May 27, 2024

John Zaid Esquire

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RE: *Benjamin Nicholson v Luis Carlos Barillas, First Coast Intermodalogistics, LLC and First Coast Logistics of Texas, LLC et al., Case No: 2022-83820, District Court, 234th Judicial District, Harris County, Texas*

Date of Crash: March 3, 2021

Date of Birth: *Benjamin Nicholson:* October 18, 1974 [46 years old at time of crash]

Dear Mr. Zaid,

I am in receipt of your correspondence regarding the above-named action. I have reviewed the documentation accompanying your correspondence including medical records, information regarding the subject crash, litigation documents, and other materials.

The purpose of this report is to provide an analysis of the causal relationship between the subject near-side impact collision and Mr. Nicholson’s subsequently diagnosed disk injuries and need for treatment.

*My qualifications to provide opinions concerning the matters herein, particularly on issues of the causal relationship between trauma and injury, are as follows:*

I am Professor and Chair of Forensic and Legal Medicine with the Faculty of Forensic and Legal Medicine of the Royal College of Physicians (UK), and a consultant in the fields of forensic medicine and forensic epidemiology. I am credentialed as a Fellow of the Royal College of Pathologists (UK), Fellow of the Faculty of Forensic and Legal Medicine (FFLM) of the Royal College of Physicians (UK) and member of the British Association in Forensic Medicine. I hold the following relevant academic degrees and certifications: a Doctor of Medicine degree (Med.Dr.) from Umeå University, a Doctor of Philosophy (Ph.D.) in public health/epidemiology from Oregon State University, a Master of Public Health (MPH) in epidemiology and biostatistics, also from Oregon State University, a master’s degree in forensic medical sciences (MScFMS) with the Academy of Forensic Medical Sciences in the United Kingdom, i.a. In addition to my degreed education, I have completed a 2-year post-doctoral fellowship in forensic pathology at Umeå University in Sweden and hold a Diploma of Legal Medicine (DLM) with the FFLM. I am also a fellow of both the American Academy of Forensic Sciences and the American College of Epidemiology. I am a Fulbright Fellow and held a 3-year roster appointment (2017-20) with the United States Department of State as a Fulbright Specialist in the field of forensic medicine. I serve as tenured Associate Professor of Forensic Medicine at Maastricht University and a joint Clinical Professor of Psychiatry and Public Health and Preventative Medicine at Oregon Health and Science University School of Medicine, where I have taught courses for the past 24 years in forensic medicine, forensic epidemiology, and injury epidemiology. From 2005-2017 I held an appointment as an Adjunct Professor of Forensic Medicine and Epidemiology at the Institute of Forensic Medicine, Faculty of Health Sciences, Aarhus University, Aarhus, Denmark, and am a recent (2020-21) visiting professor at University of Indonesia in the Faculty of Medicine.

I have been a crash reconstructionist since 1996 and have had ACTAR accreditation (the Accreditation Commission on Traffic Accident Reconstruction) since 2005. Over the past >25 years I have participated in the reconstruction of more than 3,000 crashes, including more than 300 fatalities. From 1999 through 2007 I served as a vehicular homicide investigator for law enforcement (consultant to the state medical examiner and special deputy sheriff), and I am a former affiliate medical examiner with the Allegheny County Medical Examiner’s office.

I am a member of the American Society of Biomechanics and have more than 60 scientific publications pertaining to injury biomechanics, including a book for the Society of Automotive Engineering and taught injury biomechanics in a faculty peer-reviewed course at OHSU for 15 years. I have served as a consultant on injury biomechanics to state and federal government.

I am an associate editor of the Journal of Forensic and Legal Medicine and serve or have served as an associate editor or editorial board member of 14 additional scientific peer-reviewed journals. I have published approximately 230 scientific papers, abstracts, book chapters and books on topics that include traffic crash injuries, crash reconstruction, injury causation and injury biomechanics, including the text for Elsevier, Forensic Epidemiology: Principles and Practice (2016). My publications have been cited by other authors more than 4,700 times.

I have provided testimony in more than 400 civil and criminal trials in state and Federal courts throughout the United States, Canada, and Australia. Please see my CV for further details.

