

## Not the Last Word: Carpal Tunnel Syndrome is Work-related—Because I Said So

Joseph Bernstein MD

Robert Richard is an overweight 56-year-old accountant with a smoking habit and high blood pressure, but has no symptoms. His firm has offices on the 4th and 8th floors of a small building. One day, the elevators were not working, so Mr. Richard walked up to the 8th floor from his desk on the 4th floor. After making the climb, pressure developed in Mr. Richard's

chest, with pain radiating to his left shoulder.

Barbara Brown is a 56-year-old receptionist in Mr. Richard's office with mild diabetes and hypothyroidism but no symptoms except at the height of the busy tax season, when Ms. Brown works overtime as a data entry clerk. When Ms. Brown types at her computer, but only then, she experiences a burning and tingling sensation in the palmar aspect of her thumb and index and middle fingers.

Although Mr. Richard and Ms. Brown are characters of my own creation, it seems reasonable to believe that Mr. Richard has coronary artery disease and is experiencing angina and that Ms. Brown has symptoms of carpal tunnel syndrome.

It also seems rather reasonable to believe that Mr. Richard did not sustain a work injury. Mr. Richard has an underlying condition, atherosclerosis causing coronary artery stenosis. Although Mr. Richard's symptoms may have been provoked by activity on the job, in no sense has the stair-climbing caused his disease.

Ms. Brown's case is more ambiguous. At first glance, she too, seems to have a condition that is only provoked, but not caused, by her job activity. Yet

there is at least a common perception her problem is work-related. Indeed, the fount of lay medical knowledge, Wikipedia, has declared "computer work" [20] a risk factor for carpal tunnel syndrome.

The ambiguity sneaks in because of a crucial distinction between "medically caused" and "legally recognized" that is easily lost. Observational studies link carpal tunnel syndrome to work activities [8, 12]. It is reasonable to assume that such studies are the basis of legal recognition. However, observational studies are usually not definitive with regard to medical causation. To help differentiate causation from mere association, one may employ the nine so-called Hill criteria [7]: strength of association, consistency, specificity, temporality, biological gradient, plausibility, coherence, experiment, and analogy (Table 1). These criteria, articulated by renowned English epidemiologist and statistician, Sir Austin Bradford Hill, are used for all sorts of questions of causality, but were in fact developed to define "the relationships between sickness, injury, and conditions of work" [7].

As Hill himself points out, his criteria can be fooled. One example he cites is the association between psychological stress and peptic ulcers [7]. Surgeons found that patients presenting for ulcer surgery were under greater mental duress than those presenting for hernia surgery. It would be tempting to conclude that stress causes ulcers—indeed,

---

*A note from the Editor-in-Chief: We are pleased to present to readers of Clinical Orthopaedics and Related Research® the next Not the Last Word. The goal of this section is to explore timely and controversial issues that affect how orthopaedic surgery is taught, learned, and practiced. We welcome reader feedback on all of our columns and articles; please send your comments to eic@clinorthop.org.*

The author certifies that neither he, nor any members of his immediate family, have any commercial associations (such as consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

The opinions expressed are those of the writer, and do not reflect the opinion or policy of Clinical Orthopaedics and Related Research® or The Association of Bone and Joint Surgeons®.

J. Bernstein (✉), University of Pennsylvania, 424 Stemmler Hall, Philadelphia, PA 19104, USA, Email: orthodoc@uphs.upenn.edu

All ICMJE Conflict of Interest Forms for authors and Clinical Orthopaedics and Related Research® editors and board members are on file with the publication and can be viewed on request.

