Effects of Upgraded Child Restraint Law Designed to Increase Booster Seat Use in New York

WHAT'S KNOWN ON THIS SUBJECT: Booster seats can reduce injury risk for 4- to 8-year-old children involved in motor vehicle crashes, compared with seat belts alone.

WHAT THIS STUDY ADDS: This is the first study comparing traffic injury rates for booster seat–aged children before and after implementation of a booster seat law in a single state in the United States.

abstract

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OBJECTIVE: The goal was to examine the association between the New York State (NYS) upgraded child restraint law (UCRL) implemented in 2005 and the traffic injury rate among 4- to 6-year-old children in New York State.

METHODS: A before/after comparison study of population-based, traffic injury rates for 4- to 6-year-old children, using 0- to 3-year-old children as a comparison group, was performed. The effects of UCRL on injury rates among 0- to 3-year-old and 4- to 6-year-old motor vehicle passengers were estimated by using monthly injury count data from the NYS Department of Motor Vehicles Accident Information System.

RESULTS: Children 4 to 6 years of age experienced an 18% reduction in traffic injury rate (adjusted rate ratio [aRR]: 0.82 [95% confidence interval [CI]: 0.79–0.85]) after UCRL implementation, whereas the injury rate for children 0 to 3 years of age, who were not directly affected by the UCRL, did not change appreciably (aRR: 0.95 [95% CI: 0.90–0.99]). In Poisson regression analysis, the aRR for injury for 4- to 6-year-old children was 1.06 (95% CI: 0.92–1.22]) with adjustment for monthly child restraint use rates, which reveals that the significant reduction in the injury rate among 4- to 6-year-old children was mainly attributable to the 72% increase in the child restraint use rate after UCRL implementation (from 29% before UCRL implementation to 50% after implementation).

CONCLUSIONS: This is the first study comparing traffic injury rates for booster seat–aged children before and after implementation of the booster seat law in a single state. *Pediatrics* 2010;126:484–489

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KEY WORDS

upgraded child restraint law, motor vehicle crashes, booster seat, accident, passenger, safety, injury

ABBREVIATIONS

aRR—adjusted rate ratio
CI—confidence interval
UCRL—upgraded child restraint law
DMV—Department of Motor Vehicles
AIS—Accident Information System

www.pediatrics.org/cgi/doi/10.1542/peds.2010-0249

doi:10.1542/peds.2010-0249

Accepted for publication May 28, 2010

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

Motor vehicle crashes are the leading cause of death for the age group of 4 to 6 years.[1] An estimated 244 lives of children ≤4 years of age were saved in 2008 through child restraint use.[2] The National Highway Traffic Safety Administration recommends the use of belt-positioning booster seats when children are 4 years of age and 40 pounds and no longer fit forward-facing, child safety seats but are still too young (<8 years of age) and too short (<57 inches) to fit properly into seat belts alone.[3] As of March 2010, 47 states and the District of Columbia have laws requiring appropriate child restraints, such as booster seats, for children who no longer properly fit into forward-facing, child safety seats. These laws vary according to age, height, and weight across states.[4] In New York State, the upgraded child restraint law (UCRL) became effective on March 27, 2005, and requires the use of booster seats or other appropriate child restraint systems for children 4, 5, or 6 years of age.[5]

Research on the efficacy of booster seats has been conducted. Researchers at the Children's Hospital of Philadelphia have published several articles on child restraint use. The 2003 study comparing booster seats and seat belts alone for children 4 to 7 years of age found a 59% reduced risk of injury for children using booster seats.[6] The 2006 study comparing child restraints and seat belts alone for children 2 to 6 years of age showed a 28% reduced risk of death for children in child restraints.[7] The 2007 study comparing states with booster seat laws and states without such laws found that children 4 to 7 years of age in states with laws were 39% more likely to be reported as being restrained appropriately.[8] A study in Tennessee evaluated the appropriate use of child safety restraints among 4- to 8-year-old children before and after implementation of an enhanced child safety law and demonstrated an increase in the appropriate use of booster seats after implementation.[9] However, we have not identified a study comparing the traffic injury rates for children of booster seat age before and after implementation of a booster seat law in a single state in the United States. The objective of this study was to evaluate UCRL effects in increasing age-appropriate child restraint system use and in reducing traffic injuries among 4- to 6-year-old passengers, with the 0- to 3-year age group for comparison.

