

Car seat safety: The challenge

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Introduction

The National Transportation Safety Board (NTSB), established in 1967, performed a landmark investigation in 1996 regarding the use of child restraint systems. Their examination of 120 accidents involving children revealed that in 62% of the cases, there was improper use of the safety system (NTSB 2007). This data brought national attention to the use of infant car restraint systems compelling lawmakers, industry leaders and healthcare professionals to advocate and ensure passenger safety for infants and children.

As public awareness mounted, pediatric and neonatal intensive care unit (NICU) professionals began to consider the safety implications for the NICU graduate in anticipation of discharge to home. In 1996, the American Academy of Pediatrics (AAP) first published its recommendations and guidelines to ensure safe transport of premature and low birth weight infants. In 2009, the AAP released its most recent recommendations and guidelines for car seat safety, which are based on the latest research available. The AAP's latest publication highlights the unique needs of this population in proper product selection and use of the car safety seat and other occupant restraint devices for hospital discharge culminating in the "Car Seat Challenge" guidelines used in clinical practice today (AAP 2009). Prematurity is defined as infants with a gestational age less than 37 weeks and low birth weight categorized as less than 2500 grams.

The dilemma

No one disputes the benefits of car seat safety. The NTSB and the AAP recommendations for the universal use of car seats for all infants have collectively contributed to a dramatic reduction in infant death from motor vehicle accidents. However, in the wake of this practice initiative, preterm infants have been identified as at risk for positional challenges in the standard car safety seat (Lincoln 2005).

Ensuring a safe transport to home for this vulnerable patient population has challenged prudent neonatal clinicians for decades. The lack of evidence-based research regarding the validity of the Car Seat Challenge, and the questionable implications of transient episodes of oxygen desaturation during car travel, leaves healthcare professionals searching for "best practice." The Cochrane Review (Pillely and McGuire 2006) was unable to identify any randomized controlled studies demonstrating the efficacy of a pre-discharge Car Seat Challenge, adding to the ambiguity in "best practice."

The literature review

Williams and Martin (2003) performed a nationwide telephone survey of 72 NICUs and newborn nurseries from 37 states regarding their Car Seat Challenge program. The survey consisted of 14 questions with four key themes:

- Who is performing the Car Seat Challenge in their facilities?
- How are the challenges being performed?
- Are there written policies in place?
- What are the recommendations for infants who do not pass the challenge?

The objective of the survey was to obtain a baseline of existing practice regarding the implementation of the AAP's recommendations (Williams and Martin 2003). At the time of the survey, 19% of Level III units, 9% of Level II units and 78% of Level I units did not have an infant car seat testing program as recommended by the AAP. This inconsistency in implementation poses a safety risk to an already fragile patient population. Lagging technological advances, research and development in car seat/car bed design add to the current dilemma. Monitoring studies of some infants less than 37 weeks gestation have demonstrated episodes of apnea, bradycardia and oxygen desaturation when

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seated in a standard car safety seat (Pilley and McGuire 2005, Merchant et al. 2001). Merchant et al. (2001) showed that 12% of infants with a gestational age between 35 and 36 weeks experienced apnea and/or bradycardia in their car seats. A subset of the study group (7%) experienced oxygen saturations between 85% and 90%. Although this degree of hypoxia is thought not to be harmful, it is clearly not normal for healthy infants and may be an early indicator of sleep disordered breathing (Gaultier 2000, Rosen et al. 2003). In the Merchant study group, there was a correlation between oxygen desaturation and the length of time the infant was positioned upright in the car seat. During a cross-sectional study of 42 preterm infants with gestational age range between 24 and 35 weeks, subjects were monitored for cardiorespiratory stability for 45 minutes during and after placement in a car seat (Ojadi et al. 2005). Ojadi et al. (2005) discovered that the preterm infant with and without pre-existing cardiorespiratory abnormalities had a near equal probability (80% and 83.3%) for the development of cardiorespiratory symptoms during the Car Seat Challenge. The authors concluded that pre-discharge testing is important for safe transportation. However, they point out that when symptoms manifest in the upright position, alternative modes of safe transportation must be considered (Ojadi et al. 2005).

One recent study reveals that the events may be independent of the transportation device. Salhab et al. (2007) tested 151 infants in both a car seat and car bed and found that 43 (28%) of the infants had at least one event in either or both transportation devices; 23 (15%) had an event in the car seat and 29 (19%) had an event in the car bed. Their study has three major findings:

- Apnea, bradycardia and desaturation episodes may still occur at discharge when very low birth weight infants are placed in a transportation device, particularly among infants who were born most prematurely or who are recovering from bronchopulmonary dysplasia (BPD).
- No evidence was found that indicated that these episodes are less likely in a car bed than a car seat.
- A brief observation period in a transportation device is not sufficient to identify infants at risk, but the longer these infants remain in such devices, the more likely oxygen saturation is to fall.

Further, Salhab et al. (2007) showed a mixture of the types of adverse events while in transportation devices. These are shown in Table 1 at right.

Table 1. Type of adverse events

Event type	Number of infants	
	Car seat	Car bed
Central apnea	7	5
Obstructive apnea	3	5
Mixed apnea	2	7
Bradycardia	5	8
Oxygen desaturation	20	27

Some infants are included in more than one category.

