
Court of Appeals No. 10CA1494
Industrial Claim Appeals Office of the State of Colorado
WC No. 4-745-560

City of Littleton, Colorado, Littleton Fire Rescue; and CCMSI,

Petitioners,

v.

Industrial Claim Appeals Office of the State of Colorado; Julie Christ, surviving spouse and personal representative of Jeffrey J. Christ, deceased; and Michelle Parris, on behalf of Lauren Parris,

Respondents.

ORDER AFFIRMED

Division V
Opinion by JUDGE RUSSEL
Román, J., concurs
Carparelli, J., dissents

Announced November 1, 2012

Nathan, Bremer, Dumm & Myers, P.C., Anne Smith Myers, Timothy R. Fiene, Denver, Colorado, for Petitioners

John W. Suthers, Attorney General, Katie Allison, Assistant Attorney General, Denver, Colorado, for Respondent Industrial Claim Appeals Office

Law Office of O'Toole and Sbarbaro, P.C., Neil D. O'Toole, Denver, Colorado, for Respondent Julie Christ

Wilcox & Ogden, P.C., Ralph Ogden, Denver, Colorado, for Respondent Michelle Parris

¶ 1 This workers' compensation appeal arises from an order issued by the Industrial Claim Appeals Office (the panel). The City of Littleton and its insurer, CCMSI (collectively, Littleton), seek review of the panel's order in favor of Littleton's employee, firefighter Jeffrey J. Christ (claimant). We affirm.

I. Introduction

¶ 2 Claimant was hired by Littleton in 1987. He started as a combat firefighter and was eventually promoted to battalion chief. Over his career, claimant responded to hundreds of fires and other situations involving hazardous materials.

¶ 3 In 2007, claimant was diagnosed with glioblastoma multiforme (GBM), a type of brain cancer. He underwent surgery and was treated with chemotherapy and radiation. He then sought workers' compensation benefits to cover his treatment. Littleton objected, and the case was brought before an administrative law judge (ALJ).

¶ 4 After hearing evidence, the ALJ denied claimant's request for benefits. The ALJ recognized that claimant's cancer was statutorily presumed to have resulted from his employment. *See* § 8-41-209, C.R.S. 2012. But she ruled that Littleton had proved that claimant's cancer was "not caused by his occupational exposures."

¶ 5 Claimant then turned to the panel. After reviewing the evidence, the panel ruled that Littleton had failed to sustain its burden of proof. The panel reversed the ALJ's order and remanded for a determination of benefits.

¶ 6 On remand, the ALJ awarded claimant both medical and disability benefits. The panel upheld that award.[1]

¶ 7 Littleton now appeals the panel's decision. It asks us to decide whether its evidence was sufficient to sustain its burden of proof under section 8-41-209. To resolve that issue, we must determine what the statute does and examine Littleton's evidence in light of that determination.

¶ 8 Our discussion is divided into several parts:

Part II.A	We explain how causation is established and analyzed in a traditional case.
Part II.B	We examine the statute and highlight its key features.
Part II.C	We explain the statute's practical effect in light of traditional toxic tort principles.

[1] While his benefits were being determined, claimant succumbed to his brain cancer. His widow, Julie Christ, was substituted as the claimant. Michelle Parris, the mother of claimant's biological child, Lauren Parris, joined the action as an additional claimant.

Part III We outline the evidence presented and explain the ALJ's and panel's rulings.

Part IV We analyze the evidence presented.

Part V We conclude that Littleton failed to sustain its burden of proof.

II. The Firefighter Statute

¶ 9 To understand the effect of section 8-41-209, one must first understand how causation is typically proved in a toxic exposure case. We therefore begin by reviewing proof of causation in a traditional tort or workers' compensation case.

A. Causation in the Usual Case

¶ 10 In a traditional case, the plaintiff must prove causation. That element may be easy or difficult to prove, depending, in part, on the type of case.

¶ 11 In a traumatic injury case, causation is usually a simple matter. *See* Restatement (Third) of Torts: Liability for Physical and Emotional Harm § 28 cmt. c(1) (2010) ("When a passenger in an automobile collision suffers a broken limb, potential causal explanations other than the collision are easily ruled out; common experience reveals that the forces generated in a serious automobile collision are capable of causing a fracture."). But causation is not

simple when the plaintiff claims that he developed a disease through an exposure to a toxic substance. In that case, causation is complicated by (1) significant latency periods between the alleged exposure and the claimed disease, and (2) imperfect knowledge about the biological history of that disease. *See id.*

¶ 12 In this latter type of case, courts traditionally evaluate the plaintiff's proof by examining two aspects of causation: general causation and specific causation. *See, e.g., Raynor v. Merrell Pharm., Inc.*, 104 F.3d 1371, 1376 (D.C. Cir. 1997) (causation in toxic tort cases is discussed in terms of general causation and specific causation).[2]

1. *General causation*

¶ 13 To prove general causation, the plaintiff must show that the "substance is capable of causing a particular injury or condition in the general population." *Norris v. Baxter Healthcare Corp.*, 397 F.3d 878, 881 (10th Cir. 2005).

[2] General and specific causation are not separate elements. They are analytical categories that courts use to evaluate proof of "but for" causation. *See* Restatement (Third) of Torts: Liability for Physical and Emotional Harm § 28 cmt. c(1).

¶ 14 Plaintiffs usually try to prove general causation through two types of evidence. First, plaintiffs offer toxicological evidence, which is usually based on in vitro experiments and animal studies. *See* Gerald W. Boston, *A Mass-Exposure Model of Toxic Causation: The Content of Scientific Proof and the Regulatory Experience*, 18 Colum. J. Envtl. L. 181, 214-15 (1993). Second, plaintiffs offer testimony based on epidemiological studies. Courts regard epidemiology as the best evidence of general causation. *See Norris*, 397 F.3d at 882.

¶ 15 In an epidemiological cohort study, an investigator examines disease rates in a population that has been exposed to a substance, and then compares that result with the disease rates in a population that has not been exposed. The comparison yields a ratio known as the relative risk:

> This comparison of rates is the relative risk: the risk in the exposed population relative to the risk in the non-exposed population. This may be expressed as: Relative Risk ("RR") = R1/R2, where R1 = the risk of disease in the exposed population and R2 = the risk of disease in a non-exposed population.
>
> If the relative risk equals one (i.e., the numerator is the same as the denominator), the risk in the exposed group is the same as the risk in the non[-]exposed group, and there is no suggestion of any association between

> the factor and the disease in question. If the relative risk is greater than one, the risk in the exposed group is greater than in the non-exposed group, and there is a positive association between the exposure and the disease. Conversely, if the relative risk is less than one, then the risk in exposed individuals is less than the risk in non-exposed individuals, suggesting a protective effect.

Boston, 18 Colum. J. Envtl. L. at 235 (footnotes omitted).

2. *Specific causation*

¶ 16 To prove specific causation, the plaintiff must establish, by particularized evidence, that the alleged exposure caused his specific disease. Evidence about the plaintiff's medical history and his particular exposure (the dose, frequency, and duration) will be important. *See, e.g., Allen v. Pennsylvania Eng'g Corp.*, 102 F.3d 194, 199 (5th Cir. 1996) ("Scientific knowledge of the harmful level of exposure to a chemical, plus knowledge that the plaintiff was exposed to such quantities, are minimal facts necessary to sustain the plaintiffs' burden in a toxic tort case."); *Downs v. Perstorp Components, Inc.*, 126 F. Supp. 2d 1090, 1095 (E.D. Tenn. 1999) (discussing components of specific causation — qualitative toxicity, dose-response, temporality, confounders, and coherence — and noting that "[f]ailure to establish even one of these criteria . . . is

usually fatal to the proposition that exposure to a specific chemical caused a specific medical condition").

B. Section 8-41-209

¶ 17 Consider now a firefighter who believes that his disease was caused by an exposure to a toxic substance that he encountered while battling fires. How will he fare under the traditional model?

¶ 18 The answer is "badly." And it is easy to see why. First, the firefighter may have no way of identifying the substances to which he was actually exposed. (Rarely is monitoring equipment installed at a fire scene before the firefighters arrive.) Consequently, he may be unable to locate the relevant epidemiological studies, if indeed those exist.[3] Second, even if the firefighter can show that he was exposed to a substance that is known to cause his type of disease, he may lack the kind of information needed to prove specific causation. *See, e.g., Estate of George v. Vermont League of Cities & Towns*, 993 A.2d 367, 369 (Vt. 2010) (affirming summary judgment where the firefighter presented no evidence about the substances

[3] "The vast majority of potentially hazardous substances have not been subjected to epidemiological study, creating an evidentiary gap of potential concern to the tort system." Mark Geistfeld, *Scientific Uncertainty and Causation in Tort Law*, 54 Vand. L. Rev. 1011, 1013 (2001) (footnote omitted).

present at his fires and no evidence about "the frequency of exposure or types of exposures that [he] may have had").