METHODS

Data Sources

Our study population, 4- to 6-year-old motor vehicle passengers involved in motor vehicle crashes, was identified through the 2003–2007 Accident Information System (AIS) for New York State. The UCRL was enacted on March 27, 2005. Children 0 to 3 years of age were used for comparison because they were exposed to similar driving environments but were not directly affected by the UCRL. The AIS includes crash data reported to the New York State Department of Motor Vehicles (DMV) by police officers and motorists. Police officers are required to report all crashes that result in death or injury.[10] Information is collected regarding injury severity, which is classified as none, complaint of pain, visible, incapacitating, fatal, or unknown severity. Information also is collected regarding the crash date, individual safety equipment use, and individual seating position. To estimate population-based, injury rates for children, the bridged-race population estimates according to age from the National Center for Health Statistics for 2003–2007 were used.[11]

Statistical Analyses

The population-based, traffic injury rate, the child restraint use rate, and the front seat use rate among children 0 to 6 years of age involved in motor vehicle crashes were examined from 2003 through 2007. The χ^2 test was used to evaluate UCRL effects on those rates. To evaluate the effects of the UCRL on childhood injury rates, population-based, injury rate ratios comparing the presence versus the absence of the UCRL were estimated by using a Poisson regression approach with a natural logarithm link function. The dependent variable was the monthly count of children's traffic injuries from 2003 through 2007. The traffic injuries included injuries of all levels of severity, from minor to severe, as well as injuries with unknown severity. The major explanatory variable was a binary indicator variable for the absence or presence of the UCRL regulation, defined on the basis of months before versus after March 2005 during the time period from 2003 through 2007 (0 for the months before and including March 2005 or 1 for months after April 2005). The second explanatory variable was a categorical variable indicating the quarter of the year (range: 1–4), which was used to adjust for the seasonality trend in the monthly injury counts. The third explanatory variable was a continuous variable for the monthly child restraint use rate among children involved in motor vehicle crashes. The model was fitted separately for 0- to 3-year-old and 4- to 6-year-old children. For each age group, the model was fitted separately with and without the monthly child restraint use rate. The GENMOD procedure in SAS 9.1 (SAS Institute, Cary, NC) was used to fit all Poisson regression models.

RESULTS

Immediately after the UCRL took effect on March 27, 2005, the end of the first quarter of 2005, the child restraint use rate among 4- to 6-year-old children involved in motor vehicle crashes in New

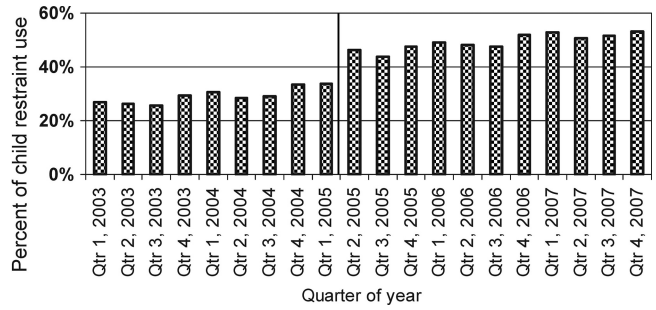

FIGURE 1

Child restraint use rates among children 4 to 6 years of age involved in motor vehicle crashes in New York State in 2003–2007. The vertical line indicates that, effective March 27, 2005, New York State law required the use of booster seats or other appropriate child restraint systems for 4-, 5-, and 6-year-old children.

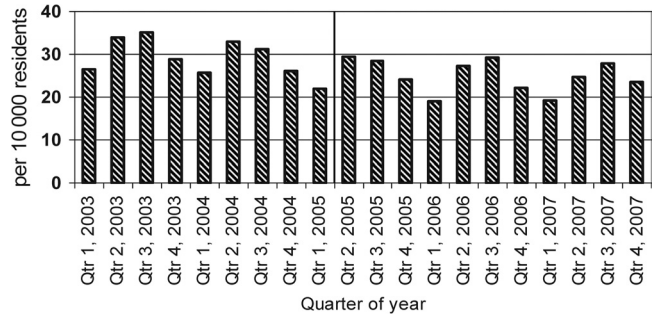

FIGURE 2

Population-based, traffic-related injury rates among children 4 to 6 years of age in New York State in 2003–2007. The vertical line indicates that, effective March 27, 2005, New York State law required the use of booster seats or other appropriate child restraint systems for 4-, 5-, and 6-year-old children.

