UC Berkeley expert on head impacts sets out to change way society deals with possible shaken baby syndrome

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By Robert Sanders, Media Relations

Berkeley - Mechanical engineer Werner Goldsmith of the University of California, Berkeley, is on a mission to reform the way doctors and prosecutors view the thousands of suspected cases of shaken baby syndrome each year.

An often fatal set of symptoms caused by violent shaking of an infant or young child, shaken baby syndrome can be difficult to diagnose because frequently there are no external signs of abuse. Most of the damage is in the brain.

Backed by decades of research on the effects of head impacts, and as author of the only book on the subject of impacts, Goldsmith nevertheless sees a rush by pediatricians, social workers and prosecutors to brand many parents and caregivers as child abusers when the injuries were more likely caused by a fall.

"Anyone who abuses a child deserves the full fury of the law," said Goldsmith, a professor of the graduate school at UC Berkeley. "But people should know the truth. The brain injuries that lead many prosecutors to file charges of child abuse can also be caused by falls or even result from chronic bleeding in the brain."

To get his message out, Goldsmith is traveling around the country educating the medical community as well as lawyers and child welfare caseworkers about the complexities of establishing a cause of child brain damage. He also counsels numerous lawyers and testifies as an expert on head impacts at trials, where he sees first-hand the rush to judgement.

"A child in someone's care dies by natural causes or accident and the district attorney files charges claiming shaken baby syndrome," he said. "Suddenly, the caregiver is faced with life in prison."

His message to doctors and lawyers is not to assume that a child with bleeding in the brain and the eye is automatically the victim of child abuse. Doctors typically look for these symptoms, called subdural hematoma and retinal hemorrhage, respectively, plus brain swelling or edema.

Such symptoms could result from an accident or, under certain circumstances, from a chronic condition. Doctors and medical examines need to look for other signs of abuse, in particular, neck damage, he argues.

"I am absolutely convinced that in order to do serious or fatal damage to an infant by shaking you have to have soft tissue neck damage," Goldsmith said. "Yet, in 95 percent of cases, medical

examiners do not look at the neck in autopsy. They look at the stomach, the abdomen, the head, but the neck is neglected."

The main problem is that very little research has been done on the effects of head impacts in infants and small children. Goldsmith, whose 1960 book, "Impact: The theory and physical behaviour of colliding solids," will be reissued next month by Dover Publishers, has written more than 50 papers on the biomechanics of head and neck injury. Yet, though he pioneered the application of biomechanics to head injury, he has conducted no studies of infants. Only one such study has been done, in 1987, and that employed a doll whose head was stuffed with wet rags.

To remedy this lack of basic data, within a few months he plans to embark on a preliminary study with UCSF neurosurgeon Geoffrey Manley, MD, PhD, using professional crash test dummies instrumented with devices to measure the types of forces an infant would sustain during shaking and other types of abuse.

"I have a very strong feeling that, given how little we really know about the mechanical issues involved in head injury, there may be people who are convicted of crimes they are not guilty of," said Manley, chief of neurotrauma at UCSF.

For now, Goldsmith hopes to make an impact on the overly aggressive approach of many pediatricians to suspected shaken baby syndrome.

Though most doctors look for brain edema, subdural hematoma and retinal hemorrhaging, many other types of trauma produce similar symptoms, he said. In fact, bleeding in the brain normally increases pressure, leading to swelling and retinal bleeding. So anything that causes intracranial bleeding, in particular falls, can display this trio of symptoms.

A fall backwards from three feet onto a hard surface, like concrete, can produce nearly 180 Gs of acceleration - 180 times the force of Earth's gravity - enough to cause a subdural hematoma, Goldsmith calculated. Shaking a child once a second through a range of one foot produces only 11 Gs, at the most.

"There is an order of magnitude difference between shaking and falling," Goldsmith said. "From the point of view of the brain, shaking is a much, much milder form of braking than a fall."

One dogma often espoused by doctors is that short distance falls do not cause serious harm. However, videotapes demonstrate that falls from as little as 32 inches can cause fatal brain damage in infants and toddlers.

To complicate matters, between 5 and 10 percent of children are born with undiagnosed subdural hematomas, and 30 percent are born with retinal bleeding, Goldsmith said.

"If you get a rebleed, you may get something that looks like shaken baby syndrome," he said.

Because of such uncertainties, Goldsmith urges physicians and prosecutors to look for more certain evidence of shaking, specifically damage to the neck.

"You should be able to show neck damage to prove shaken baby syndrome," he said.

Goldsmith also urges doctors to talk to biomechanical engineers to get an understanding of the forces involved in accidental falls versus child abuse.

The ultimate goal of Goldsmith and Manley is to build a sufficiently lifelike baby dummy containing a skull, dura (a tough membrane that lines the skull and envelops the brain) and brain whose properties are very similar to the real thing. The dummy studies planned for January will provide some of the data they need, and help them apply for a grant from the National Institutes of Health for further studies.

"The infant neck, particularly before the age of one, is dramatically different from the neck of, say, you or me," Manley said. "The same is true of the head, which in infants is soft and compliant - they haven't formed sutures yet.

"We don't believe that these crash test dummies are sufficient to represent the actual biology of the infant head and neck, so we are going to use the preliminary data to write a grant to develop a much more realistic model."

In addition, Goldsmith and graduate student Ken Monson are working with Manley to obtain fresh cerebral arteries and veins from surgery patients for measurement of their mechanical properties. Despite the fact that arteries and veins are embedded in the brain like a net, no one has considered them in models of how the brain responds to impact.

In the late 1960s, Goldsmith was chair of a committee at NIH, the Head Injury Model Construction Committee, that for four years oversaw research to construct a model of the adult head and brain. Unfortunately, funding dried up in the 1970s, and the research project was dropped.

"Well over 50,000 people die from head injuries each year. Finding out the causes and procedures is very difficult, but essential," he said.