**Background Facts:**

On March 3, 2021 at about 2:45 pm Benjamin Nicholson was the restrained driver of a 2016 Dodge Challenger 2DR coupe that was westbound in the # 2 lane of I-10/Katy Freeway, near Greenhouse Rd., Houston, Texas when it was struck on the left rear quarter panel by the right front corner/bumper of a bobtail 1999 Freightliner Conventional truck tractor, driven by Luis Barillas, that moved from the # 3 westbound lane into Mr. Nicholson’s lane. The images below depict the police diagram and the subject Dodge, post-collision:

A diagram of a car crash

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**Police diagram, Mr. Nicholson’s Dodge is labeled “Unit 2”**

**A damaged car with a hole in the side

Description automatically generatedA car with a hole in the side

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**Mr. Nicholson’s Dodge, post-collision**

No damage estimate was provided for the Dodge for review. The provided photos showed damage to the left rear quarter panel and driver’s door. The Dodge was not towed from the scene.

No damage estimate or photos were provided for the Freightliner for review. The police report listed the damage severity to the right front corner as a “1” on a scale of 0 to 7. The defendant stated in court records that no damage was done.

Mr. Nicholson’s body was thrown around during the impact, and although he had pain and stiffness straight away, Mr. Nicholson declined EMS evaluation at the crash scene.

However, on March 5, 2021, 2 days after the crash, Mr. Nicholson presented to the Memorial Heights Emergency Center with complaints of pain in his lower back. He underwent a CT scan of the lumbar spine which was negative for acute osseous abnormality. Mr. Nicholson was diagnosed with lumbar spine sprain and released home to primary care follow up in 3 days.

On March 10, 2021, 7 days after the crash, Mr. Nicholson presented to Dr. Marony Demian (chiropractic) with complaints of sharp pain in his neck, lower back, left hip, left shoulder and muscle spasms throughout his entire spine. Dr. Demian initiated treatment modalities and recommended modalities 2-3 times a week through July 30, 2021 (his projected completion date for rehabilitative therapy).

On March 10, 2021, Mr. Nicholson underwent MRIs of the left hip and left shoulder. The left hip study revealed: focal mild soft tissue contusion of the far lateral aspect of the left gluteus maximus muscle adjacent to the greater trochanter.

The left shoulder MRI revealed: a grade 1 strain of the supraspinatus tendon and minimal acromioclavicular joint arthrosis and minimal subacromial/subdeltoid bursitis.

On March 22, 2021, Mr. Nicholson underwent MRIs of the cervical and lumbar spine. The cervical spine study revealed: at C3-4, a broad-based posterior central disk herniation, (1 mm), flattening the anterior aspect of the thecal sac; at C4-5, a broad based posterior central disk herniation (2-2.5 mm) flattening the anterior aspect of the spinal cord, moderate left neural foraminal stenosis; at C5-6, a broad based posterior central disk herniation (2-2.5 mm) with an associated annular tear, flattening the anterior aspect of the spinal cord.

The lumbar spine study revealed; at L5-S1, a diffuse disk herniation (3.5 mm) with an associated posterior central annular tear, flattening the anterior epidural fat and resulting in moderate bilateral neural foraminal stenosis; at L4-5, a broad based right neural foraminal disk herniation (2 mm) resulting in mild right neural foraminal stenosis; and mild free fluid in the pelvis.

On April 22, 2021, Mr. Nicholson presented to Dr. Teodulo Aves (pain management) with persistent pain in his neck, headache, lower back pain with intermittent sharp shooting pains to both legs, and pain in his left shoulder and left hip. Dr. Aves diagnosed panniculitis, cervicalgia, muscle spasms, low back pain and lumbar radiculopathy. He recommended continued therapy, lumbar epidural steroid injections, cervical facet injections at C4-6, and a steroid injection for the left shoulder.

On April 27, 2021, Mr. Nicholson underwent a transforaminal epidural steroid injection (TFESI) at L4-5 on the left, performed by Dr. Mark Filley (pain management).

Dr. Filley also performed a left shoulder steroid injection; and a cervical facet block injection on the left at C4-6 (with good relief).