York State increased (Fig 1). However, the traffic injury rate per 10 000 residents among 4- to 6-year-old children in New York State experienced seasonal changes in the period from 2003 to 2007 (Fig 2). The injury rate increased in the second and third quarters every year and decreased in the fourth quarter. This seasonality partially masked the immediate effect of the UCRL on children's traffic injury rate, compared with the more-easily observed increase in the child restraint use rate, although careful examination revealed a general downward trend in the injury rate with the law.

The child restraint use rate among 4- to 6-year-old children involved in motor vehicle crashes in New York State experienced a significantly larger increase, compared with that for 0- to 3-year-old children, after UCRL implementation (Fig 3). The use rate increased from ~30% in 2003–2004 to 50% in 2006–2007 among 4- to 6-year-old children, whereas it increased slowly from 76% to 84% between 2003 and 2007 among 0- to 3-year-old children. Although the UCRL in New York State did not require rear seating for children, the front seat use rate among 4- to 6-year-old children experienced a larger decrease (from ~9% to 5%) during the time period of 2003–2007, compared with the rate among 0- to 3-year-old children after UCRL implementation (Fig 4). This phenomenon could be explained by the correlation between child restraint use and rear seat use among children. Children who were placed in child restraint systems were more likely to be seated in the rear. The population-based, injury rate for 4- to 6-year-old children decreased during the time period of 2003–2007, from 31 injuries per 10 000 in 2003 to 24 injuries per 10 000 in 2007 (Fig 5). For 0- to 3-year-old children, the injury rate decreased slightly from 2003 to 2004 and then remained stable from 2004 to 2007. Although the child restraint use rate increased slightly and the front seat use rate decreased slightly after UCRL implementation for 0- to 3-year-old children, the changes did not result in a statistically significant decrease in the injury rate (Table 1). However, 4- to 6-year-old children experienced a much larger increase in the child restraint use rate and a larger decrease in the front seat use rate after UCRL implementation, as well as a statistically significant decrease in the injury rate, from an average of 29 injuries per 10 000 before UCRL implementation to 25 injuries per 10 000 after implementation (Table 1).

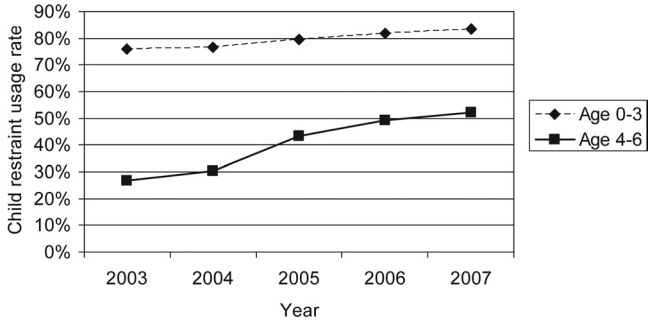

FIGURE 3

Child restraint use rates among children involved in motor vehicle crashes in New York State in 2003–2007.

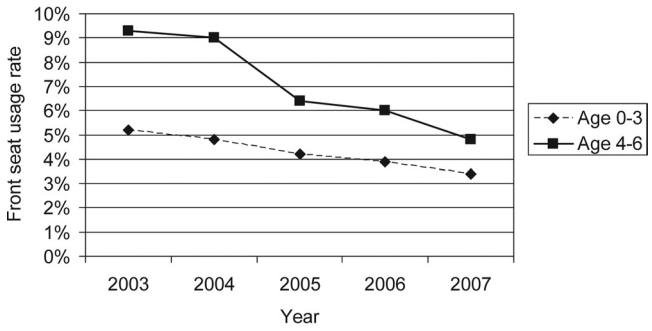

FIGURE 4
Front seat use rates among children involved in motor vehicle crashes in New York State in 2003–2007.

