeal Division panel in *Appeal Division Decision #93-0163* that epidemiologic evidence informs decision-makers, but does not determine the matter before me:

> However, epidemiological evidence, like other generalized evidence, deals with categories of occurrences rather than particular individual occurrences. Epidemiology cannot determine which particular factor caused a particular person's disease, but only what factors are statistically associated with the occurrence of the disease in groups of people. As stated by counsel for the employer:
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> > It [epidemiology] presents conclusions based on the average person within the particular population. Once this "average" result is obtained, the information can be used to assess the potential risk which an individual within the particular population may face with respect to developing a certain disease.
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> ...Therefore, epidemiology's usefulness to particular claimants relates more directly to issues of risk than of actual occurrence.
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> Epidemiological studies cannot prove or disprove causation in an individual case. Proof of excess incidence of a certain cancer in a certain defined occupational group is not "proof" that the disease of the individual claimant, who belongs to that group, was work caused. Rather, such evidence is supportive of an increased likelihood in an individual case which can be weighed along with other evidence. On the other hand, the fact that there is no general, or a very small, excess does not "prove" that the individual's disease was not work caused. Again, it is relevant evidence to be considered along with all the other available evidence when assessing the possibilities and probability that a particular worker's cancer was caused or contributed to by his work.
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> [reproduced as written]

Heyer *et al*. noted that fire smoke is a complex and variable mixture that may include asbestos fibers, polyaromatic and halogenated hydrocarbons, heavy metals, acrylonitrile, ammonia, benzene, carbon monoxide, cyanides, formaldehyde, isocyanates, sulfides, styrene, and toluene. The panel in *Appeal Division Decision #2002-1282* (which may be viewed on the Board's website) made the following observations regarding the exposure of firefighters:

> It is generally accepted that firefighters are routinely exposed to extremely hazardous environments including a wide range of chemical compounds and products of combustion in uncontrolled conditions. The literature documents that firefighters are also commonly exposed to a wide variety of potential carcinogens such as benzene which is detectable at nearly all fires; polycyclic aromatic hydrocarbons (PAHs) found in soots, tars and diesel exhaust; arsenic found in wood preservatives; formaldehyde in wood smoke; and asbestos in building insulation. There is also the potential for exposure to uncommon but potent carcinogens such as pesticides, polychlorinated biphenyls and dioxins. (See William N. Rom, *Environmental and Occupational Medicine*, 1998 pages 1455 – 1464; Peter S.J. Lees, "Combustion Products and Other Fire Fighter Exposures", *Occupational Medicine*, Vol. 10, No. 4, 1995; and Vernon N. Dodson, "Exposure to Pyrolysis Products" in Carl Zenz, *Occupational Medicine*, 1994, pp 926-936).

Landrigan *et al*. noted that there are several established occupational exposures that increase the risk for cancer of the digestive system. They commented that it is hypothesized that, once cleared from the airways, inhaled particles and carcinogens that adhere to them are transferred to the gastrointestinal tract and swallowed. They observed that adenocarcinoma of the stomach has been associated with asbestos. They commented that firefighters have been shown to be at increased risk of numerous cancers, and they list stomach cancer as part of their list.

That there may a suggestion of an increased risk for stomach cancer does not resolve the matter. In examining the studies regarding firefighters and cancer, it is necessary to take into account such matters as relative risk and statistical significance.

Relative risk (RR) is the ratio of the disease incidence or death among people exposed to an agent to the disease incidence or death among the unexposed. A relative risk of 2.0 is often equated with a 50% likelihood that an exposed person's disease was caused by the agent, and a relative risk that is greater than 2.0 would permit an inference that an individual's disease was more likely than not caused by the implicated agent.

SMR is defined as a "standardized mortality ratio, equivalent to relative risk (observed cases divided by expected cases)."[34] In cancer incidence (as opposed to mortality) studies, SMR refers to standardized morbidity ratio; some authors also refer to SIR or standardized incidence ratio. An SMR may be expressed in two ways: 150 or 1.5.

When applying epidemiologic data to a particular worker's case, even a relative risk of less than 2.0 for an occupation may be persuasive if there are individual characteristics particular to the specific worker. A simple example of that would be where the overall risk for a particular occupation is 1.6, but there is a clear dose-response relationship which establishes that those workers with 30 or more years in the occupation have a risk of 2.0 or more, and the worker in question has 30 years or more of relevant employment.

