

RoSPA Road Safety Research

Carrying premature and low birth weight babies in child car seats

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Introduction

Over the last two decades it has become increasingly common practice to use a child car seat when transporting an infant in a vehicle. Since 2006, it has been a legal requirement that children must be transported in an appropriate child car seat that is suitable for their weight and height. Children must continue to use these seats until they reach 135cm in height or 12 years old, whichever comes first¹.

The provision of safe motor vehicle transport for infants is a priority of parents and health professionals worldwide. The performance of car seats in collisions has dramatically improved over time, with appropriate car seat use reducing death and serious injury by up to 70% in infants². This means that the child car seat remains one of the most effective strategies available to protect children from death and serious injury when travelling in the early years of life.

Improved survival rates and earlier discharge of premature babies (those born before 37 weeks gestation)³ and low birth weight babies (those weighing less than 5.5lbs)⁴ has led to an increase in smaller infants being transported in child car seats.

To ensure that these smaller babies are transported safely, it is vital that the appropriate child seat is selected. This is because smaller babies are prone to conditions such as apnoea (temporarily stopping breathing), oxygen desaturation (low oxygen levels in the blood) and hypotonia (low muscle tone). This means that it is important that the infant is positioned correctly in the appropriate child car seat⁵.



Choosing a child car seat

If the infant can maintain a semi-upright position safely, a conventional rearward facing child car seat that allows for proper positioning of the child should be selected⁶. Rearward facing child car seats provide the best protection in a crash because the forces from the impact of the crash are transferred from the back of the seat to the child's back, the strongest part of the infant's body. Rearward facing seats also provide protection in side impacts. Finally, the seat also supports the child's head and severe tensile forces on the neck in flexion are prevented⁷.

However, for smaller babies who experience apnoea, bradycardia (abnormally low heart rate) or oxygen desaturation when semi-reclined in a rearward facing car seat, a lie flat seat, sometimes known as a car bed, may be more appropriate⁸. A lie flat seat is designed to accommodate a child in a fully reclined position and is placed on the vehicle seat at a 90 degree angle to the direction of travel. The child is usually secured in the lie flat seat with an internal harness and the seat is secured to the vehicle seat using the vehicle's seatbelt. These seats, like other child car seats, have weight requirements designated by the manufacturer and should be used according to the manufacturer's recommendations⁹.

If an infant is using a lie-flat seat, the baby's doctor may consider scheduling a test in the infant's car seat to observe their heart rate, breathing and oxygen levels several weeks after discharge from the hospital. This test is used to check whether the infant is ready to move into a rearward facing car seat¹⁰. This is known as the infant car seat challenge. There is a lack of universal guidelines on implementing the car seat challenge and the angle at which the car seat should be positioned during the observation, although in a vehicle the seat should be angled at 40 to 45 degrees for maximum protective effect. In some hospitals, the challenge is performed with the seat on the floor. The angle of the baby seat's back is around 30 degrees, which is flatter than the position the seat would be angled at when in use in a vehicle¹¹.

Some babies may also be discharged from hospital with medical equipment, such as cardiac and apnoea monitors and supplemental oxygen. Often, this medical equipment is very heavy and could cause serious injury if it were to hit an infant or another occupant in the vehicle in the event of a sudden stop or collision¹². At the time of writing, there are no straps or belts designed specifically to secure medical equipment in a vehicle. However, restraining this medical equipment is still recommended.

The equipment can be placed on the floor wedged with pillows, foam or blankets, or unused seatbelts can be used to restrain it. However, it is important to note that it can be dangerous to place objects under the front passenger seat in some vehicles, as it may interfere with the vehicle's airbag sensors. Therefore, it is important to consult your vehicle's manual before choosing to store any medical equipment under the seat¹³.



