Admissibility of Biomechanical Expert Testimony

I. Introduction

Defense attorneys are frequently asked to defend against, and prosecute, **allegations of personal injury. In many** personal injury and products liability **cases, a biomechanical analysis can provide a better understanding of the observed or claimed injuries and how they relate to the events of the subject incident. Such an understanding can be used to address a variety of questions, including whether an injury occurred, what caused an injury, what was the most likely scenario leading to the injury, and how any proposed changes in design or safety equipment use would affect injury risk.** Thus, biomechanical expert evidence has become an important part of many cases. *Consequently, a firm understanding of Rule 702 and its requirements for admissibility of* biomechanical *expert testimony is a vital component of every litigator's practice.*[1]

II. Injury Biomechanics in Litigation

A. Biomechanics In General

Biomechanics is the application of the principles of physics and mechanical engineering to biological structures. In biomechanics, the materials studied are biological in nature (bone, skin, brain matter, blood), and tend to have more complex material properties than traditional engineering materials. Injury biomechanics is a subset of biomechanics that looks at the mechanisms or mechanical causes of injury.

[1] *See generally* Patrick B. Omilian, "Rule of Evidence 702 and Daubert in Indiana: A Roadmap to the Admissibility of Expert Evidence in Federal and State Courts" (discussing Rule 702 in both the Federal and Indiana Rules of Evidence and the applicability of the *Daubert* standard for determining reliability of expert testimony).

A biomechanical analysis can evaluate a number of issues commonly raised in litigation. The first, and perhaps the most obvious, is how did an injury occur? In that case, the analysis follows a two-pronged approach, looking (1) **at the types of injuries received and the known causes of those injuries**; **and** (2) **at the type of injuries expected from the person's motions and contacts during the event.**

For the first **component of the analysis, the biomechanist performs a thorough review of the medical records to determine which injuries exist, and to learn as much as possible about the location, nature, size, and orientation of each injury. For example, in addition to noting a scrape, the biomechanist would like to know its size and shape and the direction in which the skin is scratched, which can help identify where the contact occurred and which direction the body was moving at the time. Similarly, a biomechanist can assess the direction and amount of loading to a bone based on a detailed description of the fracture or from looking at x-rays or even photographs of the injuries. In this way, the injuries are considered data, which are used to reconstruct what must have happened to the person during the event.**

The biomechanist then **analyzes how the person moved relative to his or her surroundings,** i.e., the occupant kinematics. **Like injury mechanisms, occupant kinematics is informed both by theory and by experimental research. From the theoretical side, Newton's Laws of Motion dictate how a body is going to move inside a vehicle and during the airborne phase of ejection. On the experimental side, results from crash testing indicate how a complex structure such as the human body moves within a vehicle, interacts with restraint systems and contacts interior**

surfaces during a motor vehicle collision. Once the motion and expected contacts are determined, the biomechanist then can evaluate the loads and accelerations associated with any contact and the contact speed to determine the type of injury expected. The biomechanist then integrates the findings from the injury mechanism and occupant kinematics components of the analysis to determine probable scenarios leading to the observed injuries.

Often, opposing parties will offer conflicting expert testimony to explain the cause of an injury.[2] For example, in *Morgen v. Ford Motor Company*, the plaintiff's experts testified that the injury he suffered in a car accident was caused by a defective structural design in the automobile.[3] Conversely, the defendant automobile company presented experts that testified that the injury was caused primarily by movements after the accident that could have been prevented had the plaintiff worn his seatbelt.[4]

Biomechanic analyses can be applied to answer other, similarly related questions, such as evaluating **injury causation, the risk of injury and the types of injuries expected in the scenario(s) described by witnesses,** and **the injuries expected in a proposed scenario.** Such applications rely on similar sources of data and similar methods of analysis.

B. Rule 702 and the Admissibility of Expert Testimony

The trial court must *act as the evidentiary "gatekeepers,"*[5] *making sure that scientific and technical evidence meet standards of admissibility so that the trier of fact is*

[2] *See e.g. Morgen v. Ford Motor Co.*, 797 N.E.2d 1146, 1148 (Ind. 2004).
[3] *Id.*
[4] *Id.*
[5] *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 589 (1997).

not presented with junk science.[6] *The admission of scientific and technical evidence implicates a number of evidentiary rules, most notably Rules 701 through 705. Rule 702 is the fundamental rule regarding the admissibility of technical and scientific evidence. Federal Rule 702 provides in full:*