¶ 19 In 2007, the legislature made it easier for firefighters to recover benefits. It enacted a statute that reverses the usual burden of proof in a narrow class of cases:

> (1) Death, disability, or impairment of health of a firefighter of any political subdivision who has completed five or more years of employment as a firefighter, caused by cancer of the brain, skin, digestive system, hematological system, or genitourinary system and resulting from his or her employment as a firefighter, shall be considered an occupational disease.
>
> (2) Any condition or impairment of health described in subsection (1) of this section:
>
> (a) Shall be presumed to result from a firefighter's employment if, at the time of becoming a firefighter or thereafter, the firefighter underwent a physical examination that failed to reveal substantial evidence of such condition or impairment of health that preexisted his or her employment as a firefighter; and
>
> (b) Shall not be deemed to result from the firefighter's employment if the firefighter's employer or insurer shows by a preponderance of the medical evidence that such condition or impairment did not occur on the job.

§ 8-41-209.

¶ 20 This statute has three important features.

1. *Causation is presumed*

¶ 21 A firefighter can rely on the statute if he meets the following conditions: (1) he has worked as a firefighter for at least five years; (2) he suffers from one of the listed forms of cancer; and (3) after becoming a firefighter, he underwent a physical exam that revealed no evidence of his current disease. § 8-41-209(1), (2)(a).

¶ 22 If those conditions are met, specific causation is presumed. The firefighter's cancer is considered an "occupational disease"[4] that is presumed to have been caused by a workplace exposure. *See* § 8-41-209(2)(a) (impairment of health "[s]hall be presumed to result from a firefighter's employment").

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[4] This term is defined as follows:

> "Occupational disease" means a disease which results directly from the employment or the conditions under which work was performed, which can be seen to have followed as a natural incident of the work and as a result of the exposure occasioned by the nature of the employment, and which can be fairly traced to the employment as a proximate cause and which does not come from a hazard to which the worker would have been equally exposed outside of the employment.

§ 8-40-201(14), C.R.S. 2012.

¶ 23 By necessary implication, general causation is also presumed. (If one presumes that occupational exposures caused a particular cancer, one necessarily also presumes that those exposures could have caused that type of cancer.)

2. *The presumption is substantive*

¶ 24 The presumption of causation is not irrebuttable, for it may be overcome "by a preponderance of the medical evidence." § 8-41-209(2)(b). But neither is it the kind of rebuttable presumption that merely shifts the burden of going forward. *See generally Krueger v. Ary*, 205 P.3d 1150, 1154 (Colo. 2009) (discussing "rebuttable presumptions"). It is a substantive presumption — one that remains in the case as affirmative evidence, creating an inference that must be overcome by contrary evidence.

¶ 25 The substantive nature of the presumption is apparent, not only from the statute's plain language, but from its underlying purpose. *See, e.g., Montgomery Cnty. Fire Bd. v. Fisher*, 468 A.2d 625, 631 (Md. 1983) (concluding that a statutory presumption is substantive, in part because it reflects a social policy affording preferential treatment to firefighters; although rebuttable, this presumption remains in the case and constitutes affirmative

evidence on the firefighter's behalf); *cf. Kokins v. Teleflex, Inc.*, 621 F.3d 1290, 1305-06 (10th Cir. 2010) (even though it uses the term "rebuttable," Colorado's products liability statute creates a substantive presumption that must be considered, with other evidence, in determining whether a product is defective).

3. *The presumption is broad*

¶ 26 The statute contains no text that would limit the ways in which a firefighter is presumed to have gotten his cancer. It presumes that the cancer resulted from the firefighter's employment *somehow*.

¶ 27 The statutory presumption is broad in two ways.

¶ 28 First, it contemplates a wide range of potential exposures. The statute presumes that the pertinent type of cancer (here, GBM) can be caused by an exposure to some unspecified substance or intangible agent (such as radiation). It presumes that the claimant was exposed to such substances or agents while working as a firefighter. And it presumes that those exposures caused the firefighter's particular cancer.

¶ 29 Second, it contemplates a wide range of biological mechanisms. The statute presumes that the unspecified exposure

caused the firefighter's cancer directly, or in combination with other genetic or environmental factors.[5] It presumes that the exposure either caused a disease that would not otherwise have occurred, or hastened the onset of a disease that the firefighter would have developed later.[6]

C. Effect of the Statute

¶ 30 The statute places a formidable burden on the firefighter's employer. The difficulty lies not in the degree of proof required (which, as noted, is merely a preponderance of the evidence), but in the breadth of the presumption, the nature of the facts presumed, and its practical effect under traditional toxic tort principles.

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[5] Under Colorado's workers' compensation scheme, a worker can recover for occupational exposures that contribute to a pre-existing condition. *See Subsequent Injury Fund v. State Comp. Ins. Auth.*, 768 P.2d 751, 753 (Colo. App. 1988) (if employment conditions act upon a pre-existing weakness so as to disable a worker, the worker suffers a compensable occupational disease), *aff'd*, 793 P.2d 580 (Colo. 1990); *Denver v. Hansen*, 650 P.2d 1319, 1321 (Colo. App. 1982) (compensation does not depend on the worker's health or his "freedom from constitutional weakness or latent tendency") (quoting *Peter Kiewit Sons' Co. v. Indus. Comm'n*, 124 Colo. 217, 220, 236 P.2d 296, 298 (1951)).

[6] Workers can also recover for "early onset" causation. *See Anderson v. Brinkhoff*, 859 P.2d 819, 825 (Colo. 1993) (accelerated progress of a worker's genetic disease, caused by occupational exposure to dust, was a compensable occupational disease).

¶ 31 In a traditional case, a defendant can prevail simply by undermining the plaintiff's assertion of general causation. For example, if the plaintiff relies on a study which indicates that a particular substance causes brain cancer, the defendant can win outright by convincing the fact finder that the plaintiff's study is unreliable.

¶ 32 The same is not true under the statute.

¶ 33 The legislature considered whether firefighting exposures can cause certain cancers.[7] And it responded with a statute that presumes causation. That statute reflects a valid policy choice, and an employer gains nothing by challenging the wisdom or the evidentiary foundation of the legislature's decision. *See City of Frederick v. Shankle*, 785 A.2d 749, 755 (Md. 2001) (employer's evidence "must be particular to the claimant . . . and not a total and absolute denial of the presumption"); *Linnell v. City of St. Louis*

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[7] *See* Hearings on H.B. 07-1008 before the H. Comm. on Business Affairs & Labor, 66th Gen. Assemb., 1st Sess. (Feb. 1, 2007) (testimony of Erika Olson, M.D., Johns Hopkins University; testimony of Mark Frank, M.D., Medical Director, Pinnacol Assurance); Hearings on H.B. 07-1008 before the S. Comm. on State, Veterans & Military Affairs, 66th Gen. Assemb., 1st Sess. (Apr. 11, 2007) (testimony of Virginia Weaver, M.D., Johns Hopkins University; testimony of Mark Frank, M.D.; and testimony of Javier Waksman, M.D., University of Colorado Health Sciences Center).

Park, 305 N.W.2d 599, 601 (Minn. 1981) (if the presumption is to have its intended effect, it cannot be rebutted by medical opinion denying the correctness of its underlying theses); *Robertson v. N.D. Workers Comp. Bureau*, 616 N.W.2d 844, 855 (N.D. 2000) (same); *Sperbeck v. Dep't of Indus., Labor & Human Relations*, 174 N.W.2d 546, 549 (Wis. 1970) (same).

¶ 34 Instead of attacking the statute, the employer must rebut the presumption. The employer must affirmatively prove, by a preponderance of the evidence, that the firefighter's cancer did not result from, arise out of, or arise in the course of the firefighter's employment. § 8-41-209(2)(b) (employer or insurer must show "that such condition or impairment did not occur on the job").

¶ 35 This means that the employer must prove a negative, which is difficult to do under any circumstances. *See Elkins v. United States*, 364 U.S. 206, 218 (1960) ("[A]s a practical matter it is never easy to prove a negative . . . ."). And this particular negative may be especially difficult for several reasons.

1. *Potential causes are not specified*

¶ 36 As noted, the statute presumes causation by unspecified means. Therefore, to sustain its burden of proof, the employer will

have to exclude (by reasonable inference, sustained by a preponderance of evidence) the wide range of potential exposures and biological mechanisms that the statute contemplates. In effect, the employer will have to prove by a preponderance that the cancer was not, or could not have been, caused by anything that the firefighter encountered on the job.

