Unsafe from the Start: Serious Misuse of Car Safety Seats at Newborn Discharge

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Objective To estimate prevalence of car safety seat (CSS) misuse for newborns on hospital discharge; and to identify potential risk and protective factors for CSS misuse.

Study design We randomly sampled 291 mother–baby dyads from the newborn unit of an academic health center. Participants completed a survey and designated someone (themselves or another caregiver) to position their newborn in the CSS and install the CSS in their vehicle. Certified child passenger safety technicians assessed positioning and installation using nationally standardized criteria. To examine factors associated with CSS misuse, we used logistic regression to compute ORs and 95% CIs.

Results A total of 291 families (81% of those eligible) participated. Nearly all (95%) CSSs were misused, with 1 or more errors in positioning (86%) and/or installation (77%). Serious CSS misuse occurred for 91% of all infants. Frequent misuses included harness and chest clip errors, incorrect recline angle, and seat belt/lower anchor use errors. Families with mothers of color (OR, 6.3; 95% CI, 1.8-21.6), non-English language (OR, 4.9; 95% CI, 1.1-21.2), Medicaid (OR, 10.3; 95% CI, 2.4-44.4), or lower educational level (OR, 4.5; 95% CI, 1.7-12.4) were more likely to misuse CSSs. However, families that worked with a child passenger safety technician before delivery were significantly less likely to misuse their CSSs (OR, 0.1; 95% CI, 0.0-0.4).

Conclusion Nearly all parents of newborn infants misused CSSs. Resources should be devoted to ensuring families with newborns leave the hospital correctly using their CSS. *(J Pediatr 2015;■:■-■).*

See editorial, p •••

More than 3.9 million children were born in the US in 2014.[1] Considering that only approximately 36 000 of those births were home deliveries,[2] the overwhelming majority of infants born in the US traveled home from a hospital or birthing center. Given that all 50 states have laws mandating car safety seat (CSS) use for young children,[3] it follows that virtually all children born in the US travel home in a CSS.

The American Academy of Pediatrics (AAP) policy statement on Safe Transportation of Newborns at Hospital Discharge states that "every newborn should be properly restrained in a car safety seat,"[4] a policy echoed by the Children's Hospital Association.[5] Although many hospitals have child passenger safety programs, and many prenatal classes include information about safe transportation of newborns, there is tremendous variability in the content and degree of integration of these programs into hospital perinatal services.[6] Constraints on time, staffing needs, financial resources, and risk management concerns are all barriers to the development and implementation of robust child passenger safety programs.[7] Research is essential to define the need and identify the essential components of effective child passenger safety programs for newborns and parents.

In 2013, 134 infants aged <1 year died in motor vehicle crashes, and approximately 500 more were hospitalized and >8000 more were treated in emergency departments for injuries sustained in crashes.[8] CSSs are very effective at protecting children in crash events, reducing the risk of death by 71% in infants aged <1 year.[9] However, research has found that some 73% of all CSS uses involve at least 1 critical misuse.[10] Misuse may be even more prevalent for newborns; 2 previous studies examining CSS use at hospital discharge reported misuse rates of 85% and 78%.[11,12] The purpose of the present study was to apply standardized criteria to examine the prevalence and types of CSS misuse, and to identify potential risk factors and protective factors, among a random sample of families of well newborns at an academic medical center.

AAP	American Academy of Pediatrics
CPST	Child passenger safety technician
CSS	Car safety seat
MBU	Mother-Baby Unit
NHTSA	National Highway Traffic Safety Administration
OHSU	Oregon Health and Science University

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Methods

This study was conducted at the Oregon Health and Science University (OHSU) Hospital, a 498-bed tertiary care academic health center in Portland, Oregon, and was approved by the OHSU Institutional Review Board. OHSU's Mother-Baby Unit (MBU) provides care for mother–infant dyads with well infants of ≥35 weeks gestational age, approximately 2500 infants per year.

