



# Clinical Outcomes Associated with a Failed Infant Car Seat Challenge

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**Objective** To assess comorbid conditions and clinical outcomes among late preterm and low birth weight term infants (<2.5 kg) who failed the Infant Car Seat Challenge (ICSC) on the Mother-Baby Unit.

**Study design** This was a retrospective chart review of consecutive infants who failed ICSC on the Mother-Baby Unit and were subsequently admitted to the neonatal intensive care unit at Prentice Women's Hospital between January 1, 2009, and December 31, 2015. Regression models were used to estimate risk differences (RDs) with 95% CIs for factors related to length of stay.

**Results** A total of 148 infants were studied (43% male; 37% delivered via cesarean). ICSC failure in the Mother-Baby Unit was due to desaturation, bradycardia, and tachypnea in 59%, 37%, and 4% of infants, respectively. During monitoring on the neonatal intensive care unit, 39% of infants experienced apnea (48% in preterm vs 17% in term infants) in the supine position, 19% received phototherapy, and 2% and 6.8% received nasogastric and thermoregulatory support, respectively. Univariate predictors of increased duration of stay (days) were younger gestational age, apnea, nasogastric support, intravenous fluids, and antibiotics (all  $P < .05$ ). In multivariable analysis adjusted for gestational age and discharge weight, only apnea (RD, 4.87; 95% CI, 2.99-6.74;  $P < .001$ ), administration of antibiotics (RD, 3.25; 95% CI, 0.29-6.21;  $P < .032$ ), and intravenous fluid support (RD, 4.87; 95% CI, 0.076-9.66;  $P < .047$ ) remained independent predictors of a longer duration of stay.

**Conclusion** Infants who failed ICSC were at risk for comorbid conditions that prolonged hospital stay beyond the neonatal intensive care unit observation period. Almost one-half of late preterm infants who failed ICSC had apnea events in the supine position. (*J Pediatr* 2017;180:130-4).

Since the 1980s, several studies have noted that premature infants are at increased risk for apnea and desaturations when placed in semi-upright car safety seats.<sup>1-5</sup> The American Academy of Pediatrics, therefore, recommended a period of observation in a car safety seat for infants born prematurely to monitor for episodes of apnea, bradycardia, and desaturations before discharge, a test now known as the infant car seat challenge.<sup>5</sup> The most recent American Academy of Pediatrics recommendations in 2009 state that all infants born at < 37 weeks' gestation should undergo an infant car seat challenge (ICSC) for 90-120 minutes or the duration of their car ride home, whichever is longer.<sup>6</sup> Because >12% of infants are born prematurely in the US every year, the ICSC is one of the most commonly performed tests on preterm infants.<sup>7</sup>

Although most hospitals perform ICSCs on their preterm neonates, many units also perform car seat tests on low birth weight infants.<sup>6</sup> The majority of infant car seats are not tested for infants weighing <5 lbs, creating a challenge for parents, given laws requiring the use of a car seat for all infants.<sup>6</sup> Studies have shown a range of 4%-36% for ICSC failure.<sup>3,8,9</sup> For infants who fail a car seat challenge but are otherwise well, the next step in evaluation varies widely between units, including retesting in a car seat, testing in a car bed, and/or admission to a neonatal intensive care unit (NICU) for a period of observation.<sup>8</sup> It is unclear whether a failed ICSC in an otherwise well-appearing infant will affect the duration of stay. A Cochrane Review from 2006 attempted to assess whether predischarge ICSCs prevent morbidity and mortality in preterm infants, but found no trials for inclusion and concluded that it is unclear whether the ICSC is beneficial or harmful to patients.<sup>10</sup> The Canadian Paediatric Society recently determined that there was insufficient evidence to warrant including ICSC as a discharge criterion for premature or low birth weight infants.<sup>11</sup>

At Prentice Women's Hospital, our practice requires ICSC for all infants born at <37 weeks, and/or birth weight of <2.5 kg.<sup>12</sup> Infants who are clinically well, born at  $\geq 35$  weeks gestation, and >1800 g are routinely admitted to the Mother-Baby Unit, and the ICSC is administered after 24 hours of life. The presence of apnea, bradycardia, or desaturation while in the car seat is considered a failed ICSC and these infants are admitted to the NICU for a 24- to 48-hour period of observation. We hypothesized that these well-appearing infants who failed ICSC on the Mother-Baby Unit would be at risk for complications related to immaturity during the observation period and, that length of stay (LOS) would be affected by these comorbidities.

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ICSC	Infant Car Seat Challenge	LOS	Length of stay
IV	Intravenous	NICU	Neonatal intensive care unit

## Methods

We performed a retrospective cohort study of consecutive infants who were admitted to the Mother-Baby Unit from January 1, 2009, and December 31, 2015, at Prentice Women's Hospital in Chicago and subsequently failed an ICSC, leading to admission to the NICU for observation and continuous monitoring before repeat testing. Medical records were abstracted for diagnostic and treatment information. Infants with congenital anomalies known to affect breathing were excluded. Study approval was obtained by the Northwestern University Institutional Review Board (STU00200782).