2. *Evidence of specific causation may be hard to obtain*

¶ 37 As noted, a firefighter is disadvantaged in a traditional case because he will be unable to obtain the kind of particularized evidence needed to prove specific causation. (There is no way to know which substances the firefighter encountered at which fire; and even if there were, there is no way to determine the dose, frequency, and duration of the exposures.)

¶ 38 The statute removes that obstacle from the firefighter's path and places it before the employer. Consequently, employers may be unable to locate the kind of evidence that would disprove specific causation. (In some cases, an employer may have evidence of alternative causation. Such evidence may be sufficient to disprove specific causation. *See, e.g., Burrows v. N.D. Workers' Comp. Bureau*, 510 N.W.2d 617, 619 (N.D. 1994) (statutory presumption

was overcome by evidence that the police officer's lung cancer was probably caused by smoking).)

3. *General causation evidence has limited value*

¶ 39 Lacking claimant-specific evidence, an employer may try to rely on general causation evidence — such as epidemiological studies — to prove that the firefighter's disease did not occur on the job. But that sort of evidence is ill-suited to the task.

¶ 40 "Epidemiology's key strength is that its findings result from observation of living human beings. Epidemiology's key weakness is that its findings apply to the populations of living human beings from which a study's sample is drawn, rather than to any individual human being." Steve C. Gold, *The "Reshapement" of the False Negative Asymmetry in Toxic Tort Causation*, 37 Wm. Mitchell L. Rev. 1507, 1520 (2011). Thus, by its nature, epidemiology is not highly probative on the issue of specific causation. It is of limited value in rebutting a presumption that a particular claimant contracted his particular disease as the result of an unspecified workplace exposure. *See* Michael D. Green, D. Michael Freedman & Leon Cordis, *Reference Guide on Epidemiology*, *in Reference Manual on Scientific Evidence* 608-09 (Federal Judicial Center, 3d ed. 2011)

(specific causation is "beyond the domain of the science of epidemiology"); *see also In re Silicone Gel Breast Implants Prods. Liab. Litig.*, 318 F. Supp. 2d 879, 892 (C.D. Cal. 2004).

¶ 41 We note two particular limitations here.[8]

a. *Substance analogies*

¶ 42 Many epidemiological studies focus on a particular substance or agent. Such studies will be of limited value to an employer that must disprove the statutory presumption.

¶ 43 Here is why.

¶ 44 Even minor changes in molecular structure can change the toxicity of a substance, particularly in chemicals that cause birth defects or increase the risk of cancer. David L. Eaton, *Scientific Judgment and Toxic Torts – A Primer in Toxicology for Judges and Lawyers*, 12 J.L. & Pol'y 5, 10-11 (2003). Consequently, courts disallow the use of evidence about substance A to prove the effect of substance B, even when A and B are similar. *See Glastetter v. Novartis Pharm. Corp.,* 252 F.3d 986, 990 (8th Cir. 2001) ("[T]his generic assumption that bromocriptine behaves like other ergot

[8] Although similar observations may be made about toxicological evidence, we focus here on epidemiology.

alkaloids carries little scientific value."); *Mitchell v. Gencorp Inc.,* 165 F.3d 778, 782 (10th Cir. 1999) (trial court correctly excluded expert opinion which assumed that, "because Defendant's products and benzene are chemically similar, they should affect the body in similar ways"); *see also* Betsey J. Grey, *The Plague of Causation in the National Childhood Vaccine Injury Act,* 78 Harv. J. on Legis. 343, 370, 376-77 (2011) (using toxicity of one agent to infer toxicity of a similar agent is considered a weak mode of reasoning).

¶ 45 By the same logic, an employer cannot rely on epidemiological evidence about the effect of substance A to disprove causation by the wide range of substances (known and unknown substances B through Z) to which the firefighter is presumed to have been exposed.

b. *Inferences based on relative risk*

¶ 46 According to some courts, the relative risk identified in an epidemiological study can support legitimate inferences about specific causation. These courts reason that, if the relative risk is greater than 2.0, one may infer the presence of specific causation. *See, e.g., Henricksen v. ConocoPhillips Co.*, 605 F. Supp. 2d 1142, 1158 (E.D. Wash. 2009). Conversely, if the relative risk is less than

2.0, one may infer the absence of causation. *See, e.g., In re Breast Implant Litig.*, 11 F. Supp. 2d 1217, 1226 (D. Colo. 1998) (citing *Daubert v. Merrell Dow Pharm., Inc.*, 43 F.3d 1311, 1321 (9th Cir. 1995)). The logic behind this view is that, if the relative risk is 2.0, one may infer "a 50% likelihood that an exposed individual's disease was caused by the agent." *Breast Implant Litig.*, 11 F. Supp. 2d at 1226.

¶ 47 Whatever the merit of this view in other contexts,[9] it is not valid in this one. As noted, section 8-41-209 contemplates many models of causation. Among other things, it requires the fact finder to presume that an occupational exposure hastened the onset of a disease that the firefighter would have developed later. Unless the employer excludes that model of causation (by reasonable inference, supported by a preponderance of the evidence), the employer cannot assert that specific causation is disproved by a relative risk of less than 2.0. *See Reference Guide on Epidemiology*, at 614

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[9] Inferences and formulas based on relative risk have been criticized for various false assumptions and logical flaws. *See generally* Sander Greenland & James M. Robins, *Epidemiology, Justice, and the Probability of Causation*, 40 Jurimetrics J. 321 (2000); Mark Parascandola, *What is Wrong with the Probability of Causation?* 39 Jurimetrics J. 29 (1998).

("[Inferences based on relative risk assume that the exposure] did not merely accelerate occurrence of the disease. . . . However, for most of the chronic diseases of adulthood, it is not possible for epidemiologic studies to distinguish between acceleration of disease and causation of new disease."); *see also* Steven N. Goodman, *Judgment for Judges: What Traditional Statistics Don't Tell You About Causal Claims*, 15 J.L. & Pol'y 93, 102-03 (2007); Sander Greenland, *Relation of Probability of Causation to Relative Risk and Doubling Dose: A Methodologic Error That Has Become a Social Problem*, 89 Am. J. Pub. Health 1166 (1999).

III. Evidence and Rulings

¶ 48 We now detail the evidence presented and highlight key features of the rulings below.

A. Evidence Presented

¶ 49 Although the parties and the ALJ were aware of the statutory presumption, this case proceeded as if it had been a traditional case.

1. *Claimant's case*

¶ 50 Claimant testified that he had been a firefighter for more than twenty-five years. He testified that, between 2000 and 2007, he

responded to 172 fires and 50 situations involving hazardous substances. He further established that, when he became a firefighter, he underwent a physical examination that revealed no cancer.

¶ 51 Claimant also presented two expert witnesses.

a. *Virginia Weaver, MD*

¶ 52 Dr. Weaver submitted a report and testified as an expert in occupational medicine. Weaver reported that firefighters are exposed to various substances that have been identified as known carcinogens. Weaver listed the following examples: arsenic, asbestos, benzene, benzo[a]pyrene, formaldehyde, soot, 1,3-butadine, creosote, diesel engine exhaust, and combustion products of wood.

¶ 53 Weaver testified that firefighters have an increased risk of brain cancer. For support, Weaver relied principally on a meta-analysis of firefighter studies, which was conducted by Grace K. LeMasters and colleagues. *See* Grace K. LeMasters et al., *Cancer Risk Among Firefighters: A Review and Meta-analysis of 32 Studies*, 48 J. Occup. Environ. Med. 1189 (2006). This study reported a "summary risk" of 1.32 for brain cancers.

¶ 54 Weaver opined that the LeMasters study probably underestimated the risk for firefighters generally because the underlying studies did not account for the "healthy worker effect." (Firefighters tend to be very fit when they enter the workforce, so they can be expected to suffer fewer chronic diseases than the general population does.) Weaver also opined that the study particularly underestimated the risk for firefighters who, like claimant, work in urban areas and thus encounter a larger range of hazardous substances.

¶ 55 Weaver noted that, for the first ten to fifteen years of his career, claimant had conducted "overhaul" of fire sites (combing the site to ensure that the fire would not start again) without protective gear. She noted that claimant's history was remarkable for the lack of chronic diseases and other risk factors. And she noted that claimant was significantly younger than the average brain cancer patient.