On June 1, 2021, Dr. Filley performed a TFESI on the left at L5-S1.

On July 2, 2021, Mr. Nicholson presented to Dr. Jose Rodriguez (orthopedic surgery) with complaints of pain in his *right* shoulder and left leg. Physical examination elicited pain over the right rotator cuff. Dr. Rodriguez diagnosed *right* rotator cuff tendinitis, recommended continuing therapy to strengthen the shoulder and hip, and prescribed Diclofenac 50 mg, twice daily.

On July 15, 2021, Mr. Nicholson returned to Dr. Aves who recommended a third lumbar ESI, and orthopedic consultation for the left shoulder and left hip.

On July 16, 2021, Mr. Nicholson presented to Dr. Anthony Owusu (orthopedic surgery) with neck pain, low back pain radiating into the left lower extremity, and left arm pain and stiffness. Dr. Owusu diagnosed cervical disk disorder, cervicalgia, cervical and lumbar radiculopathy, lumbar spinal stenosis, and low back pain. He recommended a lumbar laminectomy and decompression at L5-S1.

On September 25, 2021, Dr. Owusu performed a third lumbar epidural steroid injection (ESI), bilaterally at L4-5 and L5-S1.

On November 2, 2021, Dr. Filley performed bilateral C4-6 cervical facet block injections due to increasing neck pain.

On December 20, 2021, Mr. Nicholson returned to Dr. Owusu with persistent neck pain and lumbar radicular symptomatology. Dr. Owusu recommended proceeding with the lumbar laminectomy and decompression at L5-S1 and discussed the need for an anterior cervical discectomy and fusion at C3-4 in the future.

On January 7, 2022, Mr. Nicholson presented to Dr. Dushi Parameswaran (orthopedic surgery) with persistent lateral left sided hip and left shoulder pain. Dr. Parameswaran recommended continuing conservative treatment for the shoulder and hip with additional recommendations for a corticosteroid injection for the left shoulder (subacromial space). Dr. Parameswaran proceeded with the left shoulder subacromial injection.

**On January 24, 2022, Mr. Nicholson underwent an L5-S1 partial laminectomy and discectomy at L5-S1, performed by Dr. Owusu.**

On February 2, 2022, Mr. Nicholson recommenced therapeutic treatment with Dr. Demian, He was released from therapy on March 24, 2022.

On April 25, 2022, Dr. Owusu discussed proceeding with an ACDF at C4-5 and to commence rehab therapy for the lumbar spine.

**On May 9, 2022, Mr. Nicholson underwent an anterior cervical discectomy and fusion (ACDF) at C4-5, performed by Dr. Owusu.** Height: 5 ft 5 inches**,** weight: 180 lbs.

*Pre-crash medical history*

Non-contributory for post-crash diagnoses

*Medical and other records reviewed for history*

Plaintiff’s response to Interrogatories

Memorial Heights Emergency Center

Sugarland Sports Medicine & Injury Clinic, Dr. Demian

Upright MRI

Viking Surgery Center

Radiology Providers of Texas, Dr. Aves

Spine & Joint Institute of Texas, Dr. Owusu

Paramount Surgical Center

Next Generation Ortho and Spine, Dr. Owusu

Memorial Heights Emergency Center

Orthopedic Institute for Spinal Disorders, Dr. Rodriguez

***Injury Causation Analysis***

A crash-related injury causation analysis for a specific individual is performed by assessing the risk of injury from the collision and comparing it to the probability that the injuries or conditions would have been present at the same point in time if the collision had not occurred. The process is referred to as a "3-step" injury causation method in which improbable alternative causes are ruled out and the single most likely cause is identified. The analysis is accomplished via the application of crash reconstruction, biomechanical, medical, and epidemiologic (risk assessment) principles.[[1]](#footnote-1),[[2]](#footnote-2) This 3-step methodology has been extensively described in the peer-reviewed literature, been deemed generally accepted by Courts in the United States, and has been adopted as part of case law in the U.S.[[3]](#footnote-3),[[4]](#footnote-4) See the Appendix at the end of this report for more information.