> *If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.*

The Indiana Rule diverges somewhat from the Federal Rule. Indiana Rule 702 provides in full:

> *(a) If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.*
> *(b) Expert scientific testimony is admissible only if the court is satisfied that the principles upon which the expert testimony rests are reliable.*

III. Challenges to Biomechanical Engineering Expert Testimony

Like any other expert witness, the biomechanical engineering expert can face challenges in the courtroom. *In evaluating the reliability of expert testimony, the court performs a two-pronged analysis. First the court considers whether the expert is qualified to offer such testimony, then whether the expert has used reliable methodology in reaching her opinions and conclusions.*[7]

A. Challenges to the Expert's Qualifications

The first criterion for admissibility of expert evidence is reliability of the expert, that is, the expert must be qualified to render the proffered opinion. Federal Rule 702

[6] *Doe v. Schults-Lewis Child and Family Serv., Inc.*, 718 N.E.2d 738, 750 (Ind. 1999).
[7] *Smith v. Ford Motor Co.*, 215 F.3d 713, 717-18 (7th Cir., 2000).

allows experts to be qualified based on "knowledge, skill, experience, training, or education."[8] **Although increasing numbers of biomechanical engineers are graduating from accredited bioengineering or biomedical engineering programs today, many biomechanical engineers receive their degrees in mechanical engineering, engineering science, engineering physics, biophysics or other disciplines. Often these biomechanists have undergone rigorous academic training and have performed research in biomechanics but may not have a degree in biomechanics *per se*.**

An expert's qualifications need not stem from academic training alone, rather practical experience and training may serve as proper bases of expertise.[9] *The trial judge must consider the full range of a proposed expert's background including practical experience, academic and technical training, when determining if such witness is qualified to render a specific opinion.*[10] **In such cases, a transcript of coursework and a resume of professional experience and peer-reviewed publications can be used to demonstrate the biomechanist's educational qualifications.**

The key determination for qualification of an expert is the witness must have sufficient specialized expertise to render an opinion on the specific issue.[11] *That a witness is generally qualified to render opinions in a given area does not necessarily qualify the witness to render the specific opinion in the case. An expert's competence in a general field must extend to the specific opinion being rendered.*[12] **To be properly qualified, a biomechanist should have a thorough understanding of mechanics**

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[8] Fed. Rule of Evid. 702.
[9] *See Ty, Inc. v. Publications Int'l, Ltd.,* 2004 WL 2359250 (N.D. Ill. 2004).
[10] *Smith.*, 215 F.3d at 718.
[11] *See Ty*, 2004 WL 2359250 at 5.
[12] *See id.*, citing *Carroll v. Otis Elevator Co.*, 896 F.2d 210, 212 (7th Cir. 1990).

principles and a specialized knowledge of how those principles apply to the human body. Additionally, the biomechanist needs an understanding of functional anatomy and how the body moves under specific circumstances to apply critical loads to various tissues.

It is not uncommon for police officers, emergency responders, treating physicians, accident reconstructionists, or even eyewitnesses to have opinions on how an injury occurred. In some cases, these persons may be qualified to address some, but not all, of the components involved in a biomechanical analysis. For example, someone with extensive experience dealing with injuries may be qualified to opine on injury mechanisms but may overlook critical mechanical factors associated with the event. Similarly, someone with a thorough understanding of kinematics may offer opinions regarding occupant movement. However, without a firm grounding in both **anatomy and injury mechanisms, that expert cannot relate the occupant motions to risk of injury.**

Nonetheless, testimony admitted erroneously may not always be overturned on appeal.[13] In *Suell v. Dewees*, an orthopedic surgeon testified as to how fast he thought a car was moving when it struck another car.[14] His opinion, he admitted, was based on nothing more than his general knowledge on how slow people usually drive when they back out of a parking spot.[15] He concluded that, based on the assumed speeds of the vehicles, the injuries would not be expected to be serious.[16] The trial court did not exclude the testimony, and the Court of Appeals affirmed, concluding that the error was

[13] *Suell v. Dewees*, 780 N.E.2d 870, 875 (Ind. Ct. App. 2002).
[14] *Id*. at 871.
[15] *Id*.
[16] *Id*. at 872-73.

harmless.[17] The court stated "despite the fact that [the doctor] clearly does not qualify as an accident or reconstruction expert, he nonetheless has sufficient experience and knowledge of accidental injuries from which he could form an opinion as to the likely speed of the vehicles at the time of impact."[18]