¶ 56 Weaver admitted that it is very hard to assess causality in the absence of dose-response data, but she opined, based on the totality of circumstances, that claimant's cancer was "more likely than not" caused by a workplace exposure.

b. *Edward Arenson, MD*

¶ 57 Dr. Arenson testified as claimant's treating physician and as an expert in neurotoxicology. In Arenson's view, the relationship between claimant's cancer and his occupational exposure was "highly probable." Arenson noted that he had treated a surprising number of firefighters who had brain cancer.

2. *Littleton's case*

¶ 58 Littleton relied on evidence presented by three experts.

a. *Denise M. Damek, MD*

¶ 59 Dr. Damek submitted a written report and testified as an expert in neuro-oncology.

¶ 60 Damek stated that the cause of cancer in general, and the cause of claimant's cancer in particular, remain unknown. She noted that, although cancer can occur through normal cellular processes, the relative contribution of other factors — such as carcinogens, age, genetics, lifestyle, and viruses — remains unclear.

¶ 61 Damek stated that brain cancer was most common in white males, and she reported that the incidence of this cancer increases with age. She noted two factors that are unequivocally associated with brain cancer: inherited genetic syndromes and radiation.

¶ 62 Damek reported that "[n]o known or putative carcinogen has been definitely associated with brain tumor development in either humans or animals." She further reported that nine chemicals[10] are "weakly associated" with brain cancer in humans, and that still other chemicals[11] have been noted to increase the incidence of brain tumors in experimental animals. But she noted that "[f]ew of these chemicals have been identified as an exposure in firefighters."

¶ 63 Damek acknowledged that "firefighters are exposed to an unknown amount and extent of carcinogens" during their careers, but she cautioned that "it remains unknown if [the] brain is a target organ for these carcinogens." She further cautioned that, even if it were known that the brain is a target organ, "it is unknown if inhalation of or dermal exposure to these carcinogens could reasonably impact the brain."

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[10] These chemicals are beryllium, epichlorohydrin, chlordane, heptachlor, methylthiouracil, thiroacil, propylthiouracil, lead, diisopropyl sulfate, and dichloromethane.

[11] These chemicals are aflatoxin B_1, diethyl sulfate, acrylamide, tehylnitrosourea, methylnitrosourea, procarbazine hydrochloride, methyl methanesulfonate, dimethyl sulfate, glycidol, dacargazine, 1, 3-propane sultone, and acrylonitrile.

¶ 64 Damek agreed that the LeMasters study contained the best data currently available on the possible association between firefighting and cancer, and she agreed that the study summarized a 30% increase in brain cancers among firefighters. However, Damek characterized this as a "fairly weak association," and she repeatedly cautioned that the LeMasters study was not designed to determine causation.

¶ 65 Damek cautioned that, before postulating causality, one would want to consider other risk factors, such as prior brain irradiation and other carcinogenic exposures. She noted that, for genetic reasons, some individuals may be more likely to develop the mutations that lead to cancer.

b. *Patricia A. Buffler, PhD*

¶ 66 Dr. Buffler is an epidemiologist who submitted a written report on the epidemiology of exposures experienced by firefighters and the possible association between those exposures and brain cancer.

¶ 67 Dr. Buffler presented the following opinions:

i. The evidence from epidemiologic studies of professional firefighters does not support a causal relationship between firefighting and brain cancer.

ii. The pertinent studies, as reviewed in a large meta-analysis recently published by LeMasters et al. (2006), do not provide a sufficient basis for concluding that firefighting is causally associated with any type of brain cancer for several reasons.

- In the epidemiologic studies of firefighters, most of the results for brain cancer were based on small numbers and were not statistically significant.

- None of the studies actually measured average or cumulative amount[s] of exposure to any chemical associated with firefighting in individual subjects.

- A credible biological mechanism by which chemical exposures associated with firefighting could induce brain cancer in humans has not been established.

- None of the chemicals described as associated with firefighting are causally associated with brain cancer. If none of the individual chemicals are causally associated with brain cancer, [there is] no basis for alleging that exposure to the mixture of chemicals is causally associated with brain cancer.

- Both individually and collectively the epidemiologic studies analyzed by LeMasters et al. found a weak and inconsistent association between employment as a firefighter and brain cancer that is not regarded as consistent with a conclusion of a causal relationship.

c. *Javier C. Waksman, MD*

¶ 68 Dr. Waksman submitted a written report and testified as an expert in toxicology.

¶ 69 Waksman reported that a medical effect could be attributed to an exposure only if the following can be done: (1) establish an unbroken pathway between the source of contamination and the geographical point of exposure; (2) calculate or measure the concentration of chemicals at the exposure point; (3) calculate or measure the dose received by the individual at the exposure point; and (4) analyze the health effects that are demonstrated to occur at the dose received. Waksman noted that this information was lacking in claimant's case, and he opined that, consequently, "there is no solid and unequivocal evidence to support the assertion that [claimant's] disease is causally related to his work as a firefighter."

¶ 70 Waksman stressed that causation could not be determined on the basis of epidemiology alone. He noted that the LeMasters study was not designed to determine causation. He further noted that "[c]urrent epidemiological and toxicological data does not causally attribute benzene, formaldehyde, arsenic, asbestos, benzo[a]pyrenes, chromium compounds, dioxins, carbonized

particulates, wood oils, and soot to the development of glioblastoma multiforme."

¶ 71 Waksman concluded that "there is no evidence to suggest that firefighting caused [claimant's] brain tumor."

3. *The ALJ's ruling*

¶ 72 The ALJ made two critical rulings. First, she ruled that claimant qualified for the statutory presumption set forth in section 8-41-209. (This ruling is not at issue.) Second, she ruled that Littleton had proved that claimant's brain cancer was not caused by his occupational exposures.

¶ 73 In making her ruling on causation, the ALJ resolved credibility questions in Littleton's favor. She found that Weaver's and Arenson's opinions were neither credible nor persuasive. And she credited Littleton's evidence on several points.

¶ 74 Here is a summary of the ALJ's findings on causation:

a. *Damek*. The ALJ credited Damek's testimony and report as "credible and persuasive." In particular, the ALJ was persuaded of the following:

i. *Causes of brain cancer generally*. "[T]o date, there is no evidence that any occupational or other exposure to known

carcinogens predisposes one to the development of brain tumors. It is found that no known or putative carcinogen has been definitely associated with brain tumor development in either humans or animals."

ii. *Firefighting exposures*. Firefighters are exposed to "an unknown amount and extent of carcinogens" during their careers, but "it remains unknown" whether any of those chemicals targets the brain. Even if those chemicals do target the brain, it is "unknown" whether those chemicals can impact the brain if they are inhaled or are absorbed through the skin.

iii. *Cause of claimant's cancer*. The cause of claimant's brain cancer is unknown. But there is no scientific basis to conclude that it was caused by occupational exposures.

b. *Buffler*. The ALJ also credited Buffler's report. Here, the findings centered on the absence of a strong association between brain cancer and the exposures associated with firefighting:

i. The available research on "acrylonitrile, formaldehyde, vinyl chloride and the other chemicals associated with firefighting" indicates that these chemicals "have not been shown to be causally associated with the risk of brain tumors in humans."

ii. The available epidemiological studies do not support a conclusion that any form of brain cancer is caused by occupational exposures to chemicals associated with firefighting.

iii. The LeMasters study indicates "that the likelihood of brain cancer risk among firefighters [is] only possible, not probable."

c. *Waksman*. The ALJ also credited the report and testimony of Waksman. The ALJ's findings centered on the lack of evidence supporting causation:

i. Causation can be determined only by establishing the source, exposure, dose, and health effect of a toxic substance. But "the medical literature does not support an association between the [known carcinogens] identified by Dr. Weaver and brain cancer." Indeed, "there is no single credible or persuasive study which shows an association between brain cancer and the duties of a firefighter."

ii. Consequently, it is "impossible to reach the next step of the causal analysis." "There is no basis to conclude that any causal connection exists between the claimant's brain cancer and his exposures as a firefighter."

¶ 75 On the basis of those specific findings, the ALJ made the following determinations: (1) "the substances to which [claimant] was exposed did not target his brain"; and (2) "[t]he substances to which [claimant] was exposed do not cause brain cancer." The ALJ concluded that Littleton had proved, by a preponderance of the evidence, that claimant's brain cancer "is not related to his employment."

4. *Panel's review*

¶ 76 After considering both statutory language and legislative history, the panel concluded that section 8-41-209 "represents a legislatively adopted premise that the occupational exposure of firefighters causes cancer." Therefore, ruled the panel, the statutory presumption cannot be rebutted merely by showing "that there is no causal connection between the occupation in general and the disease in question."