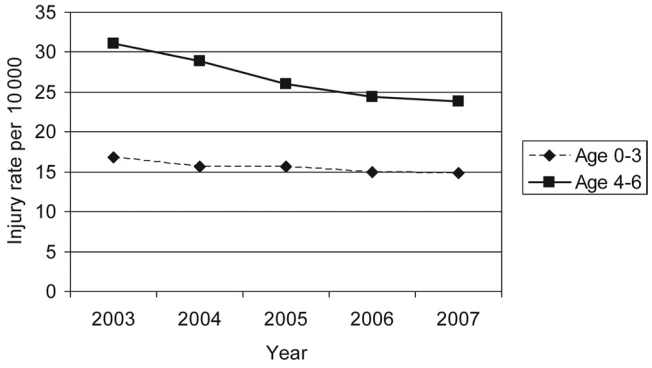

FIGURE 5
Children's crash-related injury rates per 10 000 population in New York State in 2003–2007.

TABLE 1 Effects of UCRL on Child Restraint Use Rate, Front Seat Use Rate, and Population-Based Injury Rate, According to Children's Age, in New York State in 2003–2007

Characteristics	Age 0–3 y			Age 4–6 y		
	Before UCRL	After UCRL	*P*	Before UCRL	After UCRL	*P*
Child restraint use rate, %[a]	76	82	<.0001	29	50	<.0001
Front seat use rate, %[a]	5	4	<.0001	9	6	<.0001
Population-based injury rate, cases per 10 000[b]	16	15	.54	29	25	<.0001

Among children 0 to 3 years of age, 50 762 people were involved in crashes and 7538 people were injured in crashes. Among children 4 to 6 years of age, 40 536 people were involved in crashes and 9503 people were injured in crashes. *P* values were determined with χ^2 tests.

[a] Rates were calculated among children involved in motor vehicle crashes in New York State.

[b] The rate was calculated on the basis of the crash-related injury number and the population estimates for New York State according to year and age.

There were 7538 and 9503 traffic injuries among 0- to 3-year-old and 4- to 6-year-old child passengers, respectively, in New York State in 2003–2007 (Table 2). Compared with the absence of the UCRL, the adjusted, population-based, injury rate was 18% less (adjusted rate ratio [aRR]: 0.82 [95% confidence interval [CI]: 0.79–0.85]) after UCRL implementation for 4- to 6-year-old children (Table 2). However, the aRR for 0- to 3-year-old children was closer to 1 (aRR: 0.95 [95% CI: 0.90–0.99]) (Table 2). When the Poisson regression analysis was performed with adjustment for the monthly child restraint use rate, the protective effect of the UCRL on traffic injuries to 4- to 6-year-old children decreased (aRR: 1.06 [95% CI: 0.92–1.22]) (Table 2), whereas the aRR for 0- to 3-year-old children did not change much (aRR: 0.97 [95% CI: 0.90–1.05]) (Table 2).

When we limited the Poisson regression analysis to fatal, incapacitating, and visible injuries only, there were 1921 and 1904 traffic injuries among 0- to 3-year-old and 4- to 6-year-old passengers, respectively, in New York State in the time period from 2003 to 2007 (Table 3). Compared with the absence of the UCRL, the adjusted, population-based, visible injury rate for 4- to 6-year-old children demonstrated a significant 21% decrease (aRR: 0.79 [95% CI: 0.72–0.87]) after UCRL implementation (Table 3). However, the aRR for visible injury for 4- to 6-year-old children became closer to 1 and not significant with adjustment for the monthly child restraint use rate (Table 3). The aRR for visible injury for 0- to 3-year-old children demonstrated a similar change with controlling for the monthly child restraint use rate but generally was closer to 1, compared with that for 4- to 6-year-old children (Table 3). When we limited the Poisson regression analysis to incapacitating and fatal injuries only, the point estimate for the association of UCRL implementation with these serious injury rates for 4- to 6-year-old children also suggested a protective effect (aRR: 0.92 [95% CI: 0.75–1.13]), although the 95% CI included 1 because of the limited number of serious injuries. For 0- to 3-year-old children, however, the point estimate did not suggest a protective effect of the UCRL when the analysis limited to incapacitating and fatal injuries only (aRR: 1.08 [95% CI: 0.87–1.34]).