---

J. Bernstein, Department of Orthopaedic Surgery, University of Pennsylvania, Philadelphia, PA, USA

## Not the Last Word

**Table 1.** The nine Hill criteria [1]

Name of criterion	Application in the case of carpal tunnel syndrome and typing.
Strength of association	Let's say we find that the rate of carpal tunnel syndrome is higher among typists than among opera singers. We'd have more faith in declaring a causal link if the rate observed in typists were 500% higher as opposed to only 5% higher.
Consistency	Assume there are 10 studies examining the relative rates of carpal tunnel syndrome among typists and opera singers. If all 10 (as opposed to, say, four of the 10) were to find an association between typing and carpal tunnel symptoms we'd be more convinced of a causal link.
Specificity	Do only typists get carpal tunnel syndrome? If that were the case (and it clearly is not) that would be evidence of a causal link.
Temporality	The act of typing must come before the carpal tunnel symptoms for the typing to be a cause. That's obvious here; it's hard to imagine that people with (or even prone to) carpal tunnel syndrome would seek out work as a typist. In other cases, this criterion is more central: for example, does femoral-acetabular impingement (FAI) anatomy cause labral tears [1] or do labral tears induce reactive changes in the bone hip that create FAI anatomy?
Biological gradient	Is there a dose response? If full-time typists (stenographers or transcriptionists) get carpal tunnel syndrome more frequently than secretaries who type infrequently, you would be more convinced that typing is causal.
Plausibility	Does it seem reasonable that typing could cause carpal tunnel syndrome? (As Hill wrote, "this is a feature I am convinced we cannot demand. What is biologically plausible depends upon the biological knowledge of the day" [7])

that conclusion meets many, if not all of the criteria. But as Hill notes, the observation of more stress among patients with ulcers might be confounded by the urgency of their disease [7]. Distressed patients with hernias might defer their treatment until their mood improves, whereas those with ulcers cannot wait. Thus, in the absence of experimental evidence, establishing causation is ultimately a matter of judgment.

My best medical judgment is that typing does not cause carpal tunnel syndrome. There are far too many people who type but do not develop carpal tunnel syndrome, far too many people with carpal tunnel syndrome who rarely touch a keyboard, and none of the putative mechanisms of injury ring true to my ears. All that said, I am perfectly at peace with the idea that carpal tunnel is recognized by some states as a work-related condition—since “medically caused” and “legally recognized” are not the same thing.

The crucial factor about legal recognition of a work-related condition is a given state's policy. In California, for example, hepatitis is presumed to be a work-related condition among firefighters [14]. We know that one may acquire hepatitis from bodily fluids, and we know that firefighters involved in rescues may be exposed to body fluids. Hence, a rationale exists. On the other hand, we also know that hepatitis can be contracted from activities that are certainly outside the scope of one's duties as a firefighter. Thus, a counter-rationale exists, too. Still, there is no paradox; the California legislature, when passing its labor code, made only a legal (and not medical) determination.

Even our friend Mr. Richard, the accountant with chest pain that developed after he climbed stairs on the

**Not the Last Word**

Table 1. continued

Name of criterion	Application in the case of carpal tunnel syndrome and typing.
Coherence	Does saying typing causes carpal tunnel syndrome go along with what we know about other conditions? If we were convinced that other compression neuropathies such as tarsal tunnel and cubital tunnel syndromes, to name two, were activity-related, labeling carpal tunnel syndrome as activity-related makes more sense.
Experiment	If an intervention limiting typing were shown to make a difference in the incidence of carpal tunnel syndrome (for instance, giving stenographers mandatory breaks every 20 minutes), one might be more inclined to believe that typing is cause. Needless to say, if typing were only a provocation of symptoms and not a cause of disease this criterion might mislead.
Analogy	If repetitive motion is shown to cause injury in other body parts (baseball pitchers and rotator cuff tendinitis, for instance) one may be tempted or justified to say that repetitive typing likewise can cause injury to the medial nerve or other contents of the carpal canal.

job, can be said to have a work-related condition under certain circumstances—like if his accounting firm were based in France. Just last year, a French worker who died of a heart attack after having extramarital sex while on a business trip was judged to have “suffered a work-related accident and that his employer was liable” [9]. That decision may sound medically ridiculous and morally dubious but for the key point: “French law considers any accident that happens on a business trip to be work-related, even if the activity is not closely related to the employee’s mission” [9], Hill criteria notwithstanding. If adulterous coupling can trigger a work injury, stair climbing can too.