¶ 77 The panel concluded that Littleton's evidence was insufficient because it "merely denied the underlying legislative premise of a causal relationship between the firefighter's occupational exposure and the development of cancer."

IV. Evaluation of the Evidence

¶ 78 We now review the record to determine whether Littleton's evidence was sufficient to meet its burden of proof under section 8-41-209. We conclude that it was not.

A. General Standards

¶ 79 We must uphold the ALJ's factual findings if they are supported by substantial evidence in the record. *Benuishis v. Indus. Claim Appeals Office*, 195 P.3d 1142, 1144-45 (Colo. App. 2008) (citing § 8-43-308, C.R.S. 2012). "Substantial evidence" means evidence that is "probative, credible, and competent, such that it warrants a reasonable belief in the existence of a particular fact without regard to contradictory testimony or inference." *City of Loveland Police Dep't v Indus. Claim Appeals Office*, 141 P.3d 943, 950 (Colo. App. 2006).

¶ 80 We review the evidence as a whole and in the light most favorable to Littleton. *See id.* In conducting our review, we defer to the ALJ's credibility determinations and resolution of conflicts in the evidence, including the medical evidence. *Id.* "If two equally plausible inferences may be drawn from the evidence, we may not substitute our judgment for that of the ALJ." *Id.*

B. Analysis

¶ 81 If evaluated under the standards that apply to the usual tort or workers' compensation claim, this case would be easy. Littleton's experts amply undermined claimant's assertion of general causation, and claimant had little evidence of the sort needed to prove specific causation.

¶ 82 But this case is governed by the firefighter statute. That statute creates a substantive presumption (in the nature of affirmative evidence) that claimant's GBM resulted from his employment as a firefighter. To overcome that presumption, Littleton was required to produce evidence which would support a reasonable inference, by a mere preponderance, that claimant's occupational exposures (1) could not have caused GBM (disproving general causation), or (2) did not cause claimant's particular GBM (disproving specific causation).

¶ 83 After reviewing the evidence presented, in the light most favorable to Littleton, we agree with the panel that Littleton's evidence was insufficient as a matter of law.

1. *Attacking the statute*

¶ 84 As noted, the panel concluded that Littleton's evidence was insufficient because it "merely denied the underlying legislative premise of a causal relationship between the firefighter's occupational exposure and the development of cancer." We agree with the panel, but only in part.

¶ 85 We agree that Littleton tried to attack the statute itself. (Much of Littleton's case was designed to show that there is no sound evidentiary basis for the legislature's decision.) And we agree that such an attack does not logically rebut the statutory presumption. *See Shankle*, 785 A.2d at 755; *Linnell*, 305 N.W.2d at 601.

¶ 86 But we conclude Littleton did more than merely attack the statute. Littleton also tried to rebut the presumption that the legislature created.

2. *No evidence to disprove specific causation*

¶ 87 Littleton produced no evidence about claimant's workplace exposures. (On the contrary, Littleton's experts highlighted the *absence* of such evidence.) Consequently, on the evidence presented, a reasonable fact finder could not conclude that claimant was, or was not, exposed to any particular substance or

agent. Neither could a reasonable fact finder draw any inference about the dose, frequency, or duration of any exposure.

¶ 88 Consequently, Littleton did not disprove specific causation, even by a mere preponderance of the evidence. *See Shankle*, 785 A.2d at 755 (to rebut the presumption, the employer's evidence "must be particular to the claimant"); *Linnell*, 305 N.W.2d at 601 (to rebut the presumption, an employer must show "either that the particular claimant's duties were significantly less stressful than those of most employees in his occupation or that his disease and disability were the result of recognized causative factors which are not related to his occupation"); *Fairfax County Fire & Rescue Services v. Newman*, 281 S.E.2d 897, 900 (Va. 1981) (employer failed to rebut the statutory presumption because it "offered no evidence of a non-work-related cause of the disability"); *cf. Estate of George*, 993 A.2d at 369 (affirming summary judgment where, among other things, the claimant failed to present evidence about his particular exposures).

3. *Insufficient evidence to disprove general causation*

¶ 89 In the absence of evidence about claimant's specific exposures, Littleton relied on general causation evidence. Littleton suggested,

in effect, that firefighting exposures could not have caused claimant's GBM because such exposures cannot cause any form of brain cancer. But that effort fell short.

¶ 90 Littleton's evidence supports a reasonable inference that claimant's brain cancer was not caused by any of the carcinogens commonly "associated with firefighting." (On the evidence presented, the ALJ could reasonably have found: (1) if claimant encountered those substances, he probably absorbed them by inhalation or through the skin; (2) there is no plausible biological pathway by which those substances, so absorbed, could affect the brain; and (3) those substances do not cause brain cancer.)

¶ 91 But Littleton presented no evidence to support an inference that claimant's workplace exposures were limited to that group of substances. In the absence of such evidence, a fact finder could only speculate that claimant's exposures were so limited. And speculation is insufficient to rebut a substantive presumption that claimant, while acting as a firefighter, was exposed to a substance or agent that caused his particular cancer.

4. *Additional observations*

¶ 92 For the sake of completeness, we now consider other potential findings that the ALJ did not make.

a. *Inferences about claimant's exposure to radiation*

¶ 93 Littleton's experts agreed that brain cancer can be caused by exposure to ionizing radiation. (Buffler reported, for example, that brain tumors have been caused by exposure to "therapeutic radiation and to moderate doses of radiation from the atomic bombs in Hiroshima and Nagasaki."). As noted, however, Littleton produced no evidence about claimant's specific occupational exposures. Under these circumstances, could a reasonable fact finder nevertheless conclude, by a preponderance of evidence, that claimant's GBM was not caused by an occupational exposure to ionizing radiation?

¶ 94 The answer is no. The evidence, when viewed in the light most favorable to Littleton, supports a reasonable inference that claimant was not exposed to atomic blasts and did not experience therapeutic brain irradiation. But the evidence supports no additional findings about (1) the amount of ionizing radiation required to increase the risk of brain cancer (Littleton's experts did

not address that point), (2) whether sufficient doses of radiation can occur in other situations, and (3) whether claimant could have encountered those situations on the job. Consequently, there is no evidence to rebut the presumption that claimant's cancer was caused by an occupational exposure to ionizing radiation.

b. *Inferences about other substances*

¶ 95 As noted, on the evidence presented, a fact finder could reasonably attribute certain properties to carcinogens commonly associated with firefighting: (1) these substances do not target the brain; and (2) they do not cause GBM. But what about the other substances to which claimant was presumptively exposed? Can one inferentially attribute the same properties to those?

¶ 96 For the reasons set forth in part II.C.3.a, the answer is no. Courts do not permit such inferences-by-analogy, even when the various substances are known to be similar. *See Glastetter,* 252 F.3d at 990; *Mitchell,* 165 F.3d at 782. Therefore, on the evidence presented, it would be unreasonable to infer that *no substance* targets brain tissue. (Waksman made the point directly: He testified that ethylmercury does not target the brain, but a similar substance, methylmercury, does.)

¶ 97 It would similarly be unreasonable to infer that *no substance* can cause GBM. The ALJ found, on the basis of Damek's testimony, that "no known or putative carcinogen has been definitely associated with brain tumor development in either humans or animals." However, in light of the limits of existing scientific knowledge (limits acknowledged by Littleton's experts), it would be farfetched to further conclude, from the absence of evidence showing a definite link, that no such link exists. *See City of Long Beach v. Workers' Comp. Appeals Bd.*, 23 Cal. Rptr. 3d 782, 794 (Cal. Ct. App. 2005) ("The absence of medical evidence linking a known carcinogen with a particular form of cancer simply represents a void of information, and cannot be considered proof a reasonable link does not exist.").[12]

c. *Inferences based on relative risk*

¶ 98 As noted, the statute presumes that occupational exposures hastened the onset of a cancer that claimant would have developed later. Littleton did not attempt to refute this presumed theory of

[12] This is especially true in light of the other evidence. As noted, Damek identified several chemicals, including lead, that are "weakly associated" with brain cancer in humans. And she identified still other chemicals that have been "noted to increase the incidence of brain tumors in experimental animals."

causation. (On the contrary, Littleton's evidence tends to support that theory.) Consequently, for the reasons set forth in part II.C.3.b, one cannot reasonably infer the absence of specific causation from the relative risk reported in the LeMasters study.

V. Conclusion

¶ 99 We conclude that the ALJ's ultimate findings are unsupported. Only by speculation, and not by reasonable inference, could the ALJ find that "the substances to which [claimant] was exposed did not target his brain, or that "[t]he substances to which [claimant] was exposed do not cause brain cancer."

