CROSS-EXAMINATION OF DR. KENNETH MONSON

STATE v. [DEFENDANT]

AREAS TO INQUIRE ABOUT:

1. By definition, the area of biomechanical engineering must rely on extrapolation of data learned from various sources to what would happen in a real-life event, is that right?
2. Those sources include:
   1. Animal experimentation?
   2. Anthropomorphic dummy experiments?
   3. Rare experimentation with human cadavers or body parts? – especially rare to have pediatric samples?
   4. Finite element analysis by computer?
   5. Medical literature?
   6. Other sources?

ANIMAL EXPERIMENTATION

1. Starting with animal experimentation, has there ever been an animal anatomy that is considered exactly the same as a human infant or toddler?
   1. Specifically, is there an animal equivalent that is exactly the same as the head of a human infant or toddler?
2. So, such experimentation is not 1:1 relatable to what occurs in a real living human child?
3. But it does yield some useful data that then has to be extrapolated to real-life?
   1. And, in fact, many “injury thresholds” relied upon by biomechanical engineers have been derived from experiments on animals?
   2. Are those “injury thresholds” meant to exactly replicate what happens with a living human child?
   3. And, no one has ever conducted controlled experiments on living human children? Nor would that be allowed now?
   4. Would you agree that there is no animal model that ***exactly*** replicates the anatomical features of a living human child?
   5. So, whenever animals are used in experimentation, whatever data is obtained must be extrapolated to what would happen to living human children?
4. Are there any biomechanical experiments that have been done with animals that involved subjecting those animals to a fall down stairs?
5. Why types of things have been studied by biomechanists using animals, to determine information about injuries to human children?
6. In fact, some of those experiments have been done by your colleague at the University of Utah, Dr. Brittany Coats, correct? And there are others that are ongoing by her and her team?
7. Have there ever been “injury thresholds” established for various types of injurious events to which human infants and toddlers have been subjected that represent exactly what would happen in those events to human infants or toddlers?
8. So, when biomechanical engineers talk in terms of “injury thresholds”, those were derived from something other than actual controlled experiments with children, and there is always some need for assumptions or extrapolations to be made?

ANTHROPOMORPHIC DUMMIES

1. Would it be fair to say that most of the work done by biomechanical engineers over the last several decades have been focused on the use of “test dummies” of various types in various types of experiments to determine data?
2. And much of that experimentation has focused on automobile safety and the safety of restraint devices for automobiles?
3. Has there ever been a test dummy that *exactly* replicates what occurs in various events to actual human children?
4. In fact, even in the Loyd dissertation from Duke, some of his findings in that doctoral work were that the CRABI test dummy and some of the assumptions made about that were not accurate, based on the results of his experiments with cadaver heads?
5. At least to this point in time, there is still a lot that is unknown about anatomical features of human children, or which can’t be directly created and replicated in a test dummy, right?
6. Have such test dummies been used in experiments intended to establish what types of skull fractures human children might experience from various types of events?
7. Have any of those established a 1:1 relationship of the cause of such injuries in children?
8. In fact, most dummy experiments look at various measurable forces, such as things like peak acceleration?
9. And the results of most such experimentation rely on various types of “injury thresholds” and determining what type of energy applied to the test dummy might be injurious to a living human child? So, again by definition, any such opinions require extrapolation?
10. Has there ever been a test dummy created that had a skull and properties of the intracranial contents which were *exactly* the same as a human child? If so, was that dummy subjected to various forms of trauma to determine what types of skull fractures might occur? What were the results?
11. What type of material was used in that dummy so that it would fracture in exactly the same way as a living human child’s skull would fracture?
12. If that hasn’t been done, what opinions based on experimentation with test dummies can be drawn as to what would cause skull fractures in living human children? What assumptions are a necessary component of those opinions?