The Doernbecher Children's Hospital, Tom Sargent Children's Safety Center at OHSU employs child passenger safety technicians (CPSTs) certified by Safe Kids Worldwide, and provides child passenger safety services to much of the community served by the hospital. Currently, CSS services are not routinely provided to patients in the MBU, except for children with special health care needs. For this study, certified CPSTs from the Safety Center assessed a random sample of families with newborns when positioning infants within their CSS and when installing CSSs in their vehicle. This study was conducted between November 2013 and May 2014.

Owing to resource limitations, we were unable to approach all mother–baby dyads admitted to the MBU during the study period; therefore, we randomly sampled potential participants from among the entire population of eligible mother–baby dyads. Families were excluded if the mother's medical condition precluded participation, or if the baby required angle tolerance testing according to hospital protocol, had been in the neonatal intensive care unit for longer than 4 hours, or would be traveling home by public transportation not requiring CSS use. Families with multiple-gestation deliveries were eligible, but data were collected for only 1 of the infants. Telephone interpreter services were used for any family who preferred to participate in any language other than English.

Study team members attended daily MBU rounds to identify eligible mother–baby dyads. Using a computer algorithm, we randomly sampled and approached eligible dyads, inviting their participation, until we had reached our maximum daily capacity for participants (up to 4 dyads/day). Potential participants were approached and recruited within 24-48 hours after birth. Study data were managed using REDCap electronic data capture tools hosted at OHSU.[13]

All families who agreed to participate completed the informed consent process with study staff and signed an informed consent form approved by the Institutional Review Board. They then completed a survey regarding family sociodemographic data and CSS experience and preparation. The mother (or her designee) then positioned the newborn infant in the CSS as she would at discharge, taking as much time and privacy as needed to complete the task to her satisfaction. Evaluation of infant positioning included use of harness webbing, buckles, and retainer clip, as well as use of other positioning devices in accordance with Safe Kids Worldwide[14] and National Highway Traffic Safety Administration (NHTSA)[15]-defined best practice and CSS manufacturers' recommendations. Finally, if the CSS was not already installed, then the mother (or her designee) was asked to install it in the vehicle in which the baby would be leaving the hospital. Once installation was completed, the CPST reviewed the installation, including location in the vehicle, angle of installation, and lower anchor or seatbelt use. The survey, infant positioning, and installation did not necessarily occur consecutively; each portion could occur at different times depending on the family's and healthcare team's schedules. Details on administration of the evaluation process were documented, including time to perform positioning and installation checks to the nearest 5-minute increment.

The research team worked with each family to ensure that infants left the hospital in an appropriate CSS, correctly positioned and installed by the designated caregiver, in accordance with vehicle and CSS manufacturer recommendations, and guidelines established by Safe Kids Worldwide and the NHTSA. During the study period, all families who agreed to participate had a CSS that they intended to use to take their infant home. Families with a CSS that had been recalled, had visible damage, was expired, or was of unknown history were provided with a replacement at minimal or no cost.

Dependent Variables

We categorized participants' CSS misuse at 3 levels: critical misuse, serious misuse, and any misuse. We defined critical misuse according to NHTSA guidelines published in 2004.[15] Given that this definition does not include lower anchor misuse, we defined serious misuse to include all critical misuses plus those involving lower anchors. In addition, NHTSA criteria for critical misuse does not include harness retainer misuse, although they did assess for this.[15] Our experience, as well as data that demonstrate an increased risk for infants with improper positioning of harness straps,[16] led us to include malpositioning of the harness retainer clip (too high or too low) as a serious misuse in this study. Similarly, the NHTSA criteria do not include errors in the recline angle of the CSS. Among newborns, a too-upright angle can lead to airway compromise. Again, both our experience and published data[16] led us to include incorrect recline angle as a serious misuse. Finally, the any misuse category included all serious misuses plus any additional as identified on a standardized child passenger safety checklist from Safe Kids Worldwide and in consultation with both CSS manufacturers' and vehicle owners' manuals (to ensure that both infant positioning and vehicle installation conformed to stated recommendations).[14] All categories of misuse are shown in Table I.