B. Challenges to the Expert's Data or Method of Analysis

A second type of challenge to biomechanical experts involves challenges to the expert's data or their method of analysis. ***"****After the proponent of an expert has met her burden of showing that the expert is indeed qualified to render an opinion regarding the specific question or issue at hand, the proponent must prove that the expert's opinion is based on reliable methodology."*[19] Daubert v. Merrell Dow Pharmaceuticals *outlined four factors federal courts should use to analyze the reliability of an expert's testimony: 1) whether the technique has been or can be empirically tested; 2) whether the technique has been subjected to peer review and publication; 3) the known or potential rate of error, as well as the existence and maintenance of standards controlling the technique's operation; and 4) general acceptance within the relevant scientific community.*[20]

The Daubert factors are flexible, and *do not necessarily nor exclusively apply to every expert in every case.*[21] *An expert's methodology need not yield mathematical exactness, but it must provide a rational basis upon which to make a reasonable approximation.*[22]

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[17] *Id*. at 875.
[18] *Id*. at 876.
[19] Omilian, *supra* note 1, at 4.
[20] *Daubert.*, 509 U.S. at 593-94.
[21] *See Smith*, 215 F.3d at 719 and cases cited therein.
[22] *See Ty*, 2004 WL 2359250 at 6.

Indiana Rule 702 reflects an attempt to liberalize, rather than constrict, the requirements for admissibility of expert scientific evidence.[23] *Indiana courts analyze the reliability of an expert's methodology under Rule 702(b) using the principles announced in Daubert as a guide – "Daubert is helpful, but not controlling."*[24] *Rule 702(b) differs from the federal Rule in its express requirement that expert testimony be based on reliable scientific principles.*[25]

One common concern for biomechanical experts in establishing the reliability of their testimony **is the limited amount of data available in assessing injury mechanisms and tolerance levels. Unlike samples of something like steel bolts, there is not an abundance of living human spines that can be tested for failure. Thus injury data are necessarily collected from various surrogate sources. Another challenge with biomechanical data concerns whether the data are representative of a specific injury experienced by a specific person. Opinions must be based on conservative interpretation of the data and consider the data statistically.**

Another concern is that the experts may not always apply reliable principles and methods in their analysis. If a credentialed expert's testimony is based merely upon his observations, which are little more than what a lay person may offer, the court may determine that the testimony is inadmissible.[26] In *Lytle v. Ford Motor Co.*, the plaintiff's first witness, John Marcosky, was excluded from testifying because his theory of inadvertent release[27] was only based on his observations of the seat buckle and the

[23] *See Sears Roebuck and Co. v. Manuilov,* 742 N.E.2d 453, 460 (Ind. 2001).
[24] *See Carter v. State*, 766 N.E.2d 377, 381 (Ind. 2002).
[25] *See McGrew v. State*, 682 N.E.2d 1289, 1290 (Ind. 1997).
[26] *Lytle v. Ford Motor Co. (I)*, 696 N.E.2d 465, 470 (Ind. Ct. App. 1998).
[27] Inadvertent release refers to a seatbelt unbuckling during a car crash, which allegedly caused the severe injury to the plaintiff's spouse in this case. *See id.*

configuration of buckles in the vehicle, but not on any tests or "specialized knowledge, training or experience regarding the amount of forces generally required to release a buckle or proper seat belt configurations.[28]

Marcosky's testimony regarding his theory of inertial release was also excluded, because his pendulum tests, on which he relied upon in support of his theory, were "found to be unreliable be the National Highway Traffic Safety Association" because they did not take web tension into account, a force that is usually present in real world accidents.[29] The plaintiff's other expert, Billy Peterson, also used pendulum tests to support his theory of inertial release, but the court, while finding Peterson's tests more reliable than Marcosky's, still concluded that "Peterson…failed to demonstrate an adequate nexus between his pendulum tests and real world accidents."[30] That is, the forces and circumstances during testing were not "sufficiently similar to forces or circumstances which are present in a real world accident."[31]

Lytle returned to the Indiana Court of Appeals six years later, after the trial court granted the defendant's motion to strike the testimony of two more expert witnesses.[32] Thomas Horton, a mechanical engineer, testified as to his theory of inadvertent release.[33] However, the court dismissed his theory, asserting, "Horton simply twisted and pushed two seatbelts together without any evidence that the accident could have resulted in the same forces, direction, duration, rotations, or load conditions as his manipulations."[34]