The infant child car seat challenge

Some babies born prematurely experience breathing problems when they are sitting in a semi-reclined position in a car seat. Therefore, the American Academy of Pediatrics recommends that babies born prematurely or with some medical conditions, should be observed for breathing related problems while sitting in their car seat¹⁴. This means that all pre-term and at-risk newborns should be observed for a period of time while seated in their car seat, monitoring for episodes of apnoea, bradycardia and oxygen desaturation to identify those infants that may experience cardiorespiratory problems when placed in a rearward facing infant seat¹⁵. It is recommended that these observations be as long as 90 to 120 minutes to simulate car journeys that could be of that length. The observation is usually conducted in the child's own car seat at the angle that it will be used in the vehicle¹⁶.

This test is performed primarily on premature, low-birth weight and at-risk infants because these babies can have a variety of medical conditions and their airways are weaker than a full-term baby, making them prone to breathing difficulties¹⁷. In rare cases, extreme responses to positioning can be life threatening¹⁸.

In rearward facing seats, the prominent occiput (back of the head) of a pre-term infant can push the head forward, particularly while the baby is sleeping, which could cause their airways to become obstructed¹⁹. Tonkin et al observed that infants' heads were bent when they were restrained in their car seats placed on a flat table for the test, rather than in normal use in a vehicle. When infants are young, their ability to control the movement of their head is not well developed²⁰.

A pilot study²¹ investigated the physiological effects on 40 healthy term and pre-term infants placed in a static car seat at 30 and 40 degrees and whether the motion of a moving vehicle have any adverse or beneficial effects. Infants underwent physiological monitoring for 30 minutes in a car seat in three positions (in random order to control for order effects):

- On a horizontal surface with a seat angle 30 degrees (static)
- On a simulator with a seat angle of 40 degrees (static);
- and on a simulator, at 40 degrees with movements to simulate being in a car travelling at 30mph.

Each condition was tested against a baseline (when an infant was asleep supine in a cot for up to 90 minutes after a feed). It was found that potentially adverse physiological effects were more frequent when the infant was at 40 degrees and in motion than when at 30 degrees. This suggests that the more upright position and the addition of movement is responsible for any problems rather than being in a seated position for a prolonged period. However, a larger scale study would be needed to estimate the magnitude of this effect.



Inappropriate use of child car seats

While manufacturer instructions suggest only leaving young infants in child car seats for limited periods²², it is common for infants to be left in their car seats for much longer periods. Child car seats are sometimes used for purposes other than travel. However, there can be detrimental effects of using child car seats excessively for purposes other than transport, such as for feeding or for the child to sleep. This can include exacerbation of reflux and the potential of plagiocephaly (flat head syndrome)²³.

A 2009 Slovenian study²⁴ explored whether cardiorespiratory compromise occurs when infants are positioned in rearward facing child car seats and lie-flat car seats. The percentage of time with an oxygen saturation of less than 95% was used as the primary outcome measure. The infant was placed supine in a hospital crib for 30 minutes and observed. They were then assigned to either a child car seat for 60 minutes angled at 45 degrees followed by an equal period in a lie-flat seat or vice versa. It was confirmed that respiration of full-term infants was compromised in both the lie-flat and rearward facing infant carrier.

The study also revealed that infants seemed to perform better in the first hour in the safety device than the second; regardless of whether this was a rearward facing infant carrier or a lie-flat seat. This suggests that infants might be able to compensate for the respiratory limitation initially, but less so with time, possibly because of muscle fatigue or a deeper sleep stage.

The study concluded that rearward facing car seats and lie-flat seats remain very important transport devices for newborn infants and older children, but due to respiratory limitations, these devices should be restricted to protection from injury and death in road accidents and should never serve as a replacement for a crib.

Another research study²⁵ reviewed and analysed deaths of children aged 2 years and younger that occurred in sitting and carrying devices (car seats, strollers, bouncers, swings and slings) that were reported to the US Product Safety Commission between April 2004 and December 2008. There were 31 reported deaths in child car seats, and the mean age of the child at the time of death was 9.7 months. 52% of car seat deaths were associated with strangulation from the straps and 48% were attributed to positional asphyxia. Ten of these cases (where information was available) reported improper use of the restraint/straps. Almost all (89%) deaths occurred when the child car seat was being used outside of the vehicle.