We chose serious misuse of a CSS as the primary outcome of interest for regression analyses because a large proportion of families used lower anchors for installation, and both recline angle and harness retainer clip misuses put infants at risk for injury related to airway compromise during CSS use.[15,16]

Independent Variables

Mother's age, race/ethnicity, primary language, educational attainment, marital status, parity, and preparation (ie,

Table I. Misuse categories and types of CSS misuse

Critical misuse*	Serious misuse†	Any misuse†
• Age/weight inappropriateness of CSS • Harness strap not used • Improper harness belt paths/slots • Improper use of locking clip to seat belt • Improper vehicle seat belt paths/slots • Incorrect seat direction • Incorrect location of CSS • Loose harness straps • Loose vehicle seat belt • Unbuckled harness strap • Unbuckled vehicle seat belt • Visible damage to CSS	Includes all critical misuses plus: • Harness retainer clip not used • Harness retainer clip too high or too low for infant • Improper lower anchor paths/slots • Loose lower anchor webbing • Unbuckled lower anchors • Incorrect recline angle of CSS	Includes all critical and serious misuses plus: • Harness belt twisted • Use of nonregulated products, or thick clothing • Lower anchors used with vehicle seat belt contrary to manufacturer guidelines • Vehicle seat belt webbing twisted • Incorrect use of CSS lock-offs • Locking clip used unnecessarily • CSS handle in incorrect position for car travel • Incorrect spacing between CSS and vehicle seat contrary to manufacturer guidelines

*US Department of Transportation, National Highway Traffic Safety Administration: Misuse of child restraints, 2004, p 32.[15]
†Safe Kids Worldwide, National Child Passenger Certification Program.[14]

installation of the CSS before delivery) were self-reported. Mother's insurance status was extracted from medical records.

Data Analyses

To examine potential effects of nonparticipation, we compared families that participated with those who did not by characteristics available for all eligible families (ie, those in the medical record: mother's age, ethnicity, language, insurance, and parity). We then computed the overall prevalence of critical, serious, and any CSS misuse and described types of misuse across categories of infant positioning and vehicle installation errors. We examined potential risk and protective factors for serious misuse using bivariable logistic regression analysis. ORs and 95% CIs were calculated to estimate the risk of serious CSS misuse by variables of interest, including mothers' sociodemographic characteristics, previous experience using CSSs with infants (ie, parity), and prenatal preparation (ie, having installed the CSS before delivery). We initially planned to conduct multivariable regression to examine risk and protective factors while controlling for potentially confounding variables[17]; however, very few participants correctly used their CSS, precluding stratified analyses (ie, models were unstable owing to strata with zero events).

Given the multiphase nature of data collection, some families were unable to complete the infant positioning (n = 17; 6%) or vehicle installation (n = 21; 7%) assessments. We used multiple imputation to address missing data, including these primary outcome variables and the smaller proportions of missing independent variable values (<3% for each variable).[18,19] Analyses were conducted on 10 imputed datasets, and results were combined using appropriate methods. Results based on imputed data are presented herein; for comparison, we also conducted complete case analyses, and found no meaningful differences in overall outcomes.[20] All analyses were performed using SAS version 9.3 (SAS Institute, Cary, North Carolina); multiple imputation was conducted using chained regression models as implemented in SAS callable IVEware version 0.2 (University of Michigan, Ann Arbor, Michigan).

Results

We randomly sampled 404 families during the study period; 46 were ineligible owing to the mother's medical status or healthcare needs. Of the 358 eligible families, 291 agreed to participate (81%), and 92% of those (n = 267) completed all study components. Families that chose not to participate (n = 67) were similar to participants in terms of race/ethnicity and language; however, higher proportions of nonparticipants were younger, multiparous, and covered by Medicaid.