The three fundamental elements or steps of an injury causation analysis are as follows:

Whether the injury mechanism had the potential to cause the injury in question (aka general causation);

The degree of temporal proximity between the injury mechanism and the onset of the symptoms reasonably indicating the presence of the injury; and

Whether there is a more likely alternative explanation for the occurrence of the symptoms at the same point in time (aka differential etiology).

As applied to the facts in the subject case, these 3 steps are as follows:

*Reconstruction of the crash*

According to the police report it was daylight, clear and dry. The speed limit on I-10/Katy Freeway was 60 mph.

No deposition for Mr. Nicholson was provided for review. In court documents he said he was traveling westbound on Katy Freeway when Mr. Barillas changed lanes when it was not safe to do so and struck his vehicle. In medical records, he told providers that he was merging off the ramp when suddenly the 18-wheeler hit his vehicle on the driver’s side. He was going between 55-60 mph when the impact occurred, and his body jerked around inside the vehicle.

No deposition for Mr. Barillas was provided for review. In court documents he said that he was signaling for a lane change when Mr. Nicholson came out of nowhere and struck his truck while he was still within his own lane. He immediately stepped on the brakes to slow down and pulled over to the shoulder. He thought he was going about 60 mph before he began to apply his brakes after the impact.

The police report, authored by Officer Huntsberry, stated that Mr. Barillas was in the #3 lane and changed lanes when it was not safe to do so and struck Mr. Nicholson’s Dodge.

*Analysis:*

There was likely less than one inch of damage to the Freightliner and as much as 4 inches of damage to the Dodge where the front wheel of the Freightliner gouged into the side of the Dodge. Employing a well-recognized reconstruction program[[5]](#footnote-5), it is possible to estimate the delta V imparted to the Dodge in the subject crash. Using the estimates above, the Dodge would have experienced a delta V of approximately 4.2 mph with a calculated peak acceleration of approximately 3.1 g.

*Injury biomechanics*

The driver’s-side impact would have resulted in the Dodge’s occupant to initially move to the left and somewhat forward at 4.2 mph, until Mr. Nicholson struck the center console and passenger door with his lower extremities and was restrained by his seatbelt which would have caused his head to continue to accelerate left and forward and create high bending loads on the joints and disks of his neck, combined with sudden muscular protective forces which would have produced high levels of compression on the spinal disks in the neck and back.[[6]](#footnote-6) Per his description, Mr. Nicholson then rebounded back to his right and struck the passenger side door and window. This all would have taken less time than it takes to blink an eye (around 250 msecs).

Although a 4.2 mph side impact collision does not sound like a particularly severe crash, such collisions have the potential to produce relatively violent occupant movements. This fact is illustrated in the photographic stills on the following pages, which show the sequential occupant kinematics of a healthy crash test volunteer undergoing a 3.1 mph far-side impact delta V, with forces that are around 40% of the subject crash.[[7]](#footnote-7)



Figure 1: The bullet vehicle is approaching at 7.5 mph.



Figure 3: The target vehicle is starting to rotate, and the center of mass of the vehicle is accelerated to 3.1 mph (this is the delta V). The occupant begins to move to the right, relative to the vehicle interior.



Figure 4: The occupant’s head and torso flexes violently to the right as the vehicle continues to rotate from under her.



Figure 5: Inertial forces on the occupant’s head and torso continue to cause flexion to the right as the vehicle continues to rotate, with the impact to final frame above occurring over approximately 1/5th of a second. The subject experiences compression, rotation, and shear in the low back and neck.

*Discussion*

The types of spinal injuries that Mr. Nicholson was diagnosed with (primarily symptomatic disk derangements and associated sequelae) are highly consistent with the injury mechanism of the crash. Traumatic loading of the spine that results in axial (up and down) compression, particularly in combination with the other load types occurring with the subject collision, has the potential to damage the peripheral disk annulus, which surrounds and holds in the disk nucleus. Men in their late 5th decade, like Mr. Nicholson (who was 46 at the time of the crash) typically have at least moderate age-related degenerative changes of the disks of the spine, a fact that makes the collision more likely to have "converted" at least some asymptomatic disk degeneration to a symptomatic state, rather than being the sole cause of all of the pathology identified in the post-crash imaging.