¶ 100 We reach this conclusion even though the statutory presumption is one that may be rebutted by "a preponderance of the medical evidence." § 8-41-209(2)(b). As noted, the statute places a heavy burden on employers, not because it requires a high degree of proof, but because it requires the employer to disprove a wide and unspecified range of potential causes. Littleton did not fail here because it lacked conclusive proof; it failed because it had *no evidence* of many key facts.

¶ 101 We certainly do not fault Littleton's lawyers. Under the circumstances, it is hard to imagine how Littleton's case could have

been presented more completely, or with greater skill. The problem is that Littleton had no way of obtaining evidence about claimant's specific exposures. And without that evidence, Littleton was hard-pressed to disprove causation. (In that regard, Littleton's problem is identical to one that claimant would have faced in a traditional case: without evidence of his specific exposures, claimant would have been hard-pressed to prove causation.) The difficulty is practical, and not the result of an irrebuttable presumption. *See Fairfax County Fire & Rescue Services*, 281 S.E.2d at 901 ("The absence of evidence is a problem of proof and does not automatically make the presumption irrebuttable.").

¶ 102 Because the panel properly set aside the ALJ's order and properly remanded for a determination of benefits, its final order is affirmed.

JUDGE ROMÁN concurs.

JUDGE CARPARELLI dissents.

JUDGE CARPARELLI dissenting.

We all have deep respect and appreciation for firefighters, their knowledge and skills, and the dangers they endure in service to others. Among these dangers is uncontrolled exposure to chemical substances.

The employer contends that the administrative law judge's (ALJ's) June 2009 order was supported by substantial evidence and that the Panel erred when it reversed the order in November 2009. I agree.

I disagree with the majority opinion's conclusion that the ALJ's findings are not supported by sufficient evidence. We are required to consider the evidence as a whole and in the light most favorable to the party that prevailed before the ALJ, and defer to the ALJ's determinations of the credibility and resolution of conflicting evidence. *Metro Moving & Storage Co. v. Gussert*, 914 P.2d 411, 415 (Colo. App. 1995). In my view, the majority opinion's final analysis considers the evidence in the light most damaging to the prevailing party, impermissibly makes inferences damaging to the prevailing party, and impermissibly makes its own resolution of conflicting evidence.

There are two essential issues in this case:

- What is the employer's burden of proof?
- Is there sufficient evidence to support the ALJ's June 2009 determination that the employer met that burden?

To answer the first question, I begin with the words of the statute and an analysis that leads to plain statements of the presumption and the burden to overcome it. Although I arrive at statements of the presumption and burden that are similar to those of the majority opinion, I use a different analytic framework that parties and ALJs may find useful in future cases. I also address aspects of the majority opinion's analysis with which I disagree, and others that might be misunderstood and misapplied.

I conclude that, for qualifying firefighters who have cancer of a listed organ or system, section 8-41-209(2)(a), C.R.S. 2012, creates a presumption that the firefighter's particular cancer resulted from, arose out of, or was sustained in the course of his or her employment.

For purposes of proof, this means that ALJs must presume that a firefighter's employment was *capable of causing* the firefighter's specific cancer, *and* that the firefighter's employment

did cause that cancer. To overcome this presumption, an employer must prove that it is *more likely* that the firefighter's employment was *not capable of causing* the firefighter's specific cancer, *or* if the ALJ finds that the employment was capable of causing the cancer, that it is, nonetheless, *more likely* that the firefighter's employment *did not cause* that cancer.

I then review the evidence presented here and conclude that there is sufficient evidence to support the ALJ's findings. Therefore, I conclude that the Panel erred when it reversed the ALJ's June 2009 order.

I. The Employer's Burden of Proof

A. The Workers' Compensation Act

Article 41 of title 8 of the Workers' Compensation Act of Colorado (the Act) controls workers' compensation coverage and liability. *See* § 8-40-102, C.R.S. 2012.

To receive workers' compensation benefits, a worker must first show that he or she has an injury or occupational disease that arises out of his or her employment and was sustained in the course of that employment. § 8-41-301(1)(c), C.R.S. 2012.

B. Occupational Disease Criteria for High Tenure Firefighters

Section 8-41-209(1), C.R.S. 2012, enables certain firefighters to prove that their cancers of the brain, skin, digestive system, hematological system, or genitourinary system constitute "occupational diseases," and, thus, to satisfy one condition of recovery under section 8-41-301. § 8-41-209(1).

To qualify under section 8-41-209(1), a firefighter must have completed five or more years of employment as a firefighter (high tenure firefighter). When a high tenure firefighter has died, has become disabled, or has a health impairment, and it is proved that the death, disability, or impairment was caused by a cancer of one of the qualifying organs or systems, the firefighter's cancer is considered "an occupational disease" *if the firefighter can prove that the cancer "result[ed] from his or her employment as a firefighter*." § 8-41-209(1) (emphasis added).

C. The "Resulting-From" Presumption

However, some firefighters are relieved of the burden of proving that their cancers resulted from their employment as firefighters. Any firefighter, regardless of tenure, who proves that,

upon or after becoming a firefighter, he or she had a physical examination that found no substantial evidence of a pre-existing cancer of a qualifying organ or system, is afforded a presumption, and relieved of the burden of proving, that his or her cancer "resulted from his or her employment as a firefighter" (the resulting-from presumption). § 8-41-209(2)(a), C.R.S. 2012. The presumption satisfies the section 8-41-301(1)(c) condition that, to be compensable, an occupational disease must "aris[e] out of and in the course of [the worker's] employment." Accordingly, the presumption is that the firefighter's cancer resulted from, arose out of, or was sustained in the course of the firefighter's employment.

I agree with the majority opinion that when evaluating toxic tort causation, courts have considered both general and specific causation. To prove general causation, a plaintiff must prove that the alleged substance is capable of causing the illness. Steve C. Gold, *The "Reshapement" of the False Negative Asymmetry in Toxic Tort Causation*, 37 Wm. Mitchell L. Rev. 1507, 1512, 1563-65 (2011). In addition, a plaintiff must prove that the alleged substance did, in fact, cause his or her illness, that is, specific causation. *Id.* However, I disagree with the Panel's conclusion that

the resulting-from presumption includes a conclusive presumption of general causation.

Section 8-41-209(2)(a) creates a presumption that a firefighter's qualifying cancer resulted from, arose out of, or was sustained in the course of his or her employment. For purposes of proof, this means that it must be presumed (1) that the firefighter's employment was capable of causing the firefighter's particular cancer of the brain, skin, digestive system, hematological system, or genitourinary system; and (2) that the firefighter's employment caused the specific cancer he or she suffers.

The statute refers to *organs* and *human physiological systems* that become cancerous. In a given case, the presumption is that the specific cancer of the affected organ or system resulted from the firefighter's employment, not that *all cancers* of the organ or system result from employment as a firefighter. Thus, the scope of the employer's burden is limited to the claimant firefighter's specific type of cancer.

D. Rebutting the "Resulting-From" Presumption

According to section 8-41-209(2)(b), C.R.S. 2012, the resulting-from presumption is rebutted "if the firefighter's employer

or insurer shows by a preponderance of the medical evidence that such condition or impairment *did not occur on the job*." (Emphasis added.)

Unfortunately, the phrase "occur on the job" is not a term that appears in the Act other than in sections 8-41-208 and -209. Moreover, only one Colorado state appellate court opinion has used this phrase. *See Smartt v. Lamar Oil Co.,* 623 P.2d 73, 75 (Colo. App. 1980). In that case, the division cited an earlier case that used the phrase "job-related *injuries*." *See Frohlick Crane Service, Inc. v. Mack*, 182 Colo. 34, 37-38, 510 P.2d 891, 892-93 (1973) (emphasis added).

We must determine the meaning of the phrase "did not occur on the job" in a manner that is consistent and harmonious with related provisions of the Act, including the recovery conditions of section 8-41-301(1)(c) and the presumption in section 8-41-209(2)(a). *See Farmers Reservoir & Irrigation Co. v. City of Golden*, 113 P.3d 119, 130 (Colo. 2005); *Colo. Water Conservation Bd. v. Upper Gunnison River Water Conservancy Dist.*, 109 P.3d 585, 593 (Colo. 2005); *Bd. of County Comm'rs v. Costilla County Conservancy Dist.*, 88 P.3d 1188, 1192-93 (Colo. 2004).