Sixty percent of participating mothers were aged 25-34 years, 54% were multiparous, and 56% had private insurance (Table II). Of the 79 families that did not speak English as a primary language, most (n = 53; 80%) spoke Spanish. Small numbers spoke Chinese (n = 5), Arabic (n = 4), Russian (n = 3), or various other languages (n = 1 or 2 each). Regarding CSSs, 64% of families had installed the CSS in the vehicle in which the baby would be travelling home before birth, and 15% had worked with a certified CPST before delivery. All families in the study either already had a CSS or were able to obtain a CSS on enrollment. Most families (95%) used a rear-facing-only seat with a detachable base. Fifteen families (5%) used a convertible CSS. Nine of these 15 families had received a new convertible seat from study personnel; 6 families had an expired CSS, and 3 had a CSS with visible damage that precluded its use.

Overall, the time spent by technicians with participating families ranged from 20 to 85 minutes, with a median of 35 minutes per family (mean, 37.0 ± 11.7 minutes). This time was split nearly evenly between evaluating the positioning of babies in their CSSs (mean, 18.3 minutes) and evaluating the installation of CSSs in vehicles (mean, 18.7 minutes).

Misuse of CSSs

We found that nearly all families (95%) made at least 1 error (any misuse) in either positioning of the infant or installation of the CSS; 91% had serious misuses, and 89% had NHTSA-

Table II. Odds of serious CSS misuse among 291 newborn families, by family characteristics and level of preparation

Characteristics	Serious misuse: Yes (n = 266; 91.4%), n (%)	Serious misuse: No (n = 25; 8.6%), n (%)	Total (n = 291), n	Bivariable model, OR (95% CI)
Age, y				
≤24	39 (95.1)	2 (4.9)	41	1.7 (0.3-8.9)
25-34	159 (90.3)	17 (9.7)	176	0.8 (0.3-2.2)
≥35	68 (91.9)	6 (8.1)	74	Reference
Race/ethnicity				
White/non-Hispanic	143 (86.6)	22 (13.4)	165	Reference
Nonwhite/Hispanic	123 (97.6)	3 (2.4)	126	**6.3 (1.8-21.6)**
Language				
English	187 (89.0)	23 (11.0)	210	Reference
Spanish/other	79 (97.5)	2 (2.5)	81	**4.9 (1.1-21.2)**
Education				
Associates degree or less	141 (96.6)	5 (3.4)	146	**4.5 (1.7-12.4)**
College or more	125 (86.1)	20 (13.9)	145	Reference
Marital status				
Married/partnered	217 (90.4)	23 (9.6)	240	Reference
Other	49 (96.1)	2 (3.9)	51	2.6 (0.6-11.4)
Payment type				
Private insurance	141 (85.9)	23 (14.1)	164	Reference
Medicaid/none	125 (98.4)	2 (1.6)	127	**10.3 (2.4-44.4)**
Parity				
0	121 (89.6)	14 (10.4)	135	0.3 (0.1-1.4)
1	88 (90.7)	9 (9.3)	97	0.3 (0.1-1.6)
≥2	57 (96.6)	2 (3.4)	59	Reference
Car seat installed before birth				
Yes, worked with CPST	33 (77.3)	10 (22.7)	43	**0.1 (0.03-0.4)**
Yes, did not work with CPST	131 (91.6)	12 (8.4)	143	0.4 (0.1-1.3)
No	102 (96.8)	3 (3.2)	105	Reference

Bold font denotes statistically significant results (95% CIs exclude 1.0; $P > .05$).

defined critical misuses (Table I). Among the families with any misuse, 86% made infant positioning errors and 77% made errors in installation. Overall, one-half of all families with any misuse made 5 or more types of errors, with a mean of 5.1 different errors per family. Overall, 19% of families made only infant positioning errors, 9% made only installation errors, and 72% made both infant positioning and installation errors. Among families who had worked with a certified CPST, 83% made at least 1 error; 76% made infant positioning errors, and 47% made installation errors. Of the 15 families using convertible seats, 14 (93%) made at least 1 serious error, for an overall proportion consistent with that seen for other seats.