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[28] *Id.*
[29] *Id.* at 471 ("[T]he factor that Marcosky's tests ignore, web tension, is the very factor that has been shown to prevent a seat belt from inertially releasing during real world accidents").
[30] *Id.* at 473.
[31] *Id.* at 467.
[32] *Lytle v. Ford Motor Co. (II)*, 814 N.E.2d 301, 304 (Ind. Ct. App. 2004).
[33] *Id.* at 311.
[34] *Id.*

Thus, the court held that the expert testimony was based merely on general principles of physics, and this alone could not withstand summary judgment.[35]

Similarly, the plaintiff's final witness, Anil Khadilkar, also had his testimony excluded regarding inadvertent release.[36] The court stated that the "record…shows that Dr. Khadilkar engaged in less than 10 minutes of 'testing' to reach his opinion: he placed a buckle against a table in his office and 'eyeballed' the depression necessary to release the latchplate."[37] The court concluded that there was no "indication that Dr. Khadilkar made an effort to measure the force, web tension, direction or rotation that would occur in this type of accident."[38]

C. Challenges to Expert Testimony in a Summary Judgment Motion

The proponent of expert testimony in summary judgment faces a lower burden than is required for admission of such testimony at trial with respect to Rule 702's requirement that the opinion be based on reliable methodology. Expert witnesses are frequently called upon to offer opinions regarding material issues of the case, in the form of affidavits for summary judgment proceedings. The affidavit is not required to establish the reliability of the scientific principles that form the basis of the opinion. Rather, the affidavit need only provide sufficient information to allow the court to "proceed with a reasonable amount of confidence that the principles used to form the opinion are reliable."[39]

However, this is not always an easy threshold to pass. In the *Lytle* cases, the Indiana Court of Appeals affirmed the exclusion of affidavits, depositions, and testimony

[35] *Id*. at 313.
[36] *Id*. at 313-14.
[37] *Id*. at 314.
[38] *Id*.
[39] *Doe*, 718 N.E.2d 738, 751 (Ind. 1999).

of 4 expert witnesses for the plaintiff in the defendant's motion for summary judgment.[40] This was mostly because the plaintiff relied mostly on the experts' qualifications and credentials, but not enough on ensuring that the testimony itself was based on reliable scientific principles.[41]

Similarly, in *Smith v. Yang*, the court found that the affidavit of an expert was properly excluded at the summary judgment stage because the theory upon which it relied, the "faked left syndrome," was not considered to be sufficiently reliable because there was "no objective evidence regarding the theory's general acceptance in the field," other than a reference to the theory in one article that was published in 1988.[42]

In sum, the Indiana courts have taken their gate-keeping role seriously, ensuring that the experts are not only qualified but have also used reliable procedures and methods. *Thus, once the court determines the expert's general methodology is based on reliable scientific principles and the testimony will assist the trier of fact, then the trier of fact may properly leave the accuracy, consistency and credibility of an expert's opinions to vigorous cross-examination, presentation of contrary evidence, argument of counsel, and resolution.*[43]

IV. Biomechanical Engineers and Medical Doctors

Biomechanists and medical doctors are both used as experts in the courtroom. Because both types of experts discuss human injury, there can be some confusion about the roles of experts, their areas of expertise, and which type of expert can be of assistance in an individual case. *Both federal and Indiana courts have*

[40] *See Lytle I*, 696 N.E.2d 465; *Lytle II*, 814 N.E.2d 301. *See also* discussion of these cases *infra* at 7-8.
[41] *See, e.g., Lytle I*, 696 N.E.2d at 473-474.
[42] *Smith v. Yang*, 829 N.E.2d 624, 629 (Ind. Ct. App. 2005).
[43] *Rogers v. Cosco, Inc.*, 737 N.E.2d 1158, 1169 (Ind. Ct. App. 2000).

established specific foundational requirements for admissibility of expert testimony offered to prove medical causation. Questions of medical causation are questions of science necessarily dependent upon testimony by physicians or surgeons with experience in the area.[44] **Confusion can include challenges to the expert's qualifications, with attempts to preclude the biomechanical expert from discussing injuries because he or she does not have an M.D. degree.**

Biomechanical engineers and scientists have studied engineering or physics and typically have performed research on biological structures. In the course of their education and research activities, they will have gained some understanding or medical and biological issues. However, the range of medical knowledge and education varies widely among biomechanists, from very specific knowledge relating to the anatomy and physiology related to a research project (e.g., knee joint or skin) to practicing clinicians with M.D. degrees.