DISCUSSION

This is the first study to evaluate the early effects of the implementation of the UCRL on March 27, 2005, in New York State. In addition, an extensive literature search failed to identify an-

TABLE 2 Population-Based aRRs for Children's Crash-Related Injuries, According to Children's Age, in New York State in 2003–2007

Characteristics	aRR (95% CI)	
	Age 0–3 y	Age 4–6 y
Without adjustment for monthly variation in child restraint use rates[a]	0.95 (0.90–0.99)	0.82 (0.79–0.85)
With adjustment for monthly variation in child restraint use rates[b]	0.97 (0.90–1.05)	1.06 (0.92–1.22)

For children 0 to 3 years of age, there were 7538 total injuries; for children 4 to 6 years of age, there were 9503 total injuries.
[a] The aRRs compared the presence versus absence of the UCRL with adjustment for seasonal variation in children's injury rates.
[b] The aRRs compared the presence versus absence of the UCRL with adjustment for seasonal variation in children's injury rates and monthly variation in child restraint use rates among children involved in crashes.

TABLE 3 Population-Based aRRs for Children's Crash-Related Visible Injuries, According to Children's Age, in New York State in 2003–2007

Characteristics	aRR (95% CI)	
	Age 0–3 y	Age 4–6 y
Without adjustment for monthly variation in child restraint use rates[a]	0.90 (0.82–0.98)	0.79 (0.72–0.87)
With adjustment for monthly variation in child restraint use rates[b]	0.95 (0.82–1.11)	0.91 (0.67–1.25)

For children 0 to 3 years of age, there were 1921 total visible injuries; for children 4 to 6 years of age, there were 1904 total visible injuries.
[a] The aRRs compared the presence versus absence of the UCRL with adjustment for seasonal variation in children's visible injury rates.
[b] The aRRs compared the presence versus absence of the UCRL with adjustment for seasonal variation in children's visible injury rates and monthly variation in child restraint use rates among children involved in crashes.

other research study that studied systematically the effects of an upgraded child passenger safety law on traffic-related injury rates for booster seat–aged child passengers within a single state, using police crash report data for the state. We estimated that 4- to 6-year-old children experienced a significant 18% reduction in injury rate after UCRL implementation. In contrast, our analysis did not demonstrate that implementation of the UCRL had any appreciable effect on traffic injuries among 0- to 3-year-old children, who were not directly affected by UCRL implementation.

We examined the mechanisms of how the UCRL reduced traffic injuries among 4- to 6-year-old children. Our analyses revealed that the safety benefit of the UCRL resulted mainly from increased use of age-appropriate child restraint systems, which were demonstrated in previous studies[6,7] to protect booster seat–aged children better in crashes, compared with adult safety belts only or no restraints.

We evaluated the effects of the UCRL on traffic injuries by using Poisson regression with monthly injury count data and population estimates, instead of the number of crashes in the DMV AIS data. The total data size of the DMV AIS report grew larger each year through 2 main mechanisms. First, the property damage-only reporting threshold of $1000 did not change in the years studied, which resulted in an artificial increase in the number of these reports. Second, in June 2006 the New York State DMV changed its processing system to include all police-reported, property damage-only crashes; from June 2002 until June 2006, only motorist-reported, property damage-only crashes were included. This change resulted in a very large artificial increase in the total number of crashes in 2006 and 2007. Therefore, the injury rate for individuals involved in crashes decreased automatically each year because of the inflated sample size of the crash data, which would confound our analysis of UCRL effects on injury rates.

There are several strengths of our study. First, our data on traffic injuries and child restraint use were collected systematically in the New York State DMV AIS and were more accurate, objective, and complete than data from telephone interviews of crash victims. Second, we explored the effects of the UCRL on more-severe traffic injuries among 0- to 6-year-old children as secondary findings. We estimated that 4- to 6-year-old children experienced a significant 21% reduction in the visible injury rate and a nonsignificant 8% reduction in the fatal and incapacitating injury rate after UCRL implementation. Similar to the overall injury rate, the safety benefit of the UCRL with respect to the rate of more-severe traffic injuries to 4- to 6-year-old children resulted mainly from increased use of age-appropriate child restraint systems. Furthermore, we did not observe the same degree of effects of the UCRL on more-severe traffic injuries among 0- to 3-year-old children. Our estimates of an 18% reduction in the injury rate and a 72% increase in child restraint use among 4- to 6-year-old passengers can be used not only in demonstrating the effectiveness of the UCRL to the public and to policymakers but also in educational messages for parents about the protective effects of using age-appropriate child restraint systems for their booster seat–aged children.