The symptoms of spinal disk injury may, in some cases, be instantly recognizable after a traffic crash because of the sudden onset of radiculopathy, but recent research has demonstrated that only about 1 in 17 cervical disk injuries are recognized as such in the ED after a crash.[[8]](#footnote-8) By far, the majority (94%) of what are later determined to be spinal disk injuries are initially diagnosed as in the ED as spinal strains.

Although the subject crash was no "bumper tap" it is well established in biomechanics, medicine, and epidemiology that an excessive level of force is not required to cause symptomatic injury to a spinal disk with any degree of degeneration, and that in most cases, the diagnostic imaging of the disk will not reveal whether related symptoms are of a traumatic origin or not, in the absence of fracture.[[9]](#footnote-9) Traumatic disk injuries have been described in the peer-reviewed literature as resulting from low to moderate force events, including minimal or no damage traffic crashes, roller coaster rides, and even more mild forces such as sneezing.[[10]](#footnote-10)-[[11]](#footnote-11)[[12]](#footnote-12)[[13]](#footnote-13)[[14]](#footnote-14)[[15]](#footnote-15)[[16]](#footnote-16) It is accurate to state, both from a biomechanical and epidemiological perspective, that there is no established or generally accepted lower force threshold at which it can be said that an acute intervertebral disk injury in any part of the spine cannot occur, and that the load threshold at which individual’s disk may injured is only known after the injury has occurred, and the external load has been estimated. it is impossible to estimate the additional compression due to internal forces, however, and the precise load associated with a temporally proximate spinal disk injury is often impossible to accurately determine after the fact.

Based on the preceding discussion there was ample and biomechanically appropriate force exerted on Mr. Nicholson’s body in the subject collision to have caused his medically documented injuries, and associated need for evaluation and treatment, including his spinal pain management procedures and cervical spine surgery.

**Temporal relationship between the crash and symptoms indicative of injury**

The second step of the injury causation analysis is the assessment of the timing between the trauma and the onset of symptoms indicative of injury. The hallmark of injury is that "you know it when it happens;" *i.e.* the causal relationship between the trauma and onset of the symptoms indicative of the injury is usually close enough in time that it is easy to recognize when the injury was incurred. There are some injuries that exhibit a delayed onset of symptoms, including injuries to intervertebral disks, which can first manifest with identical symptoms to a simple spinal strain. Other injuries are always immediately apparent, such as bony fractures. Some injuries are considered "distracting" from others because the pain they generate distracts attention from other, less painful injuries. There are still other injuries that can "mask" pain from nearby parts of the body through complicated pain accommodation mechanisms that are mediated at the spinal cord and in the brain. The assessment of the timing of the onset of symptoms reasonably attributed to an injury can sometimes be nuanced and complicated, and sometimes requires expert assessment.

Mr. Nicholson experienced the onset of symptoms indicative of acute spinal injury immediately after the crash, and he was diagnosed with neck and back injuries directly by 3 days following the crash, including the presentation of lower extremity radicular symptoms, an ominous early sign of injury to the intervertebral disks in the spine. The symptoms and diagnoses progressively evolved and worsened over the weeks and months following the crash and demonstrate a well-documented contiguous chain of causation linking the subject crash and their low back and cervical spinal injuries, and associated need for treatment.

Based on this history, there was a strong temporal relationship between the subject collision and Mr. Nicholson’s first development of symptoms indicative of spinal injury.

**Alternative explanations**

This last step of the injury causation analysis specific to the individual involves the assessment of the probability of the same symptoms, injuries, diagnoses, and need for treatment occurring at the same point in time, but in the absence of the investigated crash.

This part of the analysis is accomplished in 2 ways; first and most obviously, any competing contemporaneous traumatic cause of injury must be ruled out. There is, however, no such history for Mr. Nicholson, and the only source of trauma apparent in my review of materials that is temporally proximate to his post-crash injuries is the March 3, 2021, near-side, impact crash.