Doing so, I conclude that section 8-41-209(1) is not ambiguous. To rebut the resulting-from presumption, the employer must prove, by a preponderance of the evidence, that the qualifying cancer did not result from, did not arise out of, or was not sustained in the course of, the firefighter's employment.[13]

Here this means the employer was required to prove that it is *more likely* that the firefighter's employment was *not capable* of causing his GBM; *or* if his employment was capable of causing GBM, that it is, nonetheless, more likely that the firefighter's employment *did not cause* his GBM. It is this standard that the ALJ was required to apply, and it is by this standard that we must determine whether there is sufficient evidence to support the ALJ's findings.

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[13] Based on the *Smartt* and *Frohlick Crane Services* cases, an alternative phrasing might be "job-related cancers." However, that phrasing is too vague to serve as a useful standard. "'In the course of employment' generally refers to 'the time, place and circumstances under which the injury occurred.'" *Popovich v. Irlando*, 811 P.2d 379, 383 (Colo. 1991). "The 'course of employment' requirement is satisfied when it is shown that the injury occurred within the time and place limits of the employment relation and during an activity that had some connection with the employee's job-related functions." *Id.*

E. Meeting the Burden

1. Epidemiologic Evidence of General Causation

The majority opinion acknowledges that "[c]ourts regard epidemiology as the best evidence of general causation." That is, it is the best evidence that a substance is capable of causing a particular illness. However, the majority opinion later quotes a statement by Professor Gold, *see* 37 Wm. Mitchell L. Rev. at 1520, and, from that quote, concludes that "[t]hus, by its nature, epidemiology is not highly probative on the issue of specific causation. It is of limited value in rebutting a presumption that a particular claimant contracted his particular disease as the result of an unspecified workplace exposure." I disagree.

In the same article, Professor Gold says that "some evidence of general causation is a prerequisite to proof of specific causation." *Id.* at 1563. He also says that in many cases, if not the great majority of cases, courts require that both general and specific causation be proved. *Id.* at 1565. Thus, the absence of general causation forecloses the possibility of specific causation. It is in this way that a thorough, well-designed, and well-executed epidemiologic search for environmental factors capable of causing a

specific cancer can eliminate some factors as actual causes, and, thereby, narrow the task of determining whether a firefighter's particular cancer resulted from something in his employment.

The majority opinion also refers to Gerald W. Boston, *A Mass-Exposure Model of Toxic Causation: The Content of Scientific Proof and the Regulatory Experience*, 18 Colum. J. Envtl. L. 181 (1993). In that article, immediately after the discussion of relative risk that the majority opinion quotes, Professor Boston says that "[t]o determine if an association is causal, epidemiologists have developed criteria that treat the statistical association as the starting point of the analysis," but "associational data alone do not permit biological inferences." *Id.* at 237. Consequently, scientists apply "more particularistic, analytical and biological tests before reaching a conclusion respecting a causal relationship." *Id.* Professor Boston explains that *biological plausibility* is among the criteria that appear to have achieved a high level of acceptability and utility with regard to determining causation. *Id.* at 238.

Thus, once again, epidemiology *is* highly probative because it considers human physiology and the likelihood that a potential environmental factor is capable of entering the body, traveling to a

particular organ, and interacting with that organ in a way that can cause a particular cancer.

Although the majority opinion says that the presumption "contemplates a wide range of biological mechanisms," it does not appear to recognize the probative value of evidence about the extent to which biological mechanisms increase or decrease the likelihood that a chemical could cause a particular cancer.

2. Specific Causation

I agree with the majority opinion's statement that the presumption is that the firefighter's qualifying cancer *somehow* resulted from his or her employment and that the presumption is broad. However, in my view, the majority opinion's further description of the breadth of the presumption tends to confuse rather than clarify because it implies that the employer has the burden of eliminating all imaginable possibilities. In so doing, it renders reasonable inferences impermissible and section 8-41-209(2)(b) meaningless.

With regard to the probative value of scientific evidence, the majority opinion says the employer cannot challenge "the wisdom or evidentiary foundation of the legislature's [valid policy] decision."

This statement is susceptible of broad interpretation and, if not explained, could erroneously undermine the admissibility of probative evidence.

To the extent that the majority opinion's comment about not challenging the wisdom or evidentiary basis means that employers may not challenge *the statute* as unfair or unreasonable, I agree. I also agree to the extent that it means that the ALJ must afford the presumption to qualifying firefighters. There is no basis upon which the ALJ could properly decide that the General Assembly's decision to create the presumption was a bad one and should not be applied. Here, the ALJ appropriately applied the presumption.

Nonetheless, it is not clear what the majority opinion means by the "evidentiary foundation" of the legislature's policy decision. It implies that the General Assembly decided that there is scientific proof that cancers of the brain, skin, digestive system, hematological system, or genitourinary system result from firefighting. However, the statute contains no such statement.

All that can be said accurately is that the General Assembly heard complicated scientific testimony supporting both sides of the issue. It also heard testimony that it is difficult and expensive for

firefighters to prove causation, and that, as a result, few firefighters submit claims. After hearing this testimony, the General Assembly granted an evidentiary presumption of causation to certain firefighters, shifted the burden to employers, and left it to ALJs to determine causation on a case-by-case basis.

There is no basis to conclude that the General Assembly was presented with an evidentiary foundation supporting a conclusion that all variations of cancer of the listed organs result from employment as a firefighter. Nor is there any basis to conclude that the majority of legislators who voted in favor of the presumption did so because they were persuaded that all variations of cancers of those organs and systems result from employment as a firefighter. The testimony in the General Assembly was neither that specific nor that complete.

ALJs should apply the majority opinion's comment about challenging the wisdom or evidentiary foundation to mean that the firefighter must be afforded the presumption and that employers cannot be permitted to argue that the General Assembly did not have a sufficient basis to create it. ALJs should not apply the comment to disallow or give less weight to scientific evidence that

tends to prove that a particular firefighter's employment was not capable of causing his or her cancer or that, even if it was capable of doing so, it did not do so.

II. Sufficiency of the Evidence

The presumption is that the firefighter's employment was *capable of causing* and *did cause* his GBM. The employer's burden is to prove that it is *more likely* that the firefighter's employment was *not capable of causing* his GBM, *or* that, if it was *capable* of causing the GBM, it *did not* cause it in this firefighter. Applying that presumption here, I conclude there was sufficient evidence to support the ALJ's findings.

A. Standard of Review

"If the findings of fact entered by the director or administrative law judge are supported by substantial evidence, they shall not be altered by the court of appeals." § 8-43-308, C.R.S. 2012; *cf.* § 8-43-301(8), C.R.S. 2012 (same standard applies to panel's review of ALJ's order). "Substantial evidence is that quantum of probative evidence which a rational fact-finder would accept as adequate to support a conclusion, without regard to the existence of conflicting evidence." *Metro Moving & Storage Co.* 914 P.2d at 414. When

applying this standard, we consider the evidence as a whole and in the light most favorable to the prevailing party, and defer to the ALJ's determinations of credibility and resolution of conflicting evidence. *Id.* at 415. Accordingly, "we may not interfere with the ALJ's credibility determinations except in the extreme circumstance where the evidence credited is so overwhelmingly rebutted by hard, certain evidence that the ALJ would err as a matter of law in crediting it." *Arenas v. Indus. Claim Appeals Office*, 8 P.3d 558, 561 (Colo. App. 2000).

The majority opinion's final analysis does not adhere to this standard.

B. ALJ's Findings

The ALJ found that:

- the employer's expert witnesses' opinions were clear, reliable, and well-founded based on scientific evidence;
- the data analysis upon which the firefighter's experts relied did not support their opinions regarding causation;
- the firefighter's witnesses demonstrated bias, were not reliable, and did not credibly rebut the employer's evidence;

- the substances to which the firefighter was exposed did not target his brain;
- the substances to which the firefighter was exposed do not cause brain cancer; and
- the employer proved, by a preponderance of the evidence, that the firefighter's brain cancer is not related to his employment.

C. Record Support for ALJ Findings

1. Environmental Factors Capable of Causing GBM

The employer presented experts in epidemiology, neuro-oncology, and toxicology who testified that medical science has conducted extensive investigation and study of possibly carcinogenic chemicals, the means by which the human body absorbs those chemicals, the pathways by which those chemicals travel to and target human organs, and the effects of those chemicals on various human organs.

a. Thorough and Credible Scientific Investigation

The employer presented extensive testimony and reports regarding widely accepted scientific studies. For example, Dr. Patricia A. Buffler, who holds a doctorate in epidemiology, testified

that the evidence from epidemiologic studies of professional firefighters does not support a causal relationship between firefighting and brain cancer.