Our study covered 27 months before and 33 months after UCRL implementation and demonstrated the early effects of the UCRL. Crash data from future years can be used to evaluate whether the early effects are sus-

tained over a longer period. Our study did not have information on the misuse of the child restraint systems. The National Highway Traffic Safety Administration estimated that ≥1 critical misuse was found for ~50% of booster seats observed.[12] The misuse issues might explain in part why the protective effect of child restraint use was not as strong as we expected.

CONCLUSIONS

UCRL implementation in New York State has been effective in reducing traffic injuries among 4- to 6-year-old children. This safety benefit can be explained largely by the increased use of child restraint systems for child passengers after UCRL implementation. The enactment of the UCRL in New York State did not have any appreciable impact on the incidence of traffic injuries among 0- to 3-year-old children, who were not directly affected by the UCRL.

ACKNOWLEDGMENTS

This work was funded by grants from the National Highway Traffic Safety Administration, the New York State Governor's Traffic Safety Committee, and the Centers for Disease Control and Prevention.

REFERENCES

1. Centers for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting System (WISQARS). Available at: www.cdc.gov/ncipc/wisqars. Accessed March 3, 2009
2. National Highway Traffic Safety Administration. *Traffic Safety Facts: 2008 Data: Children*. Washington, DC: National Highway Traffic Safety Administration; 2009. Available at: www-nrd.nhtsa.dot.gov/pubs/811157.pdf. Accessed July 13, 2010
3. National Highway Traffic Safety Administration. *Improving the Safety of Older-Child Passengers: A Progress Report on Reducing Deaths and Injuries Among 4- to 8-Year Old Child Passengers*. Washington, DC: National Highway Traffic Safety Administration; 2005. Available at: www.nhtsa.dot.gov/people/injury/childps/BoosterSeatProgress/images/BSProgressReport.pdf. Accessed March 3, 2009
4. Governors Highway Safety Association. Child passenger safety laws. Available at: www.ghsa.org/html/stateinfo/laws/childsafety_laws.html. Accessed March 3, 2010
5. New York State Assembly Committee on Transportation. *2005 New York State Assembly Annual Report: Committe on Transportation*. Albany, NY: New York State Assembly Committe on Transportation: 2005. Available at: http://assembly.state.ny.us/comm/Trans/2005Annual/#link6. Accessed July 14, 2010
6. Durbin DR, Elliott MR, Winston FK. Belt-positioning booster seats and reduction in risk of injury among children in vehicle crashes. *JAMA*. 2003;289(21):2835–2840
7. Elliott MR, Kallan MJ, Durbin DR, Winston FK. Effectiveness of child safety seats vs seat belts in reducing risk for death in children in passenger vehicle crashes. *Arch Pediatr Adolesc Med*. 2006;160(6):617–621
8. Winston FK, Kallan MJ, Elliott MR, Xie D, Durbin DR. Effect of booster seat laws on appropriate restraint use by children 4 to 7 years old involved in crashes. *Arch Pediatr Adolesc Med*. 2007;161(3):270–275
9. Gunn VL, Phillippi RM, Cooper WO. Improvement in booster seat use in Tennessee. *Pediatrics*. 2007;119(1). Available at: www.pediatrics.org/cgi/content/full/119/1/e131
10. New York State Vehicle and Traffic Law § 603 and 603A. Available at: http://law.onecle.com/new-york/vehicle-traffic/title6.a22.html. Accessed July 13, 2010
11. Centers for Disease Control and Prevention. U.S. Census populations with bridged race categories. Available at: www.cdc.gov/nchs/nvss/bridged_race.htm. Accessed March 3, 2009
12. National Highway Traffic Safety Administration. *Misuse of Child Restraints*. Washington, DC: National Highway Traffic Safety Administration; 2004. Available at: www.nhtsa.dot.gov/people/injury/research/Misuse/images/misusescreen.pdf. Accessed March 11, 2009

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Pediatrics 2010;126;484
DOI: 10.1542/peds.2010-0249 originally published online August 9, 2010;

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