The label “work-related” is neither a medical nor moral judgment. It is a legal finding. Thus, we have the following rule: “a work-related condition is present when I say so”—provided the speaker is speaking for the state.

**Judith Green-McKenzie MD, MPH  
Professor and Chief  
Division of Occupational Medicine in  
the Department of Emergency  
Medicine  
University of Pennsylvania Perelman  
School of Medicine**

A work-relatedness determination is rarely as simple as “when I say so.” There are both medical and legal elements relevant to this determination. In terms of the medical aspect, the clinician

is paramount. The clinician must record the details of the circumstances surrounding the injury or illness and use his or her medical knowledge to make an accurate diagnosis. Epidemiology tools must also be used in order to assess the relationship between the purported exposure and the resultant injury or illness. Hill’s criteria of causation [2] discussed by Dr. Bernstein, are useful in this endeavor. The insurance company adjuster [19] then uses this information to determine work-relatedness and eligibility for workers compensation benefits.

In general, a worker qualifies for workers compensation benefits if the injury or illness arose “out of or in the course of employment” [17]. The United States workers compensation system is not unified. There are individual systems, statutes, and regulations for each state, territory, and three federal jurisdictions [6]. Even within this system, some employees can benefit from legislation that mandates benefits to be automatically approved as long as specific criteria are met under the state’s regulations [15].

Acceptance of Ms. Brown’s workers compensation claim for carpal tunnel syndrome depends on the case the clinician makes towards resolving this determination—based on medical knowledge and the epidemiology of carpal tunnel syndrome. In some jurisdictions, unless it can be shown that the injury arose “out of and in the course of” work, the claim may be denied. Indeed, carpal tunnel syndrome is common, with risk factors ranging from diabetes, pregnancy, rheumatoid arthritis, and hypothyroidism, to obesity and female sex [10]. Furthermore, regarding Mr. Richard’s situations, given that some jurisdictions offer firefighters presumptive coverage for heart and vascular conditions [15], had he been a firefighter, his angina while climbing the steps while at work might well be deemed work-related.

## Not the Last Word

Attributing occupational exposure to an illness or injury may be challenging for the insurance compensation adjudicator if the mechanism is not explained, the scientific evidence linking exposure with effect is weak, or the epidemiological basis is lacking. Often, causation of a disease is not unique to occupational exposure, and many diseases have multiple causes. Work relatedness may be more obvious when the illness is pathognomic for exposure, such as mesothelioma or asbestos poisoning [17].

Dr. Bernstein notes that work-relatedness is “neither a medical nor moral judgment. It is a legal finding.” However, in the worker’s compensation arena, medical causation is determined by scientific criteria establishing a causal association between exposure and an injury or illness, while legal causation is determined by criteria established by legal authority [5], which varies across jurisdictions. While the legal basis for work-relatedness may differ between jurisdictions, however, the scientific method for determining causation should be consistent. Work-relatedness is a medical judgment—one made within the context of the legal authority. The clinician makes the case based on medical science and epidemiology, while the final determination depends on the science overlaid by the legal authority applied. The adjuster actually has the last word. Indeed, the final determination depends on “who” says so!

**Charles Goldfarb MD**

**Co-Chief, Hand and Microsurgery Service**

**Washington University School of Medicine in St. Louis**

Amazon’s recent search for a location for its second headquarters drew national attention for many reasons, including the remarkable offers of subsidy packages such as tax incentives

from various states and municipalities [18]. States are competing to attract business relocation or expansion, and one consideration for businesses when making these decisions is the state-by-state variability in the workers compensation system.