Similarly, Tonkin et al²⁶ explored all infants referred to the Auckland Cot Monitoring Service after an apparently life threatening event during early infancy. In the 18 months between July 1999 and December 2000, 43 infants were referred to the service. All infants had been seen on one or more occasions to develop cyanosis (a bluish discolouration to the skin) and the caregiver believed the child was not breathing. Nine of these infants were restrained in a child car seat appropriate for their age. All but one of these cases occurred when the infant had been left in their child car seat indoors, allowing them to fall asleep in a relatively upright position.

A child car seat is designed to protect a child whilst they are travelling in a motor vehicle. It should not be used as a place for the infant to sit or as a replacement cot in the home. As highlighted above, placing an infant in a child car seat for prolonged periods poses health risks. It can affect the infant's ability to breathe, contribute to the development of a flat spot on the baby's head and exacerbate reflux. In addition, a child can be injured by falling from an improperly used child car seat while sitting in a seat that falls from the surface it is placed on²⁷. This is because the seat is not stable outside of the vehicle and can topple over when they are not secured, particularly when they are placed on soft surfaces such as beds.



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Research suggests that an infant who is properly restrained in a child car seat, in the car, is at very little risk of suffocation or strangulation. Bamber et al²⁸ found no cases of infants who were previously healthy dying in a child car seat when it was being used appropriately. Rather, the problem occurred when child car seats were used as sitting and sleeping. Caregivers may also be tempted, for the child's comfort, to unfasten the restraints in the child car seat once the child is out of the car, assuming that the straps are no longer needed. However, it is dangerous to leave a child partially buckled in because the infant can move and become tangled in the loose straps, which can lead to strangulation²⁹.



Best practice

Based on a review of research and best practice, proper positioning of pre-term and low birth weight infants in child car seats is essential to minimise the risk of respiratory compromise. Therefore:

- Infants should travel rearward facing for as long as possible and to the limit of the height or weight restriction allowed by the child car seat manufacturer for the greatest protection.
- A rearward facing child car seat is recommended, as they provide optimum comfort, fit and positioning for low birth weight infants. For smaller babies, child car seats with an abdominal shield or pad are not recommended because of the potential for breathing difficulties behind the shield or injury to the infant's face and neck during a sudden stop or collision³⁰.
- Child car seats with the shortest distance from the crotch strap to the seat back are recommended as they reduce the potential for the child to slip forward feet first under the harness. Child car seats with multiple harness-strap slots may also be more suitable for small infants. The distance from the lowest set of harness slots to the bottom of the child car seat should be short enough that the harness is level with or below the child's shoulders³¹.
- The infant should be properly positioned in the car. The harness should be snug and the retainer clip should be positioned correctly, not pressing on the abdomen or the front of the neck. The fabric strap should be snug enough that the fabric cannot be pinched together. It is also possible to check that the harness is adjusted correctly by doing the two finger test, that is, if you can fit more than two fingers between the underneath of the child car seat harness and the infant's shoulder bone, the harness tension should be tightened.
- Some child car seats come with head support systems or newborn inlays as standard. However, many of these support systems and inlays are sold as aftermarket products and could decrease the safety provided by the seat as it could make the harness slack. This is because these products have not been tested with the seat that the child is using. Only products that are included with the seat or sold by the manufacturer for use with that specific model of seat should be used.
- The rearward facing child car seat should be reclined in line with manufacturer's instructions. If the seat slopes or is too upright, the child's head may roll forward. Some child car seats have built in angle-indicators and adjusters to assist with achieving the best angle. However, it is important to remember that as the child grows, the angle of the seat may need to be adjusted in line with the manufacturer's instructions.
- A rearward facing car seat should **never** be placed in the front passenger seat of a vehicle equipped with



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an active passenger side/front airbag. This is because of the risk of death or injury to the infant in the case of a collision in which the airbag is deployed. In some vehicles, if it is not possible to place the seat in the rear of the vehicle, the airbag can be deactivated when the front seat is being used for a child passenger. However, the back seat is always the safest place for children to travel.