Medical education is primarily concerned with patient care, including diagnosing and treating injuries and pathologies. Many medical training programs included at least limited biomechanics, and some physicians have advanced training in the field. At some universities bioengineering has become a popular undergraduate curriculum for pre-medicine students, creating an increasing number of medical doctors with undergraduate degrees in engineering. Again, the range of "crossover" training varies widely.

The differences in the education and knowledge of biomechanists and medical doctors are reflected in their areas of expertise. As described earlier, a biomechanist evaluates the motions and loads experienced by an individual and

[44] *See e.g., Armstrong v. Cerestar USA, Inc.*, 775 N.E.2d 360, 367 (Ind. Ct. App. 2002).

compares them to the motions and loads necessary to cause injury in order to explain how injuries occur. A medical doctor diagnoses and treats patients. *Where the cause of an injury or ailment is neither objective in nature nor within the understanding of the layperson, but rather is a complicated medical question, expert testimony is required to connect the cause to the injury.*[45] **Information about both the individual (including details of any claimed injuries) and their environment are necessary for a complete biomechanical evaluation.**

Medical care providers often have limited information regarding the details of events leading to the alleged injuries and that information typically comes from a patient history, rather than objective findings (such as photographs or an inspection). However, if a medical expert gives an opinion as to whether the accident could have caused the observed injuries, appellate courts may not overturn admission of such testimony unless the error was prejudicial to the other party.[46] **A biomechanical engineer is not qualified to diagnose injuries (unless he or she is also a medical doctor), so the diagnostic information in the medical records and other documentation is taken as fact and used as data in the biomechanical evaluation. In situations where medical information is conflicting, ambiguous, or not presented in sufficient detail, the biomechanical engineer may work closely with a medical doctor to resolve the issues.**

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[45] *See Daub v. Daub*, 629 N.E.2d 873, 877-78 (Ind. Ct. App. 1994); *see also Morphew v. Morphew*, 419 N.E.2d 770, 777 (Ind. Ct. App. 1981) (plaintiff could not testify that she had "muscle disease," medical expert testimony required as to diagnosis of leg problem) (superseded by statute on other grounds), *see also Hannan v. Pest Control Serv., Inc.*, 734 N.E.2d 674, 679 (Ind. Ct. App. 2000) (requiring expert medical evidence that exposure to pesticides caused plaintiffs' injuries); *Turner v. Davis*, 699 N.E.2d 1217, 1220 (Ind. Ct. App. 1998) (testimony of medical expert required to diagnose cause of sleeping ailment).
[46] *See Suell*, 780 N.E.2d at 875.

Thus, the expertise of biomechanists and medical doctors is usually related, but independent. Each case must be evaluated individually, and a given case may require biomechanical expertise, medical expertise, both, or neither.

V. Conclusion

Biomechanical evidence is useful in court to attempt to determine how an injury occurred, both from the examination of the actual injuries and on the motions and contacts that would likely cause such injuries. However, biomechanical engineers are scrutinized in litigation as much as other expert witnesses, if not more. Their testimony is subject to Rule 702, which challenges both their qualifications and the reliability of their principles, methods, and data. Indiana courts have been especially skeptical in recent years, even when the expert's credentials are well established, and have excluded testimony on many occasions.[47] Part of this has come from skepticism towards the field of biomechanics as a whole. **Although biomechanics has roots as far back as the seventeenth century,[48] its widespread growth and application among the engineering sciences has occurred primarily in recent decades. Frequently, when people think of injuries they think of medical doctors rather than engineers, and juries and the court may expect a medical doctor to take the stand for a discussion of injury.** Nevertheless, *scientific evidence has found a home in the courtroom, as Justice Breyer suggested.*[49] Thus, the importance of Rule 702, and its application to biomechanical evidence, must establish a home as well.

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[47] *See Lytle I*, 696 N.E.2d 465; *Lytle II*, 814 N.E.2d 301; *Smith*, 829 N.E.2d 624.
[48] For example, "Borelli's *De motu animalium*."
[49] *See* REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 1 (2d Ed. 2000); available at http://www.fjc.gov/ (quoting Justice Breyer as stating, "In this age of science, science should expect to find a warm welcome, perhaps a permanent home, in our courtrooms"); *See also* Omilian, *supra* note 1, at 10 (arguing that Justice Breyer's assertion has materialized).