An estimate based on a sample is likely to be off the mark, at least by a little, due to random error. The standard error gives the likely magnitude of this random error. Confidence intervals refine this idea.

A confidence interval is a range of values calculated from the results of a study within which the true value is likely to fall. The width of the interval reflects random error. If the limits of the interval do not include an SMR of 100 (a relative risk of 1.0), the risk is statistically significant. Inclusion of 100 or 1.0 in the interval means that the actual risk may be 1.0, which is the risk found in the comparison population (often the population of the country or state or province in which the workers being studied are employed). The larger the sample size in a study (all other things being equal), the narrower the confidence boundaries will be (indicating greater statistical stability), thereby reflecting the decreased likelihood that an association found in the study would occur if the true association is, in fact, 1.0. Confidence intervals are often noted in connection with relative risks. A 95% confidence interval means that the range set by the interval will contain the true risk 95% of the time.

A *p* value is the probability of getting a value of the test outcome equal to or greater than that observed in the study, when in truth there is no association. The absence of an association is often called the null hypothesis, that is, the hypothesis that there is no association between an agent and a disease. Studies are conducted to determine whether there is evidence to reject the null hypothesis.

An outcome is statistically significant when the observed *p* value for the study falls below the pre-selected significance value. The lower the value, the less likely that random error would have produced the observed relative risk if the true relative risk is 1.0. Statistical significance does not address the magnitude of any association found in a study, but rather it assesses the role of random error. A very common significance level is .05. A .05 value means that the probability is 5% of observing an association as large as the one found in the study, when in truth there is not one. Thus, if one

[34] The Protocol, at page 450.

conducted an examination of a large number of associations in which the true relative risk equals 1.0, on average one in 20 associations found to be statistically significant at a .05 level would be spurious.

Any requirement that a relative risk be 2.0 or more, and that accompanying confidence intervals do not include 1.0 before causation is accepted, does not equal a requirement that evidence must establish there is a 95% likelihood of a causal relationship. A relative risk of 2.0 means that the association is at least 50% likely, and the appropriate confidence intervals mean that the true risk falls in the interval 95% of the time. I emphasize that the use of a figure of 95% does not involve a requirement that there be proof beyond a reasonable doubt that there is causation.

I accept that epidemiologists differ from judges and tribunal decision-makers in their viewpoints as to matters of causation and the bases of establishing causation. A number of courts in the United States have required that a study be statistically significant before it can be relied on by an expert, while others appear more cautious about using significance testing as a necessary condition, instead recognizing that the likelihood of random errors is important in determining the probative value of a study. I consider the latter approach to be a reasonable one. Thus, the issue of a causal link does not entirely rest on whether the data are statistically significant.

In applying epidemiologic concepts to the studies documented in the articles noted above, I consider it significant that there are very few studies which established that firefighters were at a greatly increased statistically significant risk♦ for stomach cancer:

- In Eliopulos *et al*. (Western Australian Fire Brigade firefighters) the standardized proportional mortality ratio for stomach cancer was 2.02, but it was not statistically significant.

- In Vena and Fiedler (Buffalo firefighters) the standardized mortality ratio of 1.19 for stomach cancer was not statistically significant. Of interest is the fact that the table setting out cause-specific mortality by number of years worked as a firefighter used the general category “digestive cancer”, which involved ICD-8 codes 150 to 159. (ICD-8 refers to the *International Classification of Diseases*, Eighth Edition). Notably, the relative risk did not exceed 1.0 for up to 29 years of work as a firefighter. Relative risks of 1.33 and 3.08, respectively, for digestive cancer were associated with from 30 to 39 years worked as a firefighter and 40 years or more. Only the latter figure was significant at the .05 level. The worker, in this case, did not work as a firefighter for 30 years, let alone for 40 years.

♦ In the following discussion, I have used the terms employed by the authors in their reports describing the risks and results. In many cases, the authors used SMR, but in other cases the authors refer to rate ratios, standardized proportional mortality ratios, and mortality odds ratios, depending on the type of study undertaken by the authors.

I consider it significant that most of the studies published after Vena and Fiedler's 1987 study break down the codes into individual cancer sites. Cancer of the stomach is item 151 in the ICD-8 and ICD-9 used by authors. Cancer risk at various portions of the digestive system is not uniform, as established by the various studies, and thus data regarding the risk of cancer in the digestive system is not of considerable assistance in assessing stomach cancer.