EXPERIMENTS WITH HUMAN CADAVERS OR PARTS THEREOF

1. Another source of information is experimentation with human cadavers where the bodies have been donated for research?
2. How common is that with pediatric cadavers? Please explain.
3. What issues have been investigated with experiments with human cadavers, in general?
4. Obviously, such experiments can’t determine things like what forces would result in bleeding anywhere in the cadaver body? Because no circulation?
5. Would that also be true for soft tissue damage? Swelling?
6. What about the effects of protective reflexes in a living human child?
7. How do biomechanical engineers use cadavers to study issues like skull fractures?
8. Isn’t it true that in most such experimentation, the head is severed from the rest of the body?
9. In fact, most such experiments involve either crush tests of the cadaver heads or drop tests? That’s what was done with the pediatric cadaver heads in the Loyd dissertation work, as well, right?
10. Are the results of such experiments *exactly* the same as what would cause skull fractures in living human children? If not, please explain what has to be extrapolated to reach conclusions?
11. In the cadaver experiments that you’re aware of which involve dropping pediatric cadaver heads to determine what type of drop results in a skull fracture, are there any articles which show what type of straight drop is required to cause a bi-parietal skull fracture?
12. Are you aware of any pediatric cadaver head experiments which have specifically tried to replicate what happens to human infants in a fall down stairs? Would that even make sense if the heads were not attached to a body? Please explain.
13. So, when experimentation is done involving “dropping” of the heads, those are straight drops onto a surface? And that was true in the Loyd dissertation work as it was in the Weber biomechanical experiments back in the 1980’s?
14. Would you also agree that results of such cadaver experiments do not always agree completely with the medical literature concerning what types of events are necessary to cause skull fractures in living human children?
15. What is your explanation of the reason for the differences?
16. It is probably obvious, but I assume there are no experiments where cadaver heads having been severed from their bodies were subjected to stairway fall testing?

COMPUTER MODELING – FINITE ELEMENT ANALYSIS

1. Tell us what types of things are being researched through computer modeling and finite element analysis?
2. What does the FE process involve?
3. What data is input to the computers in order to have the computer perform the analysis?
4. Is it accurate to say the results of FE analysis are only as good as the accuracy of the data being input into the computer?
5. And, the data to be input is still not perfect in its reflection of the true properties of a living human child’s anatomy?
6. To what extent are tissue and other properties being assumed from animal experimentation? Other sources?
7. From adult human experimentation?
8. Other sources?
9. As with other sources of biomechanical opinions, this area also involves assumptions and extrapolations because the true properties of infant and toddler human anatomy and particular body parts is not subject to direct experimental verification, correct?
10. Are you aware of any FE studies that have specifically looked at what happens to living human children in falls down stairways?
11. As I understand it, the only things that have been extensively researched by biomechanical engineers relating to injuries to young children is skull fractures, is that accurate?
12. There have been no studies yet as to the causes of subdural or subarachnoid bleeding in young children?
13. No studies, yet, as to the cause of retinal hemorrhages in young children?
14. No studies looking particularly at what it would take to cause a brain contusion to the parenchyma of a child’s brain?
15. Have there been any biomechanical studies of any kind looking at what it would take to cause all of those injuries in one 18 month old child?
16. Would you agree that the question of what would cause the collection of a bi-parietal skull fracture, extensive left-sided subdural hemorrhage, diffuse brain swelling and infarctions, contusion of the brain parenchyma, and ora to ora retinal hemorrhages in multiple layers of the retina in the left eye as a collection of injuries in an 18 month-old child is essentially a medical question?

