



Collective Wisdom

**Simulations show how child restraint systems work,
but lack of injury-exposure data impedes policy insights.**

BY WAYNE ROSENKRANS

Campaigners for and against rules requiring child restraint systems (CRSs) for U.S. airline passengers under age 2 generally were unyielding when they recently reiterated their long-held positions. Both camps agreed, however, that as long as the youngest passengers travel under this 58-year-old exception to seat belt rules, airlines should promote voluntary use of CRSs approved by the U.S. Federal Aviation Administration (FAA) and work hard to accommodate them.

For a few of these participants, another point of agreement during the U.S. National Transportation Safety Board (NTSB) Child Passenger Safety Forum in December 2010 was the recognition that — despite safety management

systems becoming the norm in civil aviation — there has been minimal collection and analysis of CRS usage-versus-injury data from line operations. Now, growing use of aviation CRSs and near-term prospects for superior designs might help justify new studies to better gauge effectiveness of this injury mitigation, they said.

The NTSB's long interest in eliminating the lap-child exception has been reflected in 14 related safety recommendations, Chairman Deborah Hersman said. As of 2011, NTSB policy makers have yet to be convinced that voluntary CRS use by passengers is sufficient. "Education is not enough because education is not going to reach everyone," Hersman said. "[Parents/

guardians] have to have requirements, laws or specific standards to help them to make the right decision."

Under the current regulation, airline Web sites should reflect in every possible manner the government-industry encouragement of passengers to use a CRS, and should remove any disincentives for them, she said. Hersman believes, for example, that options to purchase a seat specifically to accommodate a CRS should be as clear to airline Web site users as any other ticket-purchase option. Ideally, Web sites consistently should query users about any children under 2 who would be traveling, proactively inform ticket buyers of all their CRS-related options and recommend using a CRS to optimize child safety.

In 2009, approximately 6.3 million passengers under age 2 were enplaned by U.S. regional and major air carriers, said Nancy Lauck Claussen, aviation safety inspector, Air Transportation Division, FAA Flight Standards Service. The FAA has collected no data about the percentages of those passengers with children under 2 who travel with and without a CRS, she said. The agency cited fatal accident data and several studies that forecast how transportation-mode choices of U.S. airline passengers would change if the FAA eliminated the lap-child exception.

“If we look back over the last 32 years, there were three accidents where the fatality of a child under 2 would have been prevented if that child had been in a CRS; there have been none in [the last] 14 years,” Claussen said. The FAA has concluded from a series of independent studies since the 1990s that changing FAA regulations to require the purchase of an extra airplane seat to accommodate a mandatory CRS for children under 2 would have “the unintended consequence of an increase in transportation deaths,” she said. The agency has estimated that the life of one child under 2 would be saved in 10 years if this regulatory change were made. The predicted negative consequence in that period, however, would be that more parents and guardians would choose to travel via highways rather than buy an additional airline ticket and provide a CRS, with at least 60 deaths of children under 2 on highways attributable to the disparity of risk of travel by motor vehicle versus airline.

America’s exclusion of infants from seat belt requirements dates from 1953, said John Meenan, executive vice president and chief operating officer of the Air Transport Association of America (ATA). “Airlines [today] strongly encourage passengers to travel with the restraint devices

that they use in their automobiles,” he said, adding that the public understands CRSs to a much greater extent than even five years ago but “there’s always room for more education.”

The ATA believes the “vast majority” of U.S. parents/guardians traveling with a child under 2 currently bring to the aircraft the same CRS used in their motor vehicle, typically devices also certified for aviation use.

Meenan told the NTSB that he is unaware of any data compiled by the ATA, a member airline or another source on numbers of children under age 2 flying on a parent/guardian’s lap versus in a CRS. “At the time the flight manifest is created, of course, that information is recorded and maintained, but these data are not kept on any long-term basis, so no one that I’m aware of is tracking those numbers specifically,” he said. Recently, the U.S. Transportation Security Administration began compiling the names and birth dates of every air traveler, perhaps indirectly creating a resource for child safety specialists, he added.

Dennis Durbin, a pediatric emergency physician, clinical epidemiologist and professor of pediatrics at the Children’s Hospital of Philadelphia and the University of Pennsylvania School of Medicine, finds rigorous science lacking from aviation CRS debates. “[American Academy of Pediatrics] experience in child passenger safety, particularly over the past 10 years, ... illustrates the critical importance of having [good quality, child-specific] data to infuse into the conversation,” Durbin said. “I think there’s a notable lack of that, specifically when it comes to children’s safety on commercial aircraft.”

Physics of Injury

The FAA recommends that all passengers under age 4 be restrained in an

appropriately sized CRS, but does not recommend an age to wear a seat belt without a CRS. This reflects knowledge of the effectiveness and limitations of current CRSs generated by researchers at the FAA Civil Aerospace Medical Institute (CAMI) and in other countries.

“Children of any age are permitted to occupy a passenger seat and be secured with just the lap belt [on U.S. air carriers],” said Richard DeWeese, coordinator of CAMI’s Biodynamics Research Team. “Use of the lap belt can provide restraint during turbulence.” In a crash scenario, however, “essentially, children need to have upper torso restraint to prevent contact with the [rigid frame under the front of their seat] or potentially experience spinal cord injuries due to the whipping-forward effect,” he said.