- In Heyer *et al*. (Seattle firefighters) the standardized mortality ratio for stomach cancer was 113, but it was not statistically significant. The rest of the study used the category of digestive cancer, and the standardized mortality ratios did not exceed 100 in the tables dealing with deaths from cancers organized by time since first exposure and by duration of exposure. Standardized mortality ratios under 100 were identified in connection with deaths from digestive cancer, both under the age of 65 and over the age of 65.

- In Beaumont *et al*. (San Francisco firefighters) the rate ratio for stomach cancer mortality was 1.31, but it was not statistically significant. The authors calculated rate ratios dealing with stomach cancer by time since first employment and by length of employment. Notably, the rate ratio for stomach cancer was higher in the period 3 to 19 years since first employment (1.31) than the period 20 to 29 years (0.26) or the period 30 to 39 years (0.91). Thus, there were inconsistent results dealing with latency. Of interest is the fact that the only statistically significant rate ratio was that of 2.32 for the category 40 years of employment or more. (As noted above, the case before me does not concern a worker who worked for more than 30 years as a firefighter). In the table dealing with length of employment, the rate ratio of 1.56 for the category of three to nine years was larger than the rate ratio of 1.15 for the 10 to 19 years category and the rate ratio of 1.03 for the 20 to 29 years category. The rate ratio for the category of 30 years or more was 1.67. Thus, there were not consistent increasing rates of mortality associated with increasing duration of employment. These figures were not statistically significant.

- In Demers *et al.* (1992) (Seattle, Tacoma, and Portland firefighters) the standardized mortality ratio of 1.07 for stomach cancer was not statistically significant. The authors conducted specific analyses of several cancers in the rest of their study, but stomach cancer was not one of them.

- In Guidotti (1993) (urban Alberta firefighters) the standardized mortality ratio for cancer of the stomach was 80.9, and it was not statistically significant. The author selected numerous cancers for further discussion in his article, but cancer of the stomach was not one of them.

- In Aronson *et al*. (metropolitan Toronto firefighters) the standardized mortality ratio for cancer of the stomach was 51, and it was not statistically significant. The authors selected a number of cancers for further analyses in their study, but cancer of the stomach was not one of them.

- In Demers *et al*. (1994) (Seattle and Tacoma firefighters) the standardized incidence ratio for cancer of the stomach was 1.4, but it was not statistically significant. The authors calculated standardized incidence ratios by duration of exposed employment and by years since first employment. These figures were not statistically significant. Of interest is the fact that, with respect to duration of active duty in direct firefighting positions, the standardized incidence ratio did not increase consistently: 3.0 for less than ten years, 1.2 for ten to 19 years, 1.1 for 20 to 29 years, and 1.4 for 30 years or more. There was a similar lack of consistency dealing with stomach cancer incidence since date of first employment: 0.0 for less than 20 years, 2.3 for 20 to 29 years, and 1.3 for 30 years or more. These figures were not statistically significant. This study is notable for the fact that duration of employment measurement used active duty in direct firefighting positions.

- In Ma *et al*. (firefighters in 24 U.S. states) the mortality odds ratio for stomach cancer was 1.2, but it was not statistically significant.

- In Baris *et al*. (Philadelphia firefighters) the standardized mortality ratio for stomach cancer was 0.90, and it was not statistically significant. The authors calculated standardized mortality ratios for stomach cancer by duration of employment as a firefighter, and the figures did not increase consistently: 0.55 for less than nine years, 1.39 for 10 to 19 years, and 0.65 for over 20 years. These figures were not statistically significant. The authors also calculated standardized mortality ratios by company type. The standardized mortality ratio for stomach cancer for engine companies was 0.91 and for ladder companies it was 1.85. Neither figure was statistically significant. They also calculated standardized mortality ratios for stomach cancer by year of hire. Interestingly, the standardized mortality ratios dropped noticeably when moving from earliest to most recent hire year. The figure for firefighters hired before 1935 was 1.19, whereas it was 0.60 for those hired between 1935 in 1944, and 0.5 for those hired after 1944. These figures were not statistically significant. The authors also calculated standardized mortality ratios based on cumulative number of runs. The standardized mortality ratios did not increase significantly, or even approach 1.0, when moving from less than 3,323 runs (0.66), to 3,323 to 5,099 runs (0.31), to more than 5,099 runs (0.66). These figures were not statistically significant.