MEDICAL LITERATURE

1. Would you agree that biomechanical engineers also have to rely extensively on the medical literature?
2. Yet, as you have acknowledged in your report, often the results of medical analysis of the cause of injuries to children is not the same as the results of biomechanical experimentation?
   1. In fact, almost all ***medical*** articles considering the effects of stairway falls conclude that complicated or life-threatening head injuries in young children are extremely rare, if seen at all, is that right?
   2. And that is not consistent with biomechanical experimentation?
   3. Have you been involved with any biomechanical experiments attempting to recreate what happens to human infants and children in stairway falls?
   4. What can you tell us about the experiments of others?
3. One of your special areas of interest is in cerebral vasculature, is that right?
4. Have you conducted any biomechanical experiments to establish the causes of subdural hemorrhages in human infants or toddlers?
5. Have there been any such experiments, to your knowledge, that specifically looked at the properties of human infants and toddlers, as opposed to extrapolating data from adult humans, animals, or test dummies?
6. In your report for this case, you state: “The reasons for the differences between anecdotal and experimental studies are not yet known, but one logical explanation may be that children most often do not fall in such a way as to expose their heads to the full energy of a fall.” Doesn’t that indicate that your opinions must be tempered by the medical literature which continues to show that serious or complicated head injuries from short falls or stairway falls are extremely rare?
7. Is it your testimony that biomechanical experimentation shows that stairway falls in human infants and toddlers does regularly cause serious and complicated head injuries? Or just simple, parietal skull fractures?
8. Is it even possible for those biomechanical experiments to demonstrate the *exact* cause of such things as extensive subdural hemorrhages, extensive ora to ora retinal hemorrhages, brain contusions and massive brain swelling in living human children?
9. Certainly not from cadaver studies, right?
10. And animals studies, even if done with living animals, still have to be extrapolated to living human infants and toddlers?
11. And computer modeling is still limited by incomplete data as to anatomical properties of the human infant and toddler brain and skull?
12. As you consider and rely on the medical literature, do you also consider what injuries are caused to human infants and children in well-documented accidental situations?
13. As to your reliance on the medical literature, what specific medical training have you received to support the “bio” part of your degree in biomechanical engineering?
14. Just to be clear, you do not have an M.D. or D.O. degree?
15. Have you ever had authorization to diagnose the causes of any medical condition in actual patients?
16. Would you agree, in general, that the effects that any particular event will have on a particular person depend not just on what forces are applied to that person, but the unique aspects of that person?
17. In other words, for biomechanical experimentation, it is not assumed, is it, that every 9 month old baby is exactly the same? Nor that ever 18 month old child is exactly the same?
18. Would you agree that each person presents slightly different physiological and anatomical features?
19. And that physicians are in the best position to determine what those unique aspects of the individual patient might be?
20. In fact, as you attempt to express opinions about any particular legal case, you have to take into account the collection of injuries documented by medical professionals that were suffered by a person?
21. And, if it’s a child who was the injured person, the stories offered by the person who was caring for the child when an incident occurred?
22. Then you have to apply all the information we discussed earlier to your opinions, correct?
23. If you don’t do any particular calculations or testing as to the proffered facts of that particular child’s case, what then IS the basis of your opinion that a particular described event could (or could not) have resulted in a particular collection of injuries to that child?
24. In that hypothetical scenario, what would be the underlying scientific basis for opinions you might express about the likely cause of that child’s entire collection of injuries?
25. And, wouldn’t it be true that each of those scientific bases would involve at least SOME degree of extrapolation and assumption from biomechanical sources of data to what would happen to a living human child in that exact situation?

GENERAL BIOMECHANICAL PRINCIPLES

1. I’d like to ask you just some general questions about biomechanics to make sure I understand the basics.
2. First, when a biomechanical engineer considers a particular event, say a fall by a young child, tell us about the significance of “kinetic energy” in that event.
3. If a child falls down a stairway, what would you generally expect in terms of the kinetic energy involved in such a fall?
4. Isn’t it true that in any fall, most of the kinetic energy is expended in the first impact the child would have with the stairs?
5. Then as the child continues to tumble down the stairs, each subsequent impact would involve less kinetic energy than the prior impact?
6. Is there any formula that is applied to determine exactly how much kinetic energy would be lost in each impact during a fall down stairs? Is that because every stairway fall is somewhat different from every other such fall?
7. Does the type of stairway and the material the stairs are composed of have any significance? What?
8. Does the covering over the stairs have any significance? Please explain.
9. Does the age and size of the child have a bearing? Please explain.
10. What about the slope and measurements of the stairs?