Like almost every subset of health care, the costs of administering workers compensation have increased. Efforts to limit costs vary but include limiting physician compensation and narrowing the definition of a compensable injury or condition. I’ve observed remarkable variation in the definition of a compensable injury in my practice in St. Louis, MO, USA. Workers from across the Mississippi River in Illinois need only have work “contribute” to the development of carpal tunnel syndrome, whereas those working in Missouri must be deemed to have work as the “prevailing cause” of their conditions. This state-by-state variability exists in many areas of workers compensation including dramatic differences in compensation for workplace injuries, and this is something the popular press has noticed [3].

The lack of a national approach to workers compensation presents many challenges, which are magnified, as noted by Dr. Bernstein, in assessing those conditions that lack clear evidence of medical causation. Using a legal definition (“more likely than not”) allows reasonable medical providers to disagree on the causation for a particular patient. Researchers, including epidemiologists, public health specialists, hand surgeons, and others, depend primarily on observational studies (or systematic reviews and meta-analyses from these studies) to frame the best evidence for the injured worker and carpal tunnel syndrome.

One such meta-analysis is the American Academy of Orthopaedic Surgeons Clinical Practice Guideline on

carpal tunnel syndrome [4]. This Clinical Practice Guideline uses only the best observational studies and excludes smaller studies (fewer than 10 patients in a group) and all retrospective, noncase-controlled studies. The latest version of the Clinical Practice Guideline on carpal tunnel syndrome, published in early 2016 [4], included an assessment of multiple work-related risk factors for the development of carpal tunnel syndrome, and found:

- There was “strong evidence” of associating increased risk with repetitive tasks of the hand and wrist.
- Computer work and 11 other conditions were found to have “moderate evidence” of increased risk (including American Conference of Governmental Industrial Hygienists hand activity, assembly line work, vibration, and forceful grip and exertion). The inclusion of computer work in this category was controversial.
- Eight conditions were deemed to have “conflicting risk” (based on limited evidence) for the development of carpal tunnel syndrome, including wrist bending and “the workplace” and six nonwork-related factors [4].

In my opinion, additional investigations published since the Clinical Practice Guideline do not further clarify the more-controversial risk factors for the development of carpal tunnel syndrome. Specifically, the relationship between typing and/or computer work remains unclear, with conflicting evidence based on some systematic reviews and meta-analyses [11, 13, 16].

In short, Dr. Bernstein was succinct and accurate, albeit perhaps a bit flip-pant, when he concluded that “a work-related condition is present when I say so.” Because medical causation

## Not the Last Word

definitions and consensus are lacking, the legal definition of causation remains the standard. This will vary from state-to-state, and the workers compensation system remains dependent on willing providers assessing all patient factors together with state law in determining work-relatedness.