- In Bates *et al*. (Wellington firefighters) the standardized incidence ratio for stomach cancer for the period 1977 to 1996 was 0.76, and it was not statistically significant. Neither the standardized incidence ratio of 0.89 for the period 1990 to 1996 nor the standardized mortality ratio of 1.16 for the period 1977 to 1995 was statistically significant.

There was only one study which showed several risks over 2.0 that were statistically significant:

- In Tornling *et al*. (Stockholm firefighters) the standardized morbidity ratio between 1958 and 1986 for stomach cancer was 192, and it was statistically significant. The standardized morbidity ratio for stomach cancer associated with more than 30 years employment was 289, and it was statistically significant. The figures for less than 20 years of employment (102) and 20 to 30 years (118) were not statistically significant. Standardized morbidity ratios for latency periods of less than 30 years and 30 to 40 years were 481 and 606, respectively. Both of them were statistically significant. The standardized morbidity ratio for stomach cancer in firefighters who attended at more than 1,000 fires was 264, and it was statistically significant. Figures for less than 800 fires (104) and 800-1,000 fires (137) were not statistically significant.

  In Tornling *et al*. the standardized mortality ratio for deaths due to stomach cancer between 1951 and 1986 was 121, and it was not statistically significant. (Tornling *et al*. studied both mortality and morbidity.) Not one of the standardized mortality ratios for stomach cancer associated with years of employment was statistically significant: less than 20 years (108), 20 to 30 years (105), and more than 30 years (141). Standardized mortality ratios for latency periods were not consistent and were not statistically significant: less than 30 years (192), 30 to 40 years (140), and more than 40 years (104). The standardized mortality ratio for stomach cancer in firefighters who attended more than 1,000 fires was 196, and it was not statistically significant. Figures for less than 800 fires (51) and 800-1,000 fires (59) were also not statistically significant.

Some studies did not specifically deal with stomach cancer:

- Musk *et al*. (Boston firefighters) dealt with cancer of the digestive system; the standardized mortality ratio was 80, and it was not statistically significant.

- Feuer *et al*. (New Jersey firefighters) dealt with cancer of the digestive system which comprised ICD-8 code items 150 to 159.

- Hansen (Denmark firefighters) used the categories of lung and non-lung malignant neoplasms. Stomach cancer was not directly identified.

- Sama *et al.* (Massachusetts firefighters) listed cancer of the colon and cancer of the rectum, but it did not list cancer of the stomach.

- Burnett *et al*. (firefighters in 27 U.S. states) provided proportionate mortality ratios for the general category of ICD-9 codes 140 to 208 and for the rectum, but it did not provide any information specific to stomach cancer.

Epidemiological evidence is not mandatory before a claim may be accepted. As an example, there may be cases where there are clusters of rare diseases and their incidence so defies chance that there must be a causal link. Where there is a significant amount of relevant epidemiological evidence, I consider that it must be accorded a fair amount of weight, as it represents a significant assessment of the exposure and its possible effects.

Ms. A draws attention to comments in Landrigan *et al*. to the effect that, if a study does not rank firefighters according to a cumulative index of exposure, heavily exposed firefighters are co-mingled with lightly exposed firefighters, and the risks to the heavily exposed firefighters are "diluted out" and underestimated by the design of the studies. That is a valid observation, but there are studies like Baris *et al*., Burnett *et al*., Demers *et al*. (1994), and Tornling *et al*. that have sought to make allowances in this regard by addressing duration of employment and number of runs, which might assist in understanding any increases in risk associated with greater exposure. Those studies have information concerning stomach cancer. It is true that even duration of employment and number of runs may not be adequate proxies or surrogates for measuring intensity of exposure (a point made, in part, in Demers *et al*. (1994)). Further, Aronson *et al*. and Heyer *et al*. note that very different exposures can occur for two firefighters at the same fire, even if they are side by side. Thus, I accept that an assumption of uniform exposure may dilute the variability in risk associated atypical exposures.

Studies like Feuer *et al*., Heyer *et al*., Guidotti (1993), and others also have assessed duration of employment, but they have either not documented information regarding stomach cancer or have only addressed the larger category of cancers of the digestive system.