The Car Seat Challenge: Clinical implications

In examining the literature available, there is a lack of specific guidelines for car safety seat screening, but there are a few key findings described above. In line with the AAP recommendations released in 2009, some general practices included as part of the Car Seat Challenge are summarized as follows (AAP 2009):

- Hospitals should work to establish policies and procedures for conducting the car safety seat observation prior to discharge for every infant born at less than 37 weeks gestation and should consider the inclusion of older infants who may be at risk for apnea, bradycardia, or oxygen desaturation (i.e. infants with low muscle tone, airway malformation, or other congenital disorders).
- Car safety seat screening, performed to monitor for possible apnea, bradycardia or oxygen desaturation, should be conducted for a specified period of time, usually between 90 and 120 minutes or the anticipated duration of the car ride from hospital to home, whichever is longer.
- Staff members who have been trained in the proper positioning of infants in the car seat and who are skilled in identifying apnea, bradycardia, and oxygen desaturation should be conducting the car safety seat observation.
- Families should be instructed by trained hospital staff in the proper positioning of their infants in the car safety seat. Further, it should be emphasized that the duration of the time the infant is in the car safety seat should be minimized and that the seat should only be used for travel.
- If an infant is able to be maintained safely in a semiupright position, a conventional car safety seat should be selected for travel. It is suggested that better observation of the infant can be achieved in a rear-facing car safety seat than a car bed. Further, there has been better documentation of the protection provided by a conventional car safety seat than that of a car bed.

- If an infant fails the car seat screening, as defined by the treating physician or hospital policy, interventions aimed at reducing the frequency of apnea, bradycardia, and desaturation events are recommended. Such interventions include use of a car bed, delaying hospital discharge, further medical assessment, supplemental oxygen, etc.
- If a car bed is considered, a period of observation similar to that performed in the conventional car safety seat should be conducted prior to discharge. Infants considered candidates for a car bed should travel supine or prone in a Federal Motor Vehicle Safety Standard (FMVSS) No. 213-approved car bed once a surveillance period that is free of apnea, bradycardia, and desaturation events is observed.
- If discharged with a car bed for travel, before transitioning to a conventional car safety seat, an observation period similar to that conducted prior to hospital discharge should be considered. The study can be performed as a home pneumocardiogram, an outpatient polysomnogram, or an observed outpatient clinical evaluation.
- Infants at risk for cardiorespiratory compromise in a conventional car safety seat may similarly be at risk in other devices that place the infant in an upright position. Parents should be educated about limiting the use of equipment like infant swings, infant seats, backpacks, slings, or infant carriers until the infant is able to maintain a stable respiratory status when placed in a semireclined position.
- Infants for whom home cardiac and apnea monitors are prescribed should use this monitoring equipment during travel and have portable, self-contained power available for at least twice the duration of the expected transport time. Commercially available securement systems for portable medical equipment, such as monitors, are not available; therefore, this equipment should be wedged on the floor or under the vehicle seat to minimize the risk of it becoming a dangerous projectile in the event of a crash or sudden stop (Bull 1988).

Prudent practices to consider

In evaluating the stability of the former premature infant in an infant car safety seat, appropriate physiologic parameters must be evaluated to ensure safe transport to home. In addition, sleep and the infant's capacity to auto-resuscitate while in a seated position in the car safety seat add a dimension of concern that warrants consideration for

evaluation. Presentations at the 2008 Annual Conference on Sleep Disorders in Infancy and Childhood addressed topics including cerebellar injury and autonomic outflow (RM Harper), auto resuscitation from upper airway obstruction (H Wulbrand), and former preterm infants are three times more likely to develop sleep disorder breathing than their full-term counterparts (CL Rosen). Given that total sleep time in infants ranges between 16 to 20 hours per day, it is conceivable that cardiorespiratory events in this population may be a manifestation of alterations in sleep mechanics (Givan 2003, Halasz et al. 2004, Iglowstein et al. 2003).

Institutions that use multi-channel monitoring (heart rate, respiratory effort, pulse oximetry and airflow) as part of their discharge planning process should consider the incorporation of the Car Seat Challenge during such evaluations or in the instance where an infant demonstrates respiratory compromise during routine car seat testing procedures. The additional information gathered during a multi-channel study could provide the discharge team and family with a comprehensive picture of the infant's cardiopulmonary stability while seated upright in a car safety seat during sleep and wakefulness. This information is valuable not only for the immediate purpose of a safe transport but also vital information for the family in understanding the autonomic vulnerabilities of their infant at time of discharge.

Summary

Understanding the physical vulnerabilities of the preterm infant, the learning needs of the family, and emerging science pertaining to sleep-wake maturation, enable neonatal clinicians to provide for a safe discharge to home (Howard-Salsman 2006, Givan 2003). While not every infant warrants a multi-channel physiologic assessment to evaluate their cardiopulmonary stability prior to discharge, the use of such tools provides the clinician with a more complete assessment of the infant's physiologic stability during the Car Seat Challenge. If necessary, home infant apnea monitoring may be prescribed. Several studies have been performed to assess the importance of the Car Seat Challenge and the most critical physiologic channels to observe. This document provides insight into these studies as well as proposed practices to consider when performing the Car Seat Challenge.

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