The most common errors made in infant positioning and CSS installation are listed in Table III. The majority of families (69%) did not have the harness webbing snug over the child as recommended, one-third (35%) placed the harness retainer clip too low, and 31% used an incorrect harness slot. More than one-fifth of families (21%) used a nonregulated product with their CSS; in all cases, this included a cushioned head restraint not approved by the CSS manufacturer.

Overall, 152 families (52%) intended to install the CSS in their vehicle using lower anchors, and 139 (48%) intended to do so using the vehicle seatbelt; 25 families (9%) used both lower anchors and seatbelts, contrary to CSS and/or vehicle manufacturers' instructions. Eight families placed the CSS in the vehicle without actually securing it with lower anchors or seatbelts, and 11 families installed the CSS facing the wrong direction. The most common installation error overall was having the seat installed too loosely, observed among 128 (44% of all) CSSs. This error was more frequent among seatbelt users (55%) than among lower anchor users (34%). A large proportion of families (41%; n = 118) installed the seat at an incorrect angle; in nearly all cases, the seat was too upright. This misuse was also more common with seatbelt users (50%) than lower anchor users (32%). More

Table III. Types and frequencies of CSS errors among 291 newborn families

Type of error	Frequency, n (%)
Positioning errors*	
Harness too loose	201 (69)
Harness retainer clip too low	103 (35)
Incorrect harness slot	91 (31)
Nonregulated product used	62 (21)
Buckle strap too far from baby	50 (17)
Caregiver unable to adjust harness	51 (17)
Harness webbing twisted	33 (11)
Caregiver unable to connect buckle	32 (11)
Installation errors*	
>1-inch motion of CSS	128 (44)
Incorrect recline angle	118 (41)
Seatbelt retractor not locked†	74 (53)
CSS contacts front seat	59 (20)
CSS too loosely attached to lower anchors‡	47 (31)
Seatbelt and lower anchors used together	39 (14)
Incorrect seatbelt path†	32 (23)
Lower anchors used in middle seat‡	25 (16)

*Categories are not mutually exclusive.
†Percentages calculated among families that used vehicle seatbelts.
‡Percentages calculated among families that used lower anchors.

than one-half of the seatbelt users (53%; n = 74) did not switch the seatbelt retractor into locking mode.

Potential Risk Factors for Serious CSS Misuse

The odds of serious CSS misuse (infant positioning or installation) by family characteristics are presented in Table II. The results suggest that families of potentially disadvantaged socioeconomic backgrounds were more likely to misuse their CSS. Compared with families with white/non-Hispanic mothers, those with mothers of Hispanic and other race/ethnicity were more likely to misuse their CSS (OR, 6.3; 95% CI, 1.8-21.6); serious misuse was similarly elevated among those who spoke a primary language other than English (OR, 4.9; 95% CI, 1.1-21.2). In terms of educational level, compared with families with mothers with a bachelor's degree or greater, families with mothers with an associate's degree or less were significantly more likely to misuse their CSS (OR, 4.5; 95% CI, 1.7-12.4). Compared with those with private insurance, mothers enrolled in Medicaid or without insurance were 10 times more likely to misuse their CSS (OR, 10.3; 95% CI, 2.4-44.4).

Odds of serious CSS misuse by experience (ie, parity) and preparation (installation of the CSS before delivery) are also presented in Table II. Parity did not appear to be associated with CSS misuse; however, working with a CPST was strongly associated with decreased misuse.

Families that had installed the CSS and had worked with a certified CPST before delivery of their infant were one-tenth as likely to have serious errors as those who did not (OR, 0.1; 95% CI, 0.03-0.4). When examining the associations individually for infant positioning vs installation errors, our results suggest that working with a certified CPST had a greater effect on correct installation of CSSs in vehicles than on correct positioning of infants in CSSs; 65% of those who worked with a certified CPST installed their CSS without error, but only 29% positioned their infant in the CSS correctly.