The second part of the analysis requires an assessment of the probability that Mr. Nicholson would have developed the symptoms and diagnoses of spine injury at the same point in time had he not been initially injured in the March 3, 2021, near-side impact crash. As a generally healthy 46-year-old male, Mr. Nicholson was at a negligible annual risk of spontaneously developing chronically painful and potentially surgical cervical or lumbar spinal disk derangements; less than 1 in 2,000 is indicated by epidemiologic study and national hospital data.[[17]](#footnote-17) The chance that they were going to develop the onset of chronic neck or low back pain attributable to symptomatic disk derangements on the same day as the crash by pure coincidence is obviously much smaller; less than 1 in 730,000 (the annual risk divided by 365 days). In comparison the risk of acute spine injury in the subject crash was more than 50%, and the risk of a spinal disk injury was likely no less than 1 in 25 in the general population.[[18]](#footnote-18) Based on this comparison of risk during the timeframe of interest, the crash is the most likely cause of Mr. Nicholson’s chronic spinal injuries by >99%.

A relatively common medicolegal question is whether persisting symptoms of back or neck pain after a traffic crash are truly related to the crash, or more probably due to other factors incidental to an acute crash-related injury to the spine. Most typically, the "other factors" that are raised in a medicolegal setting are the presence of pre-existing degenerative changes in the spine, or pre-crash history of low level or sporadic symptoms.

The answer to this question is now decided science. Along with my research colleagues, I have recently published 2 analyses and systematic reviews of nearly 10,000 articles regarding the long-term effects of traffic crash-related injury to the neck and low back and associated chronic pain.[[19]](#footnote-19),[[20]](#footnote-20) Systematic reviews are considered the most reliable and strongest form of scientific evidence (i.e. Level I evidence), as they consist of a comprehensive synthesis of world literature on a topic.[[21]](#footnote-21) The result of the analyses indicate that when men like Mr. Nicholson have persisting neck or back pain after an acute crash-related injury, *more often than not* (>50% of the time) the symptoms are due to the crash, versus all other causes, regardless of pre-crash medical history.

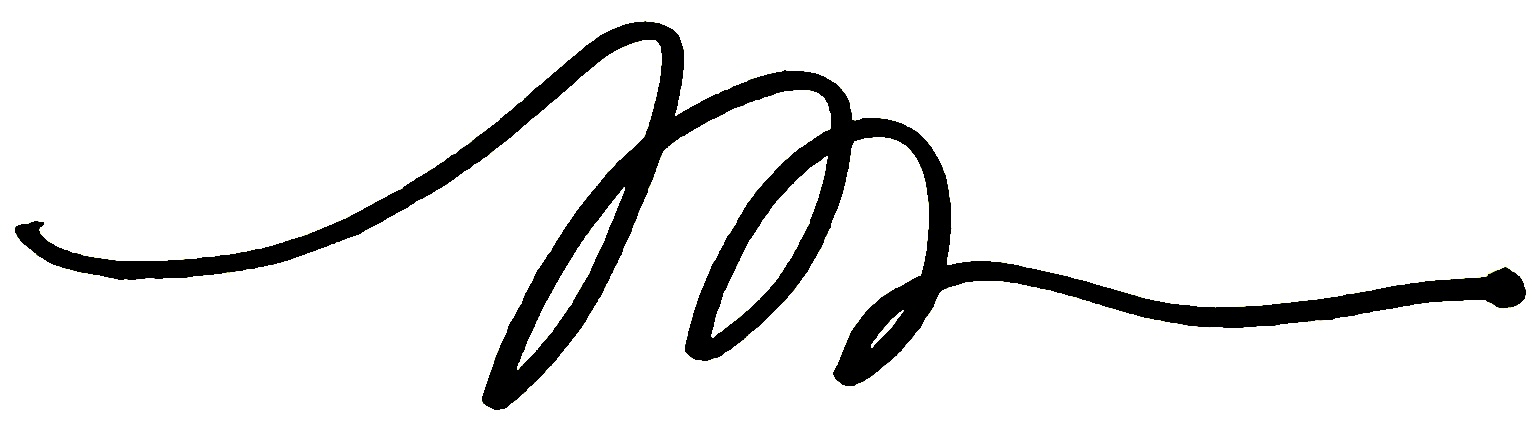
**Conclusions**

Given the contiguous chain of causation from the day of the crash through Mr. Nicholson’s most recent medical records, the lack of any significant pre-crash history of persisting spine pain and need for treatment in the years prior to the crash, as well as the relative risk of significant and persisting spine injury from the subject frontal impact crash, I conclude that the most probable cause of the post-crash acute and chronic neck and low back injuries described in Mr. Nicholson’s medical records and summarized in this report, including his symptomatic cervical and lumbar disk derangements, is the subject March 3, 2021, near-side impact crash.