Based on the evidence, the ALJ could conclude that thorough and well-designed scientific research has looked for a causal connection between the risks to which firefighters are exposed and GBM and found no causal link. Although an ALJ could not find with certainty that no link exists, he or she could properly consider and accept this evidence, and conclude that it makes it more likely that there is no causal connection.

b. Biological Plausibility of Known Exposures

Dr. Buffler testified that there is no known "credible biological mechanism by which chemical exposures associated with firefighting could induce brain cancer in humans." Dr. Denise M. Damek, an oncology physician, testifying as an expert in neuro-oncology, said there is no evidence "that the inhalation or dermal absorption of these chemicals results in any level of carcinogen within brain tissue." She also testified that "there is no evidence that [carcinogens to which firefighters are exposed] target [the] brain."

c. Known Causes of GBM

According to the employer's evidence, extensive studies have shown that the only known factors that increase the risk of GBM are:

- sex (male),
- race (Caucasians are more at risk),
- age (risk increases with age),
- family history, and
- ionizing radiation exposure.

Four of these risk factors do not result from, arise out of, or arise in the course of a firefighter's employment. The only known risk factor for GBM that arises from environmental factors is ionizing radiation exposure.

Dr. Buffler testified:

> To date, ionizing radiation is the only known modifiable or environmental risk factor for glioma. Studies of the incidence of primary brain tumors among persons exposed to *therapeutic* radiation and to moderate doses of radiation from the atomic bombs in Hiroshima and Nagasaki have shown a latency of at least 20 years and longer is associated with these exposures.

(Emphasis added.)

The atomic bomb explosions at Hiroshima and Nagasaki were created by devices that are not likely to be found in Littleton and the surrounding communities. The explosions generated extraordinary levels of ambient ionizing radiation. Considering this evidence in the light most favorable to the employer, the ALJ could properly find that it is more likely that equivalent levels of ambient ionizing radiation did not exist in Littleton and that the firefighter was not exposed to a sufficient level of ambient ionizing radiation to cause his GBM.

As an example of radiation levels high enough to increase risk, Dr. Buffler also referred to "therapeutic radiation directed at the cranium." Dr. Damek explained that ionizing radiation increases the risk of GBM, in particular, when it is "brain irradiation in a therapeutic dose."

By its very name, therapeutic brain irradiation refers to an intentional medical procedure where radiation is aimed directly at the cranium. The testimony confirms this. The ALJ could reasonably infer that therapeutic brain irradiation requires a device designed to produce an extremely high level of focused (not diffused or ambient) ionizing radiation directed at a person's cranium. More

likely than not, to create the necessary level of radiation, the device would have to be connected to a power source and turned on. Such devices are not likely to be found outside a hospital or specialized medical clinic. The record contains no evidence or argument that the firefighter was intentionally exposed to therapeutic brain irradiation in the course of his employment. Considering the evidence in the light most favorable to the employer, I conclude that the ALJ could reasonably find that it is more likely that the firefighter's cranium was not accidently exposed to ionizing radiation from such a device.

I also conclude that the ALJ could reasonably find that, more likely than not, devices capable of creating a level of focused ionizing radiation comparable to that of a therapeutic device are not common. However, even speculating that such a device might exist, the evidence supports a finding that it is more likely that the firefighter was not accidently exposed to such a device while it was generating such radiation, let alone that the firefighter's cranium was so exposed.

When reviewing the evidence for sufficiency, we are required to consider the evidence as a whole and in the light most favorable to

the prevailing party. The majority opinion's statement about the possibility of the existence of other sources of ionizing radiation of sufficient magnitude is contrary to this requirement. In addition, it requires a standard of proof beyond the preponderance of the evidence.

Based on the evidence in the record, it was reasonable for the ALJ to infer that the firefighter was not exposed to a level of ionizing radiation sufficient to cause his GBM. Thus, there is evidence that it is more likely that the firefighter's GBM did not result from, arise out of, or was sustained in the course of his employment.

2. Known Causes of Other Cancers

The employer presented a report and testimony from Dr. Javier Waksman, a toxicologist. Dr. Waksman testified that "[c]urrent epidemiological and toxicological data does not causally attribute benzene, formaldehyde, arsenic, asbestos, benzo[a]pyrenes, chromium compounds, dioxins, carbonized particulates, wood oils, and soot to the development of glioblastoma multiforme."

Dr. Damek testified that "[n]o known or putative carcinogen has been definitely associated with brain tumor development in

either humans or animals." She also testified that "there is no evidence that [carcinogens to which firefighters are exposed] target [the] brain."

The breadth of this statement is significant. Dr. Damek's statement includes all *known and putative* carcinogens. That is, it includes all substances that science knows can cause *any type of cancer*, as well as all substances that are suspected, but not proven, to cause any type of cancer. And it says that none of these substances have been definitely *associated* with brain tumor development in humans or animals. Data that shows a mere association between a substance and a particular cancer is not sufficient to permit an inference of causation. *See* Boston, 18 Colum. J. Envtl. L. at 237. To determine whether an association is causal, epidemiologists use criteria that treat the statistical association as the starting point of the analysis. *Id.* Dr. Damek's statement is *not* that there is no definite proof of *causation*; it is that there is not even definite proof of *an association* between known and putative carcinogens and the development of brain tumors. Still further, there is not only no definite association with *GBM*, there is no definite association with *any brain tumors*. And, last,

not only is there no definite association with brain tumors in humans, but there is not even an association with brain tumors in animals.

This evidence is sufficient to support a finding that it is not likely that known and putative carcinogens cause GBM. Accordingly, the ALJ could properly find that it is more likely that the firefighter's GBM did not result from, did not arise out of, or was not sustained in the course of, exposure to a known or putative carcinogen.

3. Mixtures of Chemicals

Dr. Buffler testified that "[n]one of the chemicals described as associated with firefighting are causally associated with brain cancer." She also testified that there is no basis to conclude that exposure to the mixture of chemicals is causally associated with brain cancer.

D. ALJ's Findings are Supported by the Record

The ALJ's findings plainly state that the employer overcame the presumption. The ALJ's ultimate finding is that the employer proved, by a preponderance of the evidence, that the firefighter's brain cancer is not related to his employment.

I conclude that the evidence is sufficient to support this finding. Specifically, there is sufficient evidence in the record upon which the ALJ could properly find that it is more likely that the only environmental factor capable of causing the firefighter's GBM is therapeutic brain irradiation and that the firefighter was not exposed to such irradiation in his employment. This is a finding of the absence of general causation, and is sufficient to overcome the statutory presumption by a preponderance of the evidence without additional proof of the absence of specific causation.

Nonetheless, there is also sufficient evidence upon which the ALJ could find that it is more likely that known and probable carcinogens, as well as other chemicals to which the firefighter might have been exposed, individually or in mixture, do not cause GBM. In addition, there is sufficient evidence upon which the ALJ could find that it is more likely that there is no credible biological mechanism by which chemicals to which the firefighter was likely to have been exposed could target his brain and cause GBM. This proves the absence of specific causation, which, alone, is also sufficient to overcome the presumption by a preponderance of the evidence.

I have repeatedly noted that we are required to review the evidence as a whole and in the light most favorable to the party that prevailed before the ALJ. I have done so because, in my view, the majority opinion's ultimate conclusion derives from analyses that consider the evidence in the light most damaging to the employer, impermissibly make inferences damaging to the employer, and impermissibly invade the province of the fact finder by focusing on conflicting evidence and resolving the conflicts contrary to the ALJ's findings. This is demonstrated by the majority opinion's identification of conflicting evidence regarding weak associations with brain cancer, increased incidence of brain tumors in experimental animals, and speculation that there might be sources capable of generating levels of ionizing radiation akin to those of an atomic bomb or a therapeutic device.

III. Conclusion

In this case, the resulting-from presumption operated as the General Assembly intended. The employer was burdened with the difficulty and expense of presenting evidence proving that it is more likely that the firefighter's cancer could not have resulted or did not result from his employment. The ALJ found the employer's

evidence to be clear, reliable, well-founded, and persuasive. Had the ALJ found that the employer's evidence was not based on well-founded scientific evidence and not reliable, the employer would have failed to sustain its burden and the ALJ would have been required to find in favor of the firefighter.

Under section 8-41-209, a qualifying firefighter who has any cancer of any of the five organs or systems must be afforded the presumption. This case addresses just one type of cancer of one organ of one firefighter. Although the majority concludes that the medical evidence in this case is not sufficient to prove that it is more likely that GBM did not result from this firefighter's employment, firefighters and employers should not assume that the same result would obtain in cases involving other cancers of the brain or cancers of other organs or systems. The evidence of scientific studies, known causes, and biologic plausibility will vary.

I would set aside the Panel's order and remand for reinstatement of the ALJ's June 9, 2009, findings of fact and conclusions of law.