CAMI researchers frame the problem as standard aircraft seating options for children not providing the highest level of safety possible. “While holding a child under 2 on the lap is allowed, there’s a risk for serious injury in the unlikely event of severe air turbulence or a crash landing,” DeWeese said. “This is because the person holding the child cannot react fast enough to counter an unanticipated and suddenly applied load, as occurs during turbulence. They also just don’t have enough strength to hold onto a child during extreme loading conditions that can occur during a crash landing.”

Simulations with anthropomorphic test devices (child-size dummies configured with sensors) of aircraft impact with significant forward deceleration show how an unrestrained, lap-held child slides straight forward, forcefully striking the seat back. “The adult folds forward onto the child, potentially crushing [the child],” DeWeese said. The probability would be high that the child would be ejected from the

Examples of U.S. Child Restraint System Practices

Safety Objective	Practical Application of Rules and Guidance
Keeping aviation-only CRSs out of motor vehicles	In September 2010, the FAA addressed driver/passenger/aircraft crew confusion by coining the term <i>aviation child safety devices (ACSDs)</i> to distinguish — and clearly label in coordination with the NHTSA — the subset of CRSs that are designed solely to meet aviation performance standards and are approved only for use in aircraft.
Prohibiting non-approved CRSs for ground movement, takeoff and landing	U.S. airline policies may prohibit use of non-approved CRSs. The applicable FARs require that CRSs approved for use in these flight phases be so labeled/marked. During the cruise portion of the flight, there is no regulatory prohibition regarding the use of any type of child restraint, including those prohibited from use during ground movement, takeoff and landing.
Maximizing CRS safety in aircraft	Safety factors for use of an approved and properly labeled/marked CRS include a parent/guardian accompanying the child, CRS properly secured to the seat and oriented forward or backward per label instructions in a forward-facing aircraft seat, the cabin crew check that the child is properly secured, the parent/guardian checking that the child does not exceed the weight limits for the CRS, and preferred CRS placement in a window seat so as not to block access to the aisle by the parent/guardian or other passengers during an emergency evacuation.
Prohibiting some CRSs even if approved by non-U.S. authorities	The FARs specify that “no aircraft operator may permit a child to occupy a booster-type, vest-type, harness-type or lap-held CRS during takeoff, landing and movement on the surface, except when the CRS has been approved by the FAA ... Booster-type, vest-type and harness-type CRSs approved by the FAA ... may be used during all phases of flight.”

CRS = child restraint system; FAA = U.S. Federal Aviation Administration; FARs = U.S. Federal Aviation Regulations; NHTSA = U.S. National Highway Traffic Safety Administration

Notes: The source of standards/basis of approval for ACSDs is either FAA Technical Standard Order C-100b, “Child Restraint System,” or FARs 21.305(d), “Production and Airworthiness Approvals, Part Marking, and Miscellaneous Amendments.”

Source: FAA Advisory Circular 120-87B, “Use of Child Restraint Systems on Aircraft”

Table 1

parent’s grasp and the seat area “in an actual crash, where the aircraft would be bouncing or yawed.” The CAMI CRS research focus has been on devices that accommodate a child up to approximately 40 lb (18 kg) using protective shells that have an internal harness.

One typical FAA-approved CRS, the aft-facing infant-carrier type, restrains the child within a protective shell. Another type, the forward-facing carrier, limits the child’s forward excursion and head injury risk using belts or support surfaces attached to its protective shell.

Using the FAA’s separate supplemental type certificate process for assessing equivalent level of safety, the agency in 2006 approved the non-shell AmSafe Aviation CARES device, which adds upper torso restraints to the existing lap belt.

Working with SAE International to overcome poor interfaces between

multi-purpose CRSs and aircraft, the FAA last year issued an aerospace technical standard order (TSO) for “aviation child safety devices” (Table 1) capable of providing a “very high level of safety” compared to current devices, DeWeese said, adding, “So far though, this standard has proven to be technically challenging to meet and, while there are some models under development, none has actually been issued a TSO yet.”

Overseas Innovation

U.S. airlines, cabin crews and passengers have become familiar with CRSs to an unprecedented extent, the airline industry says. “Our experience is that the vast majority of [current CRSs] do fit in the vast majority of seats aboard aircraft,” said the ATA’s Meenan. “Occasionally, we may find a situation where that’s not the case, and that passenger is then re-accommodated with a different seat.”

The NTSB also invited a non-U.S. airline to the forum to summarize its CRS practices, experience and data. From January 2005–October 2010, Virgin Atlantic Airways annually carried approximately 4.5 million to 6 million passengers. “Of these, an average of 7.5 percent were children [that is, 337,500 to 450,000 between 2 and 12 years old] and 1 percent were infants [45,000 to 60,000 under 2 years old],” said Mary Gooding, cabin safety manager at the company.

In March 2008, the airline introduced its own newly designed, U.K. Civil Aviation Authority–approved CRS for infants between 0 and 6 months; the airline recommends that they be reserved with a discounted aircraft seat during travel booking but provides the device at no cost to passengers, even while boarding if possible. The devices are installed by flight attendants. ➤