Child Injury: Forensic Human Factors Points to the Need for Better Product Designs and Warnings

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A set of cases concerning child injury is described in which there are several human factors/ergonomics (HFE) issues. Each panelist describes an injury or death of a child with a brief overview of the events that occurred. Major HFE issues are presented and discussed using the framework of the hazard-control hierarchy of designing out, guarding against, and warning about hazards. Consideration is not only given to children but also caretakers in the design of useable and safe products. A secondary purpose of the panel is to discuss interest in forming a special interest or technical group on children's HFE issues.

INTRODUCTION

Injuries can arise in many ways and many of them can be prevented by using basic strategies or techniques well known in the safety and human factors / ergonomics (HFE) literature. One set of strategies is the basic safety hierarchy of designing out, guarding against, and warning about hazards, and in certain extreme cases, the banning of a product.

Young children are particularly vulnerable to injury compared to adults. The youngest lack both physical and cognitive characteristics to make safety decisions. That responsibility for safety of young children is assigned to their caretakers particularly when the child is less than pubescent age (Laughery, Lovvoll, & McQuilkin, 1996). Indeed most warnings regarding child safety are directed to caretakers, not to the child itself (Kalsher & Wogalter, 2007). One of the difficulties in preventing injury in children is that a child's development is a continuously changing and dynamic process. A child may be incapable of doing something one day and the next day have that capability. Different children progress at different rates. Additionally, very young children, particularly infants, are incapable of telling what exactly is causing them to have pain. The examples are numerous, but children are vulnerable and need special care (Kim, Wogalter & Taylor, 2011). Moreover there is a role in this that human factors and ergonomics (HFE) professionals can play in the special protection needed for children.

This panel focuses on child injury cases in forensic (legal) settings. Often the search and discovery of information in litigation in its Discovery process is very detailed and thorough. Each of the panel members discusses a case in which they have worked with different child injury scenarios. Emphasis is given to issues of relevance to HFE and how HFE could have contributed to the prevention or reduction of the likelihood and severity of these and other injuries.

The panel will help to gauge interest by the HFE attendees on child issues. Some of the panel discussion will likely flow into determining interest in pursuing the development of a special interest group within HFES on children's issues. Potential areas of interest would be not only on child injury and safety, but also other concerns such as play activity, physical ergonomics and cognitive considerations. A formal technical group may help foster research and the sharing of interests and stories by a core group. Perhaps this session could be the beginning of such group's establishment.

APPROPRIATE ACETAMINAPHEN PRODUCT SELECTION AND DOSAGE FOR INFANTS

Kenneth R. Laughery

This case concerned the death of a six-month-old infant girl in January, 2003. The child's mother had taken her to a hospital emergency room because she had been crying and exhibiting symptoms of fever, and a tender abdomen. During the wait in the emergency room she also experienced diarrhea and vomiting. Following an examination by a physician, the child was administered a dose, one teaspoon, of Children's Tylenol. The parent was then instructed to administer a dose of Tylenol every 4 to 6 hours. After leaving

the hospital the parent stopped and purchased Infant's Tylenol. The labeling on the Infant's indicated it was the appropriate product for infants up to age 2 and the labeling on the Children's up to age 4. Thus, the parent thought she had purchased the appropriate Tylenol for the six-month-old child. This Tylenol was administered during the next 2-3 days, when the child exhibited symptoms of severe distress. She was returned to the hospital emergency room where she was diagnosed with acute liver failure. She died four days later.

The active ingredient in Tylenol is acetaminophen. A known hazard associated with acetaminophen is the potential for liver damage if taken in excess. The problem in this case was that the hospital's instructions to administer Tylenol was intended to apply to the Children's Tylenol, not the Infant's Tylenol. The concentration of acetaminophen was greater in the Infant's than in the Children's. Specifically, the concentrations are 80mg/0.8ml for the Infant's and 160mg/5ml for the Children's. In terms of a common denominator, the Infant's and Children's concentrations were 400/4.0ml and 128/4.0ml respectively; the Infant's is more than 3 times the concentration of the Children's. Thus the child received an overdose that caused her death.

The defendants in the case were the hospital and the Tylenol manufacturer/marketer. Warnings issues were a focus of the Plaintiff's case. Specifically, it was contended that the hospital failed to emphasize that the recommended one-teaspoon dosage applied to the Children's Tylenol, not the Infant's. With regard to the manufacturer, it was claimed that the warnings on the Tylenol did not adequately warn of the hazards of an overdose of acetaminophen and the importance of following dosage instructions. It was further contended by the Plaintiff that the fact that the concentration of acetaminophen in the Infant's was greater than in the Children's was not consistent with consumers' expectations regarding the relative concentrations of the two products and the relative overdose hazards associated with them.