### References

- Bernstein J. The myths of femoroacetabular impingement. *Clin Orthop Relat Res*. 2014;472:3623-3628.
- Celentano D, Szkle M, Gordis. *Gordis Epidemiology*. 6<sup>th</sup> ed. Philadelphia, PA: Elsevier Saunders; 2018.
- Grabell M, Berkes H. As workers' comp varies from state to state, workers pay the price. Available at: <https://www.npr.org/2015/03/06/391149235/as-workers-comp-varies-from-state-to-state-workers-pay-the-price>. Accessed February 18, 2020.
- Graham B, Peljovich AE, Afra R, Cho MS, Gray R, Stephenson J, Gurman A, MacDermid J, Mlady G, Patel AT, Rempel D, Rozental TD, Salajegheh MK, Keith MW, Jevsevar DS, Shea KG, Bozic KJ, Adams J, Evans JM, Lubahn J, Ray WZ, Spinner R, Thomson G, Shaffer WO, Cummins DS, Murray JN, Mohiuddin M, Mullen K, Shores P, Woznica A, Linskey E, Martinez Y, Sevarino K. The American Academy of Orthopaedic Surgeons evidence-based clinical practice guideline on: management of carpal tunnel syndrome. *J Bone Joint Surg Am*. 2016;98:1750-1754.
- Greaves W, Das R, Green-McKenzie J, Sinclair D, Hegmann K. Work-relatedness. *J Occup Environ Med*. 2018;60:e640-e646.
- Green-McKenzie J. *Workers' Compensation*. *Occupational Health Services: A Practical Approach*. Abingdon, UK: Routledge; 2012.
- Hill AB. The environment and disease: association or causation? *Proc R Soc Med*. 1965;58:295-300.
- Jackson R, Beckman J, Frederick M, Musolin K, Harrison R. Rates of carpal tunnel syndrome in a state workers' compensation information system, by industry and occupation - California, 2007-2014. *MMWR Morb Mortal Wkly Rep*. 2018;67:1094-1097.
- Karasz P. A French worker died after sex on a business trip. His company is liable. Available at: <https://www.nytimes.com/2019/09/12/world/europe/france-sex-work-accident.html>. Accessed January 17, 2020.
- Kothari JM. Carpal tunnel syndrome. In: Shefner J, Eichler A, eds. *Clinical Manifestations and Diagnosis*. Available at: <https://www.uptodate.com/contents/carpal-tunnel-syndrome-clinical-manifestations-and-diagnosis>. Accessed February 17, 2020.
- Kozak A, Schedlbauer G, Wirth T, Euler U, Westermann C, Nienhaus A. Association between work-related biomechanical risk factors and the occurrence of carpal tunnel syndrome: an overview of systematic reviews and a meta-analysis of current research. *BMC Musculoskelet Disord*. 2015;16:231.
- Lund CB, Mikkelsen S, Thygesen LC, Hansson GA, Thomsen JF. Movements of the wrist and the risk of carpal tunnel syndrome: A nationwide cohort study using objective exposure measurements. *Occup Environ Med*. 2019;76:519-526.
- Mediouni Z, de Roquemaurel A, Dumontier C, Becour B, Garrabe H, Roquelaure Y, Descatha A. Is carpal tunnel syndrome related to computer exposure at work? A review and meta-analysis. *Occup Environ Med*. 2014;56:204-208.
- Owen D. Hepatitis C virus. Available at: <http://www.sffidlocal798.org/Vol30no3/hepc.html>. Accessed January 17, 2020.
- Racicot F, Spidell B. Presumptive coverage for firefighters and other first responders. NCCI Research brief 2018. Available at: <https://www.ncci.com/Articles/Documents/Insights-Research-Brief-Presumptive-Coverage.pdf>. Accessed February 17, 2020.
- Shiri R, Falah-Hassani K2. Computer use and carpal tunnel syndrome: A meta-analysis. *J Neurol Sci*. 2015;349:15-19.
- United States Department of Labor. Occupational Safety and Health Administration. 1904.5. – Determination of work-relatedness. Available at: <https://www.osha.gov/laws-regs/regulations/standardnumber/1904/1904.5>. Accessed February 17, 2020
- Staff Verge. Amazon HQ2: all of the news about its controversial search for a new headquarters. Available at: <https://www.theverge.com/2018/11/14/18095197/amazon-hq2-new-headquarters-controversial-search-new-york-city-virginia-backlash>. Accessed February 18, 2020.
- Wendt C, Emmett T. The art of directing a workers' compensation claim: personal observations on the role of the workers' compensation claims adjuster. In: Green-McKenzie J, ed. *Managing Workers' Compensation Costs*. *Clinics in Occupational and Environmental Medicine*. Philadelphia, PA: Elsevier Saunders; 2004.
- Wikipedia. Carpal tunnel syndrome. Available at: [https://en.wikipedia.org/wiki/Carpal\\_tunnel\\_syndrome](https://en.wikipedia.org/wiki/Carpal_tunnel_syndrome). Accessed January 17, 2020.