Discussion

This study used comprehensive best practice use criteria for CSSs as defined by the NHTSA, Safe Kids Worldwide, the AAP, and CSS and vehicle manufacturers. We found that nearly all families made at least 1 error in CSS use, and that serious misuse may be most likely among families of disadvantaged socioeconomic status. Prenatal collaboration with a certified CPST was associated with a strong reduction in misuse, especially in errors installing the CSS in the vehicle.

Best practice recommendations suggest that children should ride rear-facing as long as possible, up to the weight and length limits for the seat, but up to at least age 2 years.[21] Previous studies examining CSS misuse rates and patterns have found high misuse rates for rear-facing seats, with approximately 84% of all rear-facing seats used incorrectly.[10-12,22-26] Almost all families (91%) in this study made at least 1 serious error, and most demonstrated misuse in both infant positioning and installation. Rogers et al,[11] in a similar study conducted in Connecticut, found an overall misuse rate of 85%, in line with previous studies of rear-facing CSSs.[10,24,26] Rogers et al[11] focused on 5 types of infant positioning errors and 4 types of installation errors. It is likely that our study's reliance on NHTSA and Safe Kids definitions of misuse, along with the consistent use of CSS and vehicle manufacturers' recommendations, can explain the higher prevalence of errors that we found. Regardless, the results of both studies clearly show that families with newborns are at high risk for making serious CSS errors, and underscore the need for more effective interventions to help families do better.

The perinatal period is a stressful time for many families, during which inexperience, fatigue, and the physical rigors of childbirth all coalesce with the stress of a hospital stay and discharge. Before going home, families entertain visitors ranging from family and photographers to audiologists, phlebotomists, nurses, lactation specialists, physicians, and students. They receive substantial amounts of paperwork and discharge education on numerous topics, including maternal and infant care, umbilical cord care, fever recognition, and follow-up instructions. Although proper CSS use may be included in these educational topics, it is logical that many families might not be functioning at an optimum level as they are discharged.

Socioeconomic factors play a significant role in the risk of injuries, with disadvantaged populations bearing a disproportionate burden of injury risk.[27] We found that mothers of color who spoke a primary language other than English, were receiving Medicaid, and had lower educational achievement had significantly higher prevalence of serious CSS misuse, consistent with previous studies.[10,11,27] It is likely that lower levels of health literacy, fewer financial or social resources, and other modifiable factors are contributing to this risk. Further research into the root causes of these disparities will be important as we strive to develop effective interventions to help all families protect children travelling in motor vehicles. We found that families who had worked with a CPST before delivery were significantly less likely to misuse their CSS; this finding is similar to other studies that have examined prenatal CSS education.[12]

Even though families that worked prenatally with a CPST had a significantly and substantially decreased odds of misuse, it is important to note that 77% still made 1 or more serious errors. This suggests that the provision of certified CPST services during prenatal care is not sufficient to mitigate this risk. Furthermore, the finding that families who worked with CPSTs more frequently made infant positioning errors than installation errors points to the need for postnatal collaboration in which parents can learn to correctly position their own child in their CSS. Further examination of programs to help families use their CSS correctly is needed. It is reasonable to consider that CSS misuse rates and patterns may differ based on previous parental experience with CSS; however, we found no association between maternal parity and CSS misuse, a finding that is difficult to explain.

Our results should be considered in context with potential limitations of this study. First, although this study had a relatively high participation rate, some participation bias is possible, in that those who declined participation were more frequently younger, multiparous, and covered by Medicaid. Our results suggest that those families might be more likely to have CSS misuses, thus suggesting that the true prevalence of misuse actually could be greater than what we found in our study. Second, the high overall prevalence of misuse made analysis models potentially unstable owing to small cell sizes. Future larger studies would allow more detailed and robust analyses. Third, infants were positioned in their CSS in the mother's hospital room; it is possible that this environment led to different error patterns than otherwise might be observed in a vehicle. Finally, even though we adhered to NHTSA, Safe Kids, and manufacturers' recommendations for correct use in both infant positioning and installation, we cannot rank CSS misuse in terms of risk of injury in the event of a crash. Some misuses, like not attaching the CSS to the vehicle with either lower anchors or a seatbelt, would obviously carry a significant increase in risk to the child, whereas others, including errors in position of the carrying handle or contact with the front vehicle seats, are more difficult to assess.