I have not examined Mr. Nicholson and I therefore have no opinions about his diagnoses, treatment, or prognoses outside of what is reflected in the medical record. This is not to say that I am not qualified, licensed, and extensively experienced in performing such evaluations, but that I have not done so in this case.

The preceding opinions were given as reasonable medical, and scientific probabilities. I reserve the right to amend any of my opinions should new information come to light.

Very truly yours,



Michael D. Freeman, MedDr, PhD, MScFMS, MPH, FRCPath, FFFLM, FACE, DLM

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**Appendix**

The 3-step causation methodology that I have used in this case is set forth in a number of my peer-reviewed publications, including a paper entitled *A Systematic Approach to Clinical Determinations of Causation in Symptomatic Spinal Disk Injury Following Motor Vehicle Crash Trauma*, published in the Journal of Physical Medicine & Rehabilitation in 2009. I first described this 3-step methodology in a paper published in 2008 and have since published more than a dozen papers describing some of the manifold applications of the causation methodology. As I describe below, the 3-step causal methodology has recently become part of United States Appellate Court case law on injury causation.

The methodology set forth in my 2009 paper consists of 3 steps or elements that need to be satisfied in an injury causation analysis in order to conclude that an injury resulted from a particular event to a reasonable degree of medical/scientific probability, which are as follows:

1. Plausibility: This first step addresses whether it is biologically *possible* for the injury event to have caused the condition (a.k.a general causation). A finding of plausibility is unrelated to the *frequency* of the injury, because even if the injury occurs in only 1 in 100 or fewer cases of exposure to the event (e.g. a spinal disk injury following a car crash), it is still *plausibly* caused by the event. Plausibility is a relatively low hurdle to clear in a causal analysis and is largely satisfied by the lack of evidence of *implausibility* of the relationship. Although it is common in crash injury litigation for the defendant to assert minimal vehicle damage as a basis for disputing injury causation, the approach is unhelpful for evaluating plausibility, as such an analysis does not have a sufficiently low error rate to establish impossibility, and at best can only be used to suggest a low frequency of injury in the general population. An example of an *impossible* causal relationship is the discovery of leukemia the day after a crash, as it is well established that it is not biologically plausible for trauma to cause leukemia. Plausibility is often, but not necessarily, established with epidemiologic data or information.

2. Temporality: This second step examines the clinical and other evidence of the timing between the onset of the symptoms of injury and the injury event and must be satisfied to assess specific causation. First, it must be established that the sequence of the injury and the event is appropriate; the symptoms cannot be identically present prior to the event. Further, the onset of the symptoms of injury cannot be implausibly latent, relative to the injury event. For example, while the symptoms of a spinal disk injury in the neck may not immediately include upper extremity radiculopathy (most such injuries are initially diagnosed as a simple sprain or strain), a complete absence of symptoms in the neck for 3 months after a traffic crash, followed by the sudden insidious onset of symptoms of a cervical disk injury with radiculopathy, could not be plausibly related to the crash in most cases.