Ms. A contends that "the available epidemiologic and medical literature presents **convincing and consistent** evidence of causal associations between toxic exposures encountered by firefighting and cancer." (emphasis added) She also submits that "According to the **statistically significant** research that has been performed and the data collected, stomach cancer in firefighters is an occupational disease and should be recognized as such, provincially, federally and internationally." (emphasis added)

As demonstrated by a review of the individual articles concerning the various studies, there is very little statistically significant data supporting a strong link between

firefighting and stomach cancer. Further, I do not think that much of the evidence as to a link is convincing and consistent. In viewing the results of studies where the standardized mortality ratios were above 100 or 1.0, I consider that it must be kept in mind that, as noted in the Protocol at page 445, a relative risk of 1.4 or 1.5 (similar to a standardized mortality ratio of 140 or 150), by itself, is not very impressive because there are so many confounding variables. The Protocol goes on, however, to note two qualifications regarding the overall relative risk. An intermediate relative risk can become more "convincing" when a dose-response relationship is indicated, and, where a relative risk is below 2.0, the "attributable risk technique" can be used to provide a measure of the probability that an individual case is work-related.

There are numerous studies with data that point away from a link. In Baris *et al.* standardized mortality ratios for stomach cancer did not exceed 1.0 for duration of employment of over 20 years, or for medium or high numbers of runs. A figure of less than 1.0 is consistent with firefighters having a cancer risk less than that found in the general population. While the figures in Baris *et al*. were not statistically significant, it is notable that the standardized mortality ratios in the Baris *et al*. were well below 1.0.

The *Baris et al*. study is of note as the number of Philadelphia firefighters involved (7,789) and the time period covered (1925 to 1986) meant that 204,821 person years at risk were accumulated. There were 2,220 deaths. The study is considerably larger than the 316 deaths among the 1,116 Stockholm firefighters studied by Tornling *et al*. for the period from 1951 to 1986, concerning firefighters who worked for the city from 1931 to 1983. The Burnet *et al*. study did involve a large number of deaths (5,744 in 27 U.S. states), but there is no information in that study specific to stomach cancer.

It was noted in *Appeal Division Decision #2003-0599* and *WCAT Decision #WCAT-2003-02212-AD* (viewable on the Internet at the websites of the Board and WCAT, the latter which is found at: http://www.wcat.bc.ca) that there have been arguments in support of preferring positive study results. The panel in that case did not consider that the evidence established that biases toward the null association were necessarily stronger than biases away from the null such that one should automatically attach greater weight to studies whose positive results may have overcome biases toward the null. I accept the comments by that panel which observed that, in the absence of a demonstrable concern with a study and its resulting data, the results of all studies should be given some weight. There may be cases where, owing to concerns with design, a study is not the equal of a larger, better conducted study, but that concern would apply to any study, regardless of whether it produced positive results, or inconclusive or negative results. Thus, the focus perhaps should be on design, although magnitude may also be of significance. In that regard, I note that the Baris *et al*. study is considered one of the larger studies, with very good follow-up, that has statistical power and is well designed and allows for subgroup analysis.

I am aware that studies of firefighters are not uniform, in the sense that they may differ in the nationality of the firefighters, the period during which they were exposed, the types of exposure involved, and the type and usage of protective equipment like self-contained breathing apparatuses, to name a few factors. Yet, many of the studies noted above concern firefighter populations that would likely share some similarities with the firefighter population of which the worker was a member. As well, those are the reports that are available in the literature.

In *Appeal Division Decision #2003-0599* and *WCAT Decision #WCAT-2003-02212-AD* the panels discussed in detail whether the data obtained for firefighters should take into account the "healthy worker effect" when assessing matters of association. There may be some basis to modify the figures obtained in connection with various studies, to take into account the effect. However, I do not consider that any modification in the range of 8 or 10% would significantly affect the review of the issue of association or causation.

In assessing the issue of causation generally, I consider it appropriate to consider the Hill criteria. A critical analysis of epidemiologic studies includes an analysis of causation based on criteria generally accepted by epidemiologists as factors useful in making judgments about causation. These criteria were initially developed by the U.S. Surgeon General in 1964, to be used to assess the relationship between smoking and lung cancer, and they were expanded upon by A. Bradford Hill in 1965[35]. They are listed by Hill as follows:

1. Strength of the association
2. Consistency
3. Specificity of the association
4. Temporal relationship
5. Dose response relationship
6. Biological plausibility
7. Coherence
8. Experiment
9. Analogy

Similar criteria are set out in the Board's Protocol.

