Causation is an essential reference for all stakeholders involved with medical-legal claims of any kind. It provides hope that the resolution of such claims can be based on science and other sources of facts, rather than on unsubstantiated opinions.

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Evaluating Causation for the Opposite Lower Limb

By Christopher R. Brigham, MD, Charles N. Brooks, MD, and James B. Talmage, MD

Causation analysis should always be based on current scientific evidence and the facts of a specific case. However, certain beliefs have evolved that lack scientific basis. One unsupportable myth is that "favoring" one lower extremity will often result in injury or illness of the opposite lower limb.

This is exemplified by the case of a 40-year-old male longshoreman who reportedly sustained an injury to left knee at work on September 1, 2009. His past history is remarkable for prior knee problems bilaterally, including high school football injuries that resulted in "arthroscopy" (details unavailable) and subsequent documented osteoarthritis. He weighs 225 pounds and is 5 feet 6 inches tall. The calculated body mass index of 36.3 meets the criterion for obesity. In December 2009 the longshoreman underwent an arthroscopic partial lateral meniscectomy of left knee. Two years following this left knee surgery he developed increased right knee pain attributed to osteoarthritis. His treating physician opined the right knee pain was a "compensatory consequence of limping and full weight bearing pivoting as a body mechanics change in limping and unloading his left knee following his left knee injury." Review of the longshoreman's medical records fails to demonstrate any notation of limping or an antalgic gait.

This is a common scenario, where an opinion on causation appears based on *post hoc ergo propter hoc* ("after this, therefore caused by this") reasoning, but is unsupported by science. Temporal sequence does not prove causation. An example often cited to point out the false logic in such causal opinions is that even though one follows the other, the rooster crowing doesn't make the sun come up. In causation analysis, one must also consider temporal proximity, or in this case disparity: whether there was an injury or exposure likely to cause the condition in question, and if there is another, more probable, cause for it.

As implied, causation analysis must be based on both scientific evidence (in this case, the medical literature) and facts of the individual case. To conclude that a given cause and effect are etiologically associated with a reasonable degree of medical probability or certainty (ie, more than 50% probability), all 3 of the following criteria must be met:

1. The cause is medically probable: more likely than not, the patient had a trauma or exposure.
2. The effect is medically probable: more likely than not, the patient has the injury or illness.
3. The cause and effect probably are etiologically related: more likely than not, the trauma caused the injury or the exposure the illness.

This is the premise physicians are asked to analyze and to support or refute when assessing causality: that a probable cause and effect likely are etiologically related. If any 1 of the 3 criteria is possible but not probable, causation has not been established. Further, 2 or more possible causes do not equal a probable one. (They are not additive.)

When evaluating causation, the physician must identify possible causes (occupational and nonoccupational) and the correct diagnosis or diagnoses (the effect), and then assess the likelihood of a causal relationship between them. In other words, causation analysis must be based on an analytical approach.[1] However, as apparently occurred in this case, some physicians opine that an injury or exposure, often at work, caused or aggravated a condition based on temporal sequence alone. Sometimes a causal opinion is based on patient history. However, the premise that history reported by claimants and plaintiffs is accurate has repeatedly failed scientific testing, as detailed in the September/October 2009 issue of the *Guides Newsletter*.[2]

In this case, the longshoreman had three known risk factors for osteoarthritis: age, obesity, and prior injury in high school.[3] He had documented osteoarthritis in both knees before the claimed occupational injury. However, the question remains, was the arthritis in the right knee aggravated (permanently worsened) due to "favoring" the left lower extremity after the knee injury on that side?

Review of the medical literature reveals no generally accepted studies that support such a causal relationship, nor is there any reasonable scientific logic therefor. In fact, the literature available, most notably an editorial entitled "Can favoring one leg damage the other?" by Ian Harrington, MD, and W. Robert Harris, MD,[4] refutes the reported cause and effect relationship. They explain:

> Lay people, and many doctors as well, believe that pain or disability in one leg can stress the other one and produce symptoms in it.
>
> We believe that there is no scientific basis for such reasoning. The mechanics of limping are poorly documented in the orthopaedic literature and we have found few references to the effect of a limp on the other leg. To clarify the position for lay adjudicators and the physicians who advise them we reviewed the mechanics of the two basic limps: paralytic and antalgic. In the former, the muscles of the weak leg are not strong enough to balance body-weight and the patient walks with a characteristic lurching gait. The trunk, head, and arm are displaced towards the affected side, moving the body's centre of gravity directly over the weak leg and thereby reducing the muscle force required to balance the body weight. In the antalgic gait, the patient shortens the stance phase by adopting a similar Trendelenburg lurch.
>
> It may seem logical that manoeuvres designed to lessen the load on one leg must increase that on the other, but there is no evidence to support this.[4]

Harrington and Harris reference gait studies using force plates on patients with longstanding poliomyelitis who had a paralytic and short-leg limp that confirmed the force transmitted in the affected lower extremity was reduced, but the force in the opposite limb was the same as in normal individuals.[5] Similar findings were seen with an antalgic gait resulting from arthritis.[6,7] They also noted studies revealing the magnitude of hip force in normal individuals varies with body weight, stride length, and walking speed.[8] Because someone with lower limb pain typically walks more slowly than an asymptomatic person, shortens his/her stride length, and reports the injury or illness of the originally involved lower limb resulted in a marked decrease in weight bearing activity (steps taken each day), both the forces and number of loading cycles on the unaffected limb are likely to be *less*, not more, than before the original injury or illness.

It is improbable that crutch or cane use would stress the uninvolved lower extremity because there is little change in the rhythm of gait, and the force transmitted thereby is increased only by the weight of the walking aid. In fact, using a cane may reduce the force in the normal lower limb because cane users walk more slowly.

Harrington and Harris note that in the days of poliomyelitis, when limping was common, symptoms in the normal leg were seldom attributed to the limp, and that amputees rarely develop arthritis in the joints of the uninvolved limb, despite the fact that no artificial leg or brace can restore a normal gait.

In 2005 Harrington provided a discussion paper entitled "Symptoms in the Opposite or Uninjured Leg" prepared for the Workplace Safety and Insurance Appeals Tribunal in the Province of Ontario[9] that concluded:

> There is no clear evidence to suggest that an injury to one lower extremity would have any significant impact on the opposite uninjured limb unless the injury resulted in major muscle or nerve damage causing partial or complete paralysis of the damaged leg, and/or shortening of the injured lower extremity resulting in a limb length discrepancy of more than four or five centimetres so that the individual's gait pattern has been

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Evaluating Causation (continued)

altered to the extent that clinically there is an obvious lurching type gait (a significant limp). In order for this type of gait to have impact on the opposite or uninjured leg, it is likely that the abnormal gait or limp would need to be present over an extended period–years. A temporary abnormality in gait, eg, a limp over a relatively short period of weeks or months is unlikely to have any effect on the opposite leg. The use of a cast, cane, and crutches is also unlikely to have any major impact on the stress borne by the uninjured limb. Increased body weight (obesity) does, however, have a detrimental effect on both lower extremities and magnifies all of the previously described risk factors.[9]

In assessing causation it is imperative to base conclusions on scientific evidence and facts of the case at hand rather than relying solely on patient history or false logic such as *post hoc ergo propter hoc* reasoning.

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