- Parents often travel in the front of the vehicle, leaving their infant alone in the rear. On longer journeys, the infant's head may slump forward, which could lead to respiratory compromise. This can be an issue for smaller infants, as the shoulder straps in the seat could be too long, allowing for movement. Infants travelling in the rear of the vehicle can be difficult to observe, and wherever possible, parents should arrange for an adult to be seated in the rear with the child. If the baby begins to slouch, the adult in the rear can then re-position the child. A mirror can also be used to observe the infant's position.
- An infant not be left unattended in a child car seat inside or outside of the vehicle³².
- In the first few months journeys should be kept short, ideally no longer than 30 minutes. If you need to travel for longer remember to take regular breaks where your baby is taken out of the seat.



Current UK practice

Since the American Academy of Pediatrics recommended that all premature and at risk infants undergo an infant car seat challenge, it has become routine to screen infants before they are discharged from hospital in the United States. Guidelines from 2009 recommend screening all babies born before 37 weeks for a period of 90-120 minutes or the duration of the car journey home, whichever is longer³³.

To understand current practice in the UK and the advice given to parents and carers transporting premature and low birth weight infants in child car seats, RoSPA contacted a number of child car seat manufacturers, Public Health England and NHS midwives.

Public Health England stated that they believed that the child car seat challenge was carried out in most neonatal units prior to discharge, but different variables were tested in different units. Some neonatal units only carry out the challenge on infants who are oxygen dependent and are being discharged with medical equipment, some units carried out the test on all small babies (although the weight threshold varies) and some units carried it out on all neonatal admissions, including infants who were born full-term. Public Health England also stated that different units had differing policies about thresholds for infants who 'pass' or 'fail' the challenge. Although all babies are monitored for oxygen saturation and heart rate, the actionable threshold varies from unit to unit, ranging from around 90-94% oxygen saturation.

One member of NHS staff reported that in the hospital they work in, parents of all babies in the neonatal unit are asked to bring the child car seat in which they intend their baby to travel in before the infant is discharged to check that the seat is in good condition and is a good fit. Members of staff explain where the harness should be positioned, head position and appropriate clothing for infants to travel in. Some smaller babies require a seat insert to ensure that they are positioned well in the seat, and parents are advised of this ahead of discharge.

Additionally, all babies that are born less than 36 weeks gestation, have had any airway or tone abnormalities or congenital heart disease or go home with any oxygen aids will have a car seat challenge before they are discharged. This involves monitoring the baby's oxygen saturation in the car seat for one hour, or the length of the journey home, whichever is longer. Observations are recorded at ten-minute intervals, whilst ensuring that there are no signs of respiratory distress or apnoea. If the heart rate drops below 80 beats per minute or oxygen saturation is below 90% for 10 seconds or more, the test is not passed. If the failure is thought to be due to poor positioning, the seat may be modified e.g. a seat insert could be added. The test is then repeated 24-48 hours later. If the test is not passed a further two times, a lie flat seat may be suggested as a safer alternative or the possibility that the baby is not ready for discharge can be considered.

NHS staff cannot suggest brands or models of child car seats, as they are unable to endorse products. The staff are also unable to help parents fit the seat into their vehicle. If parents are unsure of how to fit the seat correctly, staff will help them to find the fitting instructions for the seat or videos produced by the manufacturer demonstrating how the seat is fitted.

Manufacturers typically recommended that any infant born prematurely or at a low birth weight should be cared for on an individual basis, and a seat selected based on their needs, meaning that a parent will need to work closely with doctors and specialists at the hospital. Although there are very few seats designed for this purpose, some rearward facing infant seats on the market have newborn or premature baby inserts, which offer a snug fit for smaller babies and helps to support their head, neck and spine.



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Manufacturers were also asked how long a child should be left in a car seat. Although there has been studies on how long a child should be left in their car seat, there is very mixed advice across the industry, ranging from 20 minutes up to 2 hours. However, it is advised that when parents get out of the car for a break on a longer journey, they should remove their child from the child seat too, promoting sensible use.



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