The Plaintiff's settled with the Hospital. The case against the Tylenol manufacturer went to trial in June, 2010, and the jury returned a Plaintiff's verdict. The manufacturer now makes infant's and children's' products the same strength.

EVALUATION OF SCHOOL SCISSORS SOLD TO PRESCHOOLS

Alison G. Vredenburgh and Ilene B. Zackowitz

Daisy, a 5-year old preschool student, was instructed by a staff member to get a pair of school scissors, like those shown in Figure 1, from a wooden caddy. While returning, Daisy amputated part of her left index finger. She did not fall, bump into anything, or notice that she cut herself until her teacher saw blood on the child and the floor. The company had three prior injury reports.

Figure 1. *School scissors*

These scissors have characteristics that give mixed messages as to whether they are intended for "preschool" or "school" age children. On the one hand, they are small, have colorful plastic handles and blunt tips, making them appear appropriate for preschool children, typically ages 5 and under. On the other hand, they are sold as "school scissors" that are "not for children under 5 years old" and "SHARP."

The Consumer Product Safety Commission's (CPSC) technical requirements for sharp edges in toys and other articles for children under 8 years of age, 16 CFR 1500.49, requires that articles not have sharp edges (CPSC 1978). However, toys, by reason of their functional purpose which necessarily present a hazard of sharp metal edges, are exempt from the technical requirements, "*Provided the toy is identified by a conspicuous legible, and visible label at the time of any sale, as having functional sharp metal . . . edges*."

These warning requirements were not met. While there is a comment about sharpness embedded in the product description, there is no conspicuous warning. There is no safety signal, no signal word, no mention of consequences, or how to avoid them. Furthermore, the words "school scissors" and "easy to hold" imply that they are for young users. Moreover the information in the catalog is not on the packaging accompanying the scissors when sold. The company's position was that product testing decision-making is left to the buyers.

Representatives of the school supply company testified that at no time did it perform any type of testing to evaluate the sharpness of the scissors and that no age guidelines and no evaluation was performed to determine a safe user age. Thus they did nothing to determine if the product that they were representing as a children's product was appropriate for young children. However they also testified that they believed the difference between adult scissors and the children's scissors is that the school scissors would not be as sharp as adult scissors. According to the school supply catalog (see excerpt in Figure 2), teacher's scissors cut "cardboard, paper, fabric, tape, film and many other materials."

Figure 2. *School Supply catalog for teacher's scissors*

Our laboratory testing indicated that the edges are in fact sharp. After conducting sharpness testing per UL 1439 (UL 2013), for which the scissors failed, we designed a device to test other objects with the scissors: copper wire, wooden Popsicle stick, leather, and chicken wing. The children's school scissors also cut the materials listed that teacher's scissors would cut. As a matter of fact, we found that the school scissors were sharper than any office scissors we had in our office. Based on an evaluation of the company's hazard management and our laboratory testing, we concluded that the product was unsafe for the intended user population. The case settled after depositions.

SUFFOCATION ON INFANT SLEEP POSITIONERS

Shelley Waters Deppa

In September 2006, a 3-month-old male was placed to sleep in a crib on his side on an infant sleep positioner, intended to keep sleeping infants from turning onto their stomachs to reduce the risk of suffocation or Sudden Infant Death Syndrome (SIDS). Yet later he was found face down and had suffocated due to accidental positional asphyxia.

This is a case where a child asphyxiated using a product intended to prevent that specific hazard. HFE issues focused on the relationship between product function, parental concerns, and child development.

In 1992, the American Academy of Pediatrics (AAP) issued a policy statement that infants should only sleep on their back or side due to SIDS being associated with stomach sleeping (AAP, 1992). This created parental concerns that infants could roll onto their stomachs even after being put to sleep on their side or back. In response, infant sleep positioners (consisting of side bolsters attached to a level or inclined pad) were marketed to keep sleeping infants from turning onto their stomachs.

The AAP also recommends that infants be put to sleep on a firm, flat mattress (AAP, 1996). This is because until about 4 months of age, most infants cannot roll completely over in any direction on a firm flat, mattress (Caplan, 1977) and when they do develop the ability to turn over, they also have the ability to move out of danger provided they are on a firm flat mattress.