Although there have been many innovations in the engineering and manufacture of CSSs over the last 20 years, this study shows that their correct use still poses a challenge for almost all families. Indeed, if a product is used incorrectly 95% of the time, then we must consider that product to be inherently flawed in some way. In our study population, families that used their vehicles' lower anchor systems were less inclined to position their CSS too loosely or at an incorrect angle. This suggests that this design is helping some families do better. We hope that our findings will serve as a stimulus to both vehicle and CSS manufacturers to continue to develop child restraint systems that are easier for families to use correctly.

The AAP policy statement on "Safe Transportation of Newborns at Hospital Discharge" states that "provision of information and training for parents and guardians should be presented before discharge on the generic issues related to correct use of CSSs. Hands-on teaching, including 'return demonstration,' should be a part of this instruction."[4] Key messages to families regarding installation need to include ensuring that the CSS is rear-facing, that it is tightly installed using lower anchors or seatbelts (meaning <1 inch of motion side-to-side or front-to-back when tested at the belt path), and that the recline angle is correct, all in accordance with the CSS manufacturer's instructions. Positioning guidance should include ensuring that the harness webbing is snug over the child, such that the caregiver cannot pinch any slack webbing over the child's shoulder; that the harness is routed through a slot at or below the child's shoulders; and that both the buckle and harness retainer (chest) clip are connected correctly, again in accordance with the manufacturer's recommendations.

Our findings suggest that some degree of both prepartum and postpartum education and support for correct CSS use for both infant positioning and installation can help families safely use their CSSs. Similar to ongoing work by Rogers et al,[28] having postpartum nurses or other staff trained to teach parents proper infant positioning in their CSS, and integrating that into standard discharge preparations, might help address positioning misuse. Even though most families who had worked with a CPST before the birth of their baby had installed their CSS correctly at hospital discharge, 35% still made serious installation errors. This suggests that prenatal collaboration with a CPST alone is insufficient to ensure correct CSS installation, and that postpartum assistance might decrease misuse rates. Further research is needed to develop programs that can be delivered efficiently but effectively by hospital staff during this vulnerable window of time for infants and their families.

Although there are significant financial and logistical barriers to implementation of these suggestions, it is our hope that the conversation will shift from "how can we afford to provide child passenger safety resources to families with newborns?" to "how can we afford not to?" ■

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References

1. Hamilton BE, Martin JA, Osterman MJK, Curtin SC; Division of Vital Statistics. Births: preliminary data for 2014. National Vital Statistics Reports. US Centers for Disease Control and Prevention. http://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_06.pdf. Accessed September 11, 2015.
2. Martin JA, Hamilton BE, Osterman MJK, Curtin SC, Matthews TJ; Division of Vital Statistics. Births: final data for 2013. National Vital Statistics Reports. US Centers for Disease Control and Prevention. http://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_01.pdf. Accessed September 11, 2015.
3. American Academy of Pediatrics Division of State Government Affairs. State Advocacy, Child Passenger Safety. https://www.aap.org/en-us/advocacy-and-policy/state-advocacy/Pages/State-Advocacy.aspx. Accessed September 11, 2015.
4. Bull M, Agran P, Laraque D, Pollack SH, Smith GA, Spivak HR, et al. American Academy of Pediatrics, Committee on Injury and Poison Prevention. Safe transportation of newborns at hospital discharge. Pediatrics 1999;104(4 Pt 1):986-7.
5. Expert Working Group, National Highway Traffic Safety Administration. Hospital discharge recommendations for safe transportation of children. http://cpsboard.org/cps/wp-content/uploads/2014/04/FINAL_dischargeprotocol_2014_logos.pdf. Accessed September 11, 2015.
6. Wolf D, Tomek DJ, Stacy RD, Corbin DE, Greer DL. Promoting hospital discharge of infants in safety seats. J Community Health 1995;20:345-57.
7. McDonald EM, Gittelman M, Zonfrillo M, Rains C, Hoffman B. Development of a national database to assess children's hospital safety centers. Presentation at Injury-Free Coalition for Kids annual meeting. December 6, 2014; Orlando, FL.

8. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS). http://www.cdc.gov/injury/wisqars/index.html. Accessed September 11, 2015.
9. National Highway Traffic Safety Administration, National Center for Statistics and Analysis. Traffic safety facts, 2012 data. http://www-nrd.nhtsa.dot.gov/pubs/812011.pdf. Accessed September 11, 2015.
10. Decina LE, Lococo KH. Child restraint system use and misuse in six states. Accid Anal Prev 2005;37:583-90.
11. Rogers SC, Gallo K, Saleheen H, Lapidus G. Wishful thinking: safe transportation of newborns at hospital discharge. J Trauma Acute Care Surg 2012;73(4 Suppl 3):S262-6.
12. Tessier K. Effectiveness of hands-on education for correct child restraint use by parents. Accid Anal Prev 2010;42:1041-7.
13. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap): a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42:377-81.
14. Safe Kids Worldwide, National Child Passenger Certification Program. Child passenger safety checklist. http://cert.safekids.org/sites/default/files/2013_checklist_-_generic.pdf. Accessed September 11, 2015.
15. US Department of Transportation, National Highway Traffic Safety Administration. Misuse of child restraints. http://www.nhtsa.gov/people/injury/research/Misuse/images/misusescreen.pdf. Accessed September 11, 2015.
16. Batra EK, Midgett JD, Moon RY. Hazards associated with sitting and carrying devices for children two years and younger. J Pediatr 2015;167:183-7.
17. Hosmer DW Jr, Lemeshow S, Sturdivant RX. Applied logistic regression. 3rd ed. Hoboken (NJ): Wiley; 2013.
18. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ 2009;338:b2393.
19. Little R, Rubin D. Statistical analysis with missing data. 2nd ed. Hoboken (NJ): Wiley; 2002.
20. Greenland S, Finkle WD. A critical look at methods for handling missing covariates in epidemiologic regression analyses. Am J Epidemiol 1995;142:1255-64.
21. Durbin DR, Committee on Injury, Violence, and Poison Prevention. Child passenger safety. Pediatrics 2011;127:e1050-66.
22. Bull MJ, Stroup KB, Gerhart S. Misuse of car safety seats. Pediatrics 1988;81:98-101.
23. Cynecki MJ, Goryl ME; Transportation Research Board. Study of child safety seat misuse (abridgement). http://trid.trb.org/view.aspx?id=306851. Accessed September 11, 2015.
24. Eby DW, Kostyniuk LP. A statewide analysis of child safety seat use and misuse in Michigan. Accid Anal Prev 1999;31:555-66.
25. Transport Canada. Child restraint use in Canada: 1997 survey data. Road safety leaflet CL 9804, TP 2436. www.tc.gc.ca/roadsafety/tp2436/cl9804/menu_e.html. Accessed September 11, 2015.
26. Arbogast KB, Jermakian JS. Field use patterns and performance of child restraints secured by lower anchors and tethers for children (LATCH). Accid Anal Prev 2007;39:530-5.
27. Bernard SJ, Paulozzi LJ, Wallace DL , US Centers for Disease Control and Prevention. Fatal injuries among children by race and ethnicity–United States, 1999-2002. MMWR Surveill Summ 2007;56:1-16.
28. Rogers SC, Gallo K, Saleheen H, Lapidus G. Can nurse education in the postpartum period reduce car seat misuse among newborns? J Trauma Acute Care Surg 2013;75(4 Suppl 3):S319-23.