HOLD TIGHT

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Some infant restraint systems work better than others. Mark Bathie and Sue Rice review the latest research and explain the safety rules.

In the past few years, slings, papooses and back-pack style infant carriers have become popular. You see parents in shopping centres and on the street using them to carry their babies all the time. They allow parents freedom of arm movement while carrying their infants on the chest, facing forward or to the rear.

They are comfortable and practical, and have even become a bit trendy. They come in all sorts of styles, from structured and funky hi-tech to free-form cloth varieties. You can get them in vintage, retro or contemporary fabrics. The no-frills designs are $30, the chic $150. Parents use them when boarding an aircraft to leave hands free. Unfortunately, cabin crew must ask parents to remove the child, who is usually asleep at the time, and convince them to place the child in a supplementary loop belt. Quite often the new parents are convinced the infant carrier is the safer option arguing it provides better support for the child.

They might be practical on the ground, but these carriers are unsuitable for infant restraint on an aircraft, according to recent research conducted under an Australian Transport Safety Bureau (ATSB) research grant. Tom Gibson and Kim Thai from Human Impact Engineering, working with Michael Lumley from Britax Childcare Australia, put four styles of infant carrier or sling through the standard series of safety tests, including simulations of turbulence and emergency landing conditions. High speed video recordings of the tests helped researchers analyse the results.

The turbulence test simulated aircraft conditions by inverting the seated and belted adult dummy with an infant dummy in a commercially available baby carrier or sling. The results showed that three of the carriers failed to restrain the infant when the baby's arms were inside the carrier. Tests of supplementary loop belts, known as "belly belts" showed they were effective in restraining the child.

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To test the effectiveness of infant carriers in an emergency landing, the researchers used a dynamic sled apparatus that accelerates a row of aircraft seats to simulate a rapid deceleration up to 9G. In all tests the infant carrier failed to restrain the infant. The supplementary loop belt was tested in a similar manner. This time the child was restrained. However, during the test the infant dummy travelled forward until the head hit the seat back in front at a dangerous speed.

US studies have also found that belly belts can inflict high levels of abdominal injuries in an accident. As a result, the US Federal Aviation Administration (FAA) has banned the use of belly belts. However, as a consequence the US and other countries with similar bans have no choice but to allow lap-held children to ride completely unrestrained except by the parent's arms. Previous research and accident analysis shows this to be completely inadequate even in turbulence.

The researchers concluded that infant carriers and slings are unfit for restraint of infants during an emergency landing. Additionally, there is no Australian Standard for the manufacture of infant carriers. The researchers suggested that infant carriers could be redesigned to be more effective in turbulence and in emergency landing situations. This would also require provision of a shoulder restraint for the adult to prevent forward motion.

The results confirm the position of the Civil Aviation Safety Authority (CASA) which requires under Civil Aviation Regulation (1988) 251 that "seat belts shall be worn by all crew members and passengers" at appropriate times of flight. A baby carrier or sling is insufficient. The belly belt, whilst being far from ideal, does restrain the child.

The rules allow children up to 3 years of age to be restrained on an adult's lap using a belly belt. Current practice is to allow belly belts for infants up to 24 months of age, which is in line with international practice. The safety regulations permit the use of rearward and forward facing automotive child seats that are internationally approved for aircraft use, or meet Australian automotive design standard AS/NZS 1754.

Children of any age may use a lap belt in their own seat but is not recommended until they have reached their fourth birthday.

Seats and cushions: The ATSB sponsored research also looked at the effectiveness of child car seats.

The researchers tested twenty baby seat models certified to Australian standards in a typical commercial aircraft seat. Nine of the models could not be adequately installed because they would not fit in the available space, or there were other design incompatibilities.

The good news was that all of the baby restraint seats that fitted the aircraft seats were able to retain the infant dummy when

exposed to turbulent conditions (acceleration of -1G). However, the results of the sled tests to simulate the more severe forces of an emergency landing (deceleration of 16G) were not as good. Tests which did not use a top tether showed significant forward motion, rotation and rebound as a result of design incompatibilities between the aircraft seat and the lap belt system.

Safety advice on use of child car seats was issued by CASA as an advisory in 1992 and updated in 2002. The advice is that child and infant seats should:

- Be installed in accordance with the manufacturer's instructions.
- Not be located in the row adjacent to an emergency exit. However, this does not apply where the low seating capacity of the aircraft is such that this limitation is impractical.
- Not obstruct access and passageways to any emergency exit.

The advisory publication says the preferred location for baby seats is a window seat or the middle row of seats in a two-aisle aircraft. Aisle seats are acceptable when the seats in the same row are occupied by the people caring for the infant.

Only one infant seat should be located in any one row, unless the infants are in the same family or travelling group.

The condition and continued maintenance of these child car seats is the responsibility of the owner of the seat. The seat should be serviced in accordance with the manufacturer's instructions.

Operators or passengers may supply these infant seats. The option of using infant seats on certain flights is a matter to be decided between operators and passengers.

The test results for the safety of booster seats, which allow older children to be restrained in the normal lap belt and to see out the window, were disturbing. In simulated emergency landings the child dummy's head impacted the seat cushion between its legs.

Booster seats are not recommended unless an upper torso harness is fitted to the aircraft seat, as found in some business jets and general aviation aircraft.

Bassinets: Bassinets have often been used in aircraft to allow infants to rest during flight. A common installation for the bassinet has been to mount it to a bulkhead immediately ahead of the passenger seat. The bassinet is stowed for takeoff and landing as it would otherwise interfere with an emergency evacuation.

BOOSTER SEATS

Impact: Tests of booster seats that allow children to use normal lap belts showed that in a simulated emergency landing the child dummy's head impacts the seat cushion between its legs. Booster seats with a lap belt are not recommended for young children.

According to the Australian safety rules, a bassinet or other device mounted separately to a passenger seat would only be acceptable for takeoff and landing if the installation has been shown to provide protection for the infant and does not interfere with any other safety aspect of the aircraft. No bassinets have been approved for this purpose for use in Australian registered aircraft.

Safety regulators and airlines worldwide are struggling with reform of rules for restraint of infants. The problem is that studies like the tests carried out for the ATSB have shown that the level of safety provided by systems of restraint varies widely.

A fundamental of crashworthiness is that every person must have their own survival space. The safest system would be for all infants to be in their own seat with their own four-point harness. However, no safety regulator at this time requires this. The safest currently available option is the use of an approved car seat.

The researchers concluded that the infant car seat could be redesigned to be more effective in turbulence and emergency landings.

CASA has launched a review which aims to improve the child restraint systems available for infants and children aged 0-4 years.

Part of the review will look at updating standards for automotive child restraint systems (AS/NZS1754) for use in air travel. The review will also look at adopting new attachment methods for the child restraint.

Meanwhile, the US Federal Aviation Administration (FAA) is amending operating regulations designed to increase the number of child restraint options that are available for use on aircraft, while maintaining safe standards for certification and approval.

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INFANT CARRIER

Failure: Infant carriers failed when they were tested for their ability to restrain an infant dummy during simulated emergency landings. Safety rules require use of a belly belt or properly fitted car seat for infant restraint, and prohibit use of slings or infant carriers without the use of a belt.