All infants admitted to the Mother-Baby Unit with birth weights of <2.5 kg and/or gestational age of <37 weeks underwent an ICSC challenge. The ICSC was performed in a uniform fashion: after 24 hours of age and before discharge from the Mother-Baby Unit, a registered nurse or patient care technician observed the infant in an ICSC. Before placing an infant in the seat, cardiorespiratory electrodes and an oximeter probe were placed and baseline vital signs of heart rate, respiratory rate, and oxygen saturation were recorded. Parents or the nurse then positioned the infant in the car seat and heart rate, respiratory rate, and oxygen saturation were monitored continuously for 90 minutes. The test was considered a failure if the pulse oximeter saturation was  $\leq 85\%$  for >10 seconds, apnea >20 seconds, bradycardia <80 bpm for >10 seconds, or an apnea or bradycardia event requiring stimulation.

Infants who failed the ICSC on Mother-Baby Unit were admitted to the NICU for a period of observation for 24–48 hours. During the observation period, all NICU procedures, including careful evaluation of feeding, strict input and output, and vital signs, as well as continuous cardiorespiratory and pulse oximetry monitoring, are followed. Apnea, bradycardia, and desaturation events were ascertained and quantified by bedside observations of monitor alarms and confined to supine sleep-related events. Our unit's practice is to record each event independently and to consider events significant only if the apnea event is >20 seconds or accompanied by a bradycardia and/or desaturation event. If the infant has no clinical issues during this observation period, the car seat challenge is repeated and the infant is discharged home.

### Statistical Analyses

Data were collected on the following variables: date of birth; gestational age; sex; mode of delivery; birth weight; length and head circumference; Apgar score; date of admission and discharge; reasons for ICSC failure; NICU admission and discharge weights; frequency of apnea (defined as sleep-related events in the supine position recorded by nursing staff); need for nasogastric or intravenous (IV) fluids, antibiotics, and temperature support; bilirubin levels and need for phototherapy; and frequency of hypoglycemia. LOS was considered the primary study outcome and was calculated as the period between date of birth and date of discharge in days. Where appropriate, birth measurement variables referenced the Fenton growth chart.<sup>13</sup>

For categorical variables, the  $\chi^2$  test of association was used to examine the significance of relationships, and for continuous variables, the *t* test was used to compare means. Associations were examined between selected patient characteristics and dichotomized gestational age. Regression models were used to estimate risk differences with 95% CIs for factors related to the primary outcome, LOS. Multivariable models were adjusted for gestational age and birth weight as continuous variables a priori because both were considered confounders of the relationship between infants having failed ICSC and LOS. Analyses were conducted using Stata statistical software, version 14 (StataCorp, College Station, Texas), and all tests were 2-sided with a threshold for significance of .05.

## Results

A total of 148 infants were admitted from the Mother-Baby Unit to the NICU after a failed ICSC (43% male; 37% delivered via cesarean). The car seat challenge on the Mother-Baby Unit was performed at 1.98 ( $\pm 0.85$ ) days for infants <37 weeks, and 2.04 ( $\pm 0.82$ ) days for infants >37 weeks.

Failure of the ICSC was owing to desaturation, bradycardia, and tachypnea in 59%, 37%, and 4% of infants, respectively. Seventeen infants (11%) had a combination of 2 factors resulting in a failed ICSC. The distribution of baseline characteristics by gestational age is provided in [Table I](#). Compared with infants of  $\geq 37$  weeks' gestation, those <37 weeks were significantly more likely to have higher birth weights, NICU admission and discharge weights, more frequent apnea of prematurity, hyperbilirubinemia requiring phototherapy, more frequent requirement for temperature support, and longer LOS (all  $P < .05$ ). In addition, infants born at <37 weeks were less likely to have a birth weight at less than the 10th percentile (15% preterm vs 91% term) and hypoglycemia during admission to the NICU (8% preterm vs 22% term) (all  $P < .05$ ). One infant born at >37 weeks was excluded from analysis owing to antenatal diagnosis of trisomy 21, a condition associated independently with many of the outcomes studied.

On admission to the NICU, 9.5% of infants (11% preterm vs 6.5% term) were reported to be  $\geq 8\%$  below their birth weight. As a result of monitoring, 39% of all infants admitted were identified with apnea (48% in preterm vs 17% in term infants). At discharge, preterm infants had a higher mean weight compared with term infants ( $P < .005$ ). LOS was greater in the preterm infants (9 days), compared with term infants (6 days;  $P < .022$ ). Thirty-nine infants (25%) displayed no comorbid conditions during the observation period and were discharged after repeat testing. Of these, 37 infants passed and 2 failed repeat car seat testing; the infants who failed the retest were discharged in a car bed. [Table II](#) shows associations between selected factors and LOS from regression models.

Apnea ( $P < .001$ ), nasogastric tube support ( $P = .015$ ), IV fluid support ( $P < .001$ ), and administration of antibiotic therapy ( $P < .001$ ) were significantly associated with LOS in univariate models. In multivariable models adjusted for

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