The original presentation at which Hill posited these factors indicated that they were applied when there was a clear-cut association between two variables that was not due to chance, and one wanted to consider aspects of the association before deciding that the most likely interpretation of the association was causation. It is true that, in the case before me, the literature does not establish a clear-cut association

[35] A Bradford Hill, The Environment and Disease: Association or Causation? 58 *Proceedings of the Royal Society of Medicine*. 295. Hill acknowledged that his factors could only serve to assist in the inferential process: "None of my nine viewpoints can bring indisputable evidence for or against the cause-and-effect hypothesis and none can be required as a *sine qua non*."

between firefighting and stomach cancer. Thus, it may not be strictly necessary to consider the Hill criteria. However, for the sake of completeness, I have proceeded to examine them as part of a method of reviewing the literature generally.

I consider that in the case before me the critical factors are strength of association, consistency, and dose-response relationship and that those factors are not satisfied when applied to the firefighter population in general.

As noted above, the strength of association is rarely found in the studies to be close to 2.0 or 200, and it is often below 1.0 or 100. Certainly, any pooling of the risk as part of a meta-analysis would produce a global risk figure well below 2.0 or 200. The results are not consistent among the studies. Further, the data do not persuasively establish a dose-response relationship. In that regard, in Baris *et al*. the risk of stomach cancer mortality varied significantly using the measurement of duration of employment and number of runs, rather than rising steadily. A steady increase might be expected if the cancer was a response to increasing exposure to carcinogens. I am aware of the results in Tornling *et al*., which point to an increased risk of morbidity associated with the number of fires attended, years of employment, and latency. The mortality data in Tornling *et al*. were not as consistent in suggesting a dose-response. As well, Tornling *et al*. was but one study, and one study does not represent the sum of the literature. Further, even the standardized morbidity ratio for firefighters, like the worker in the case before me, who worked between 20 and 29 years, was 118 which is not an especially elevated number. In Demers *et al*. (1994) the data regarding duration of employment and incidence since first employment did not show a consistent increasing risk. In Beaumont *et al.* the data also did not show a consistent increasing risk associated with increasing years since first employment and length of employment.

I question whether the assessment process stops once one is not satisfied that the studies consistently demonstrate a positive association from which one can exclude the contribution of chance. In that regard, the issue before me is not whether firefighters as a group have a doubling of risk, but rather whether the individual worker had a doubling of his risk. The case before me does concern a particular firefighter, and I must decide his widow's entitlement. However, assessment of risk of an individual cannot be divorced from an assessment of the risk attached to firefighters as a group.

Ms. A has commented that, owing to the size of the fire department, the worker would have attended most fires to which the department responded in the years between 1976 and 1993. He also attended fires after 1993. The documents provided by her establish that there were 1,507 "fire incidents" between 1976 and 2003 in the area served by the worker's fire department. While she asks that the employer provide copies of log books and payroll records for that time period so that it may be determined how many fires the worker attended, I do not consider that is necessary. I accept that the worker attended hundreds of fires. She indicates that he was usually the first firefighter into a burning building and the last man out. She has also provided

information about some of the fires attended by the worker. The employer has also provided journal entries dealing with some of the fires attended by the worker. It also comments that attendance at a fire does not establish exposure to a carcinogen and does not indicate what activities a firefighter might have undertaken.

I do not consider that the evidence is sufficient to establish that the worker's individual exposure was such that his personal risk was so elevated that the possibility that his cancer was due to the nature of his employment was equally balanced with the possibility that it was not. The worker's exposure would have to have been extraordinary, when compared to a cohort of firefighters with a similar number of years of employment, to elevate his personal risk to 2.0 or more. I consider that it would be speculative to determine that his risk was more than triple that of the firefighters studied by Baris *et al*. whose risk associated with employment of more than 20 years was 0.65, or more than triple the risk of firefighters who undertook a high number of runs (0.66). In Demers *et al*. (1994) the cancer incidence risk of firefighters whose duration of employment involved in active duty in direct firefighting was between 20 and 29 years was 1.1. I consider that it would be likely that those firefighters would have attended the types of fires attended by the worker.

Ms. A notes that the worker attended a fire at which rubber-based bales of artificial turf were on fire. I am not persuaded that attendance at such a fire put the worker at a risk similar to workers studied by Straif *et al*. which concluded that there was an association between excess mortality from stomach cancer and employment in early production stages of rubber manufacturing. That fire occurred six months before the worker was diagnosed with stomach cancer, and it would seem very unlikely that his cancer would have been caused by that exposure.

Conclusion

I deny Ms A's appeal. I confirm the review officer's decision, and I find that the worker's death was not due to the nature of his employment.

Randy Lane
Vice Chair

RL/jy