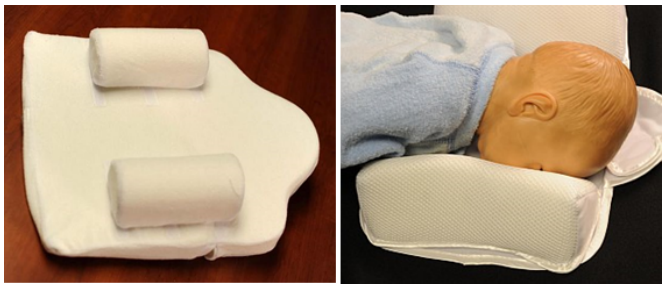

Figure 3. *Inclined sleep positioner and example of hazard.*

Infant sleep positioners create a hidden hazard because instead of sleeping on a firm, flat mattress, infants are being put to sleep on and around cushions marketed as a safety device. At some point, unbeknown to parents, infants develop the capability to deliberately turn over onto their stomachs, and since sleep positioners cannot prevent strong infants from turning over, their faces become buried in the compressible side bolsters or cushioned pad of the sleep positioner.

In 2009, my research resulted in the opinion that infant sleep positioners are not needed and present an unreasonable suffocation/positional asphyxia danger due to defective design that actually increases the risk of suffocation, as they allow infants to roll onto their stomach turning their face into the bolsters or pads that have a high rebreathing potential. This position was supported by injury data on 30 sleep positioner incidents, 10 of which were fatal, to infants 4 months of age and younger (CPSC, 2009).

In 2010, the U.S. Consumer Product Safety Commission and the U.S. Food and Drug Administration jointly issued a warning that caregivers should stop using infant sleep positioners as they are "dangerous and unnecessary" (CPSC & FDA, 2010) which resulted in "Manufacturers stopped making the product and retailers stopped selling them for the most part" (KID, 2011).

RESIDENTIAL ELEVATOR CAR ENTRAPMENT

Rani Lueder

In December 2010, a tragic event occurred involving a 37-month old boy. He became entrapped in the gap between the hoistway and elevator car doors of his family's residential elevator when his mother called for the elevator from the floor above. The child arrived at the hospital immobilized in a coma, undergoing full respiratory / cardiac arrest signs of blunt injuries to his neck, head and chest. Figure 4 is a photograph of an area of the elevator in which a small child could be entrapped.

Discovery during the lawsuit that followed indicated that the elevator manufacturer was well aware of the risk to children. They played key roles in the development of

Figure 4. *Space of an elevator that could entrap children*

minimum safety guidelines for ASME A17.1 (Section 5.3.1.7.2) and also knew that similar entrapments had caused at least two other children's deaths. Yet they did not warn their vendors, installers or purchasers of the associated entrapment risk to children.

It has long been known that small children are easily entrapped in small spaces, and that entrapment risk varies by opening size and shape. Yet the manufacturer failed make any of the downstream parties aware of viable design solutions that would have protected the children from injury.

Children exposed to these accordion-type elevator doors continue to be at risk today. The aim of the initial panel presentation is to briefly present and discuss the confluence of organizational and design factors led to the design that was used, as well as the alternative designs that would have prevented their occurrence.

WITHOUT RESTRAINT: A BABY SEAT THAT FAILS TO RETAIN

Michael S. Wogalter

Courtney, a nine-month-old child, was playing with her plastic jingle toy in her Plopsie baby seat (not the actual name of the product) positioned on the kitchen counter. Her mom, Elsie, was next to her rinsing off dishes she had used to feed her daughter. Suddenly, and without warning, Courtney dropped her toy, and while reaching for it, arched her back and fell out of her baby seat with one leg hitting the counter's edge on the way down to the floor head first. It happened so fast and so unexpectedly that her mom could not react fast enough to stop the fall. Emergency services were called and Courtney was diagnosed with a skull fracture.

Elsie received the Plopsie from her sister-in-law as a gift after Courtney was born. It had been purchased from a big-box retailer for her son who was then in pre-school and was too old and large to use it. The box had been discarded soon after it had been opened. Figure 5 shows the type of baby seat involved.

In 2007, the U.S Consumer Product Safety Commission (CPSC, 2007) required a recall of the Plopsies. It was prompted by the reported occurrence of many similar instances of parents attending to their children when suddenly they come out of the seat. Because caretakers tended to place the child in the Plopsies on tables, counters, beds, sofas and chairs, this occurrence also resulted in a consequential fall from height. Injuries have also been reported from floor use.

Figure 5. *Baby Seat*

Neither Elsie, nor her sister-in-law, knew that there had been a recall a year earlier. In the 2007 recall, existing users were to place an additional warning on the seat. The subject Plopsie had only the original warning that was printed with red ink on the rear of the seat, at its lower edge. An example of the warning is shown in Figure 2. Elsie said she never saw the warning before the fall event occurred. The CPSC reported that many Plopsies had smeared printing, sometimes to the point of making the words illegible. Even if one could read the material (if the printing was not smeared), caretakers might not notice the warning in the first place, as the warning was not positioned so it could be seen when facing the child. It is small and lacks contrast and is absent many attributes that would have increased its prominence. Attributes that could have been incorporated are described in ANSI (2006) Z535.4 safety label standard and in research.