3. Lack of a more probable alternative explanation: This final step examines the probability of the injury condition occurring at the same point in time in the plaintiff, given what is known about the plaintiff from the review of medical records and other evidence, but in the absence of the injury event (a.k.a. differential etiology). First, evidence of competing injury events must be evaluated, and compared for injury risk. Then, the likelihood of the condition occurring spontaneously must be assessed. For example, the plaintiff may have evidence of degenerative changes in the spinal disks pre-existing a traffic crash, but no symptoms. The question of interest (after the first 2 steps are satisfied) is what the probability was that the condition would have "converted" from asymptomatic to symptomatic in the absence of ("but-for") the crash. Since there is no information that can be gleaned from an examination of the plaintiff regarding her or her condition in the hypothetical absence of the crash, epidemiologic data often serves as the basis for the evaluation of the probability of alternative explanations. More probable alternative explanations are often intervening traumatic events that alter the clinical history in a substantive way. As an example, for a plaintiff with neck strain symptoms that lasted for 1 week after a crash, who is then involved in second collision a month later that results in neck and arm pain and is ultimately diagnosed with a cervical disk herniation, the second collision is easily identified as a more probable cause of the disk derangement than the antecedent crash. This is in part due to the abrupt change in the distribution of the symptoms more consistent with a disk derangement, but also the epidemiologically based conclusion that it is rare for a cervical strain that improves rapidly to evolve into a cervical disk herniation, and thus but-for the second crash, the condition would not have manifested.

The methodology described above was used to evaluate the cause of the Plaintiff’s injury in Etherton v Owners Insurance Company, entered on March 3, 2014 in United States District Court for the District of Colorado. In Etherton, the Plaintiff’s medical expert relied on the above referenced article to support her methodology (see footnote 3 on page 8 of the decision). The expert specified the same 3-step approach to assessing causation outlined above, described by the Court on page 8 of the order as follows:

"…his first step was to determine general causation… whether or not the type of injury that the plaintiff sustained could have been caused by the type of collision that the plaintiff was in… her second step was to consider whether there was a temporal relationship between plaintiff’s injury and the collision… her third step was to… rule out alternative causes of plaintiff’s injury."

The defense challenged, among other things, the reliability and fit of the methods described by the expert. After an extensive examination and discussion of the 3-step process used by the expert, the Court found that the methodology appropriately fit the specific facts of the case, and that a population-based (epidemiologic) approach was an appropriate part of the causal methodology. The Court denied the Defendant’s motion to strike the expert’s testimony.

The Defendant appealed the ruling from the District Court, and in July of 2016, the Tenth Circuit U.S. Court of Appeals unanimously affirmed the 3-step causal methodology described in my 2009 publication cited above as generally accepted and well established for assessing injury causation (see *Etherton v. Owners Insurance Company*, No. 14-1164, 10th Cir, entered on July 19, 2016). Using the 3-step methodology, the Court determined the expert’s methodology fit the specific facts in the case, and that the District Court properly applied Rule 702/Daubert standard to the expert’s testimony in finding his methodology reliable. The judicial panel included current Supreme Court Justice Neil Gorsuch.

Below is a partial list of publications in scientific journals in which my descriptions of the 3-step methodology described in the *Etherton* decision and its various applications have been subjected to peer review. The foundation for the specific causation methodology described in all of these papers is the "Hill criteria," a guideline for the assessment of general causation that has been universally relied on in medicine and science for more than 50 years.

Dianita Ika Melia P, Zeegers MP, Herkutanto H, Freeman MD. Medicolegal causation investigation of bacterial endocarditis associated with an oral surgery practice using the INFERENCE approach. *Int J Environ Res Public Health* 2021:18,7530. https://doi.org/10.3390/ijerph18147530.

Dianita Ika Melia P, Zeeger MP, Herkutanto H, Freeman MD. Development of the INFERENCE (INtegration of Forensic Epidemiology and the Rigorous EvaluatioN of Causation Elements) approach to causal inference in forensic medicine. *Int J Environ Res Public Health* 2020;17:8353; doi:10.3390/ijerph17228353

Dianita Ika Melia P, Freeman MD, Herkutanto H, Zeeger MP. A review of causal inference in forensic medicine. *For Sci Med Path* 2020:doi.org/10.1007/s12024-020-00220-9.

Freeman MD. A practicable and systematic approach to medicolegal causation. *Orthopedics* 2018;41(2):70-2.

Freeman MD, Zeegers M. Principles and applications of forensic epidemiology in the medicolegal setting. *Law, Probability, & Risk* 2015; doi:10.1093/lpr/mgv010.

Freeman MD. Medicolegal causation analysis of a lumbar spine fracture following a low speed rear impact traffic crash. *J Case Rep Prac* 2015; 3(2): 23-29.

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