Another major issue with the warning is that the information conveyed by the warning is inadequate. The warning never directly states that children can sometimes suddenly get out of the seat. The product affords placement on counters and tabletops, and when children do get out, it can produce resulting falls. There have been numerous times events like these have been reported to the manufacturer and to big box retail stores prior to Courtney's fall.

Although Elsie did not see the original box, the information printed on it made the strong suggestion that Plopsie is capable of retaining children due to its special design. The original box depicted large color photographs with what appeared to be the seat being used on an elevated table until the 2007 CPSC recall required the photo be changed in existing inventories and in future manufacture.

The recall required a revised warning to be placed on the Plopsie. The revised warning is somewhat better than the original but still not up to an adequate level. More recently, in 2012, there has been a second recall, since there continued to be reports of children being injured despite the first recall. This second recall required the addition of seat belt restraints. This was, of course, a main solution for the hazard all along. Designing out and guarding against hazards are usually better methods to prevent injuries than warning about them. Consumer complaints and the CPSC documented the need for

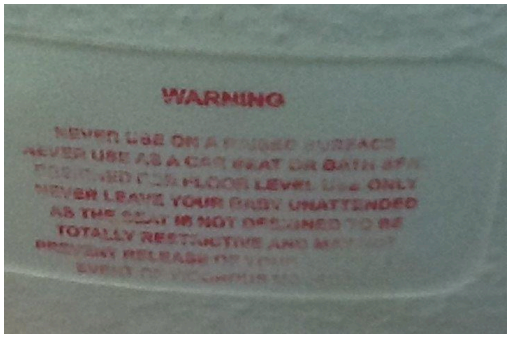

Figure 6. *Warning on rear lower panel. Smeared illegible print is commonly found on this product.*

restraints years before the first recall but warnings were used as the initial fix. The first recall's warning revision, while better than the original warning, was nevertheless inadequate because it had numerous deficiencies, such as size, location, prominence, and content. The late arriving seat belts may not eliminate all injuries because some falls have occurred because the child was able to move or slide the Plopsie off of a surface and fall with the Plopsie while still seated. Potential design solutions to this (i.e., the first stage of the basic hazard-control hierarchy) might be to increase friction of the base or make a wider base. To this author's knowledge, most of the more severe injury cases have settled out of court. I know of one in which the Defendant manufacturer prevailed at trial but it was done without HFE expert testimony.

Probably relatively few Plopsies will get retrofitted with a revised warning or the seat belt restraints. It is a sturdy product that will take many years to degrade over time and thus defective Plopsies will be sold or given away on the used market for some time to come. HFE input in the early years of design and manufacturer of the product would have been better. Units sold in other countries have not been recalled.

DICUSSION

The panel describes major HFE issues concerning child injuries that have occurred in U.S. litigation. There is a need for greater or special emphasis on children in the HFE area because it is underrepresented relative to the number of issues. HFE work in child safety would likely focus on preventing or reducing injury through design, guarding, and warning. But HFE considerations would likely benefit other aspects of children's daily lives (e.g., in toys and play) and their changing physical and cognitive development as they mature. Additionally a systems approach would also consider aspects such as caretaker supervision and other factors. That is, not only the child needs to be considered, but also his or her caretakers and their child- and nonchild-related tasks and the environments in which these processes occur. How can we enable caretakers to do their job at caring for and supervising a child, while also performing other tasks and activities? These are important questions whose answers would benefit from HFE considerations.

The panel will consider child injury through the eyes of expert witnesses, and some potential solutions for the prevention of future injury are offered. Another potential utility in the discussion is the recognition that there may be a need in the Human Factors and Ergonomics Society (HFES) for a group focusing on children's issues. HFES has numerous technical groups pertaining to different demographic groups (e.g., Aging, Individual Differences in Performance) and for various circumstances and domains (e.g., Safety, Product Design) but not one of them is wholly or mostly dedicated to children in particular. Nor is there a special interest group currently and formally in place for the development of a TG for HFE matters pertaining to children (although the International Ergonomics Association has a group that HFES members can participate). The lack of a group makes it less likely that persons interested in the area will find a place to publish their research and ideas. In HFES proposals are sent to TGs for merit review by peers but if there is no group then the papers get scattered to different groups that might not have a single reviewer interested in children's issues, and the selected reviewers might not see the relevance or importance of the research. Thus by not having a TG, it helps to maintain a gap in this aspect of the field. The formalization of a group could serve as the beginning of a critical mass so as to energize research and interest in the area. The point is that there is no focal point or center of focus on the topic of children in HFES. The panel discussion might serve a trigger point to launch the start of a new group in the area.

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