Risk of Pediatric Back-over Injuries in Residential Driveways by Vehicle Type

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Objective: Research suggests that children experience driveway back-over injuries at a significant rate and the severity of the resulting injuries differ by type of vehicle. Yet no US study attempted to quantify "back-over risk" for classes of vehicles because of the difficulties with determining exposure. Using vehicle registration information, we set out to estimate the relative risk of driveway back-over injuries to children by type of vehicle.

Methods: Driveway back-over events were identified from state police reports and medical records from the state level-1 pediatric trauma center and compared with vehicle registration information to estimate injury incidence for 4 classes of vehicles (passenger cars, trucks, sport utility vehicles, and minivans) over 6 years in the state of Utah.

Results: Reported driveway back-over injuries represent an incidence of 7.00 per 100,000 children (<10 years old) per year. Overall, passenger cars account for 1.62 injuries per 100,000 registered vehicles. Compared with passenger cars, children were 53% more likely to be injured by a truck ($P = 0.01$) and 2.4 times more likely to be injured by a minivan ($P < 0.001$). Among children transported to a trauma center, admission ($P = 0.01$) and need for surgery ($P = 0.03$) were greater among children backed over by trucks, sport utility vehicles, and minivans compared with passenger cars.

Conclusions: Findings suggest that when assessing driveway back-over injuries, larger high-profile vehicles are associated with a higher incidence and severity of injuries when compared with injuries resulting from passenger cars.

Key Words: driveway, rollover, back-over, children, pickup truck, minivan, sport utility vehicle, injury severity

Children experience a disproportionate percentage of the severe and fatal pedestrian injuries that occur in this country.[1,2] Children under 4 years of age are at greatest risk, with 1 in 3 deaths related to a pedestrian-motor vehicle injury.[3,4] The bulk of pediatric pedestrian deaths occur in nontraffic situations such as residential driveways.[5,6] Data from the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) and the KIDS'N CARS program suggest that as many as 9160 nonfatal and 80 fatal nontraffic injuries occur among children every year, with 27% of these events involving a motor vehicle backing over a child.[7] Unfortunately, driveway-related injuries are not typically reported by police and, if reported, are often miscoded.[8] This has led to an under recognition of the magnitude of the problem of driveway back-over injuries.[6] A more recent investigation, using a probabilistic sample of US emergency departments, estimates that approximately 2492 children (≤14 years) seek treatment in US hospital emergency departments (per year) for nonfatal injuries resulting from motor vehicle back-over injuries.[7]

To date, research evaluating pediatric injuries resulting from a vehicle traveling in the reverse direction in a driveway has focused on the child's age and other victim-related risk factors,[2,8–10] attributes of residential driveways,[11] injury severity,[3,4,6] and vehicle type.[4,6,8,9,12] By far the most frequently reported injury risk factor is age, suggesting that toddlers and preschool aged children are more likely to be severely injured or killed.[2–4,8,9,13] Reported mortality rates associated with driveway back-over vary between 6% and 16% of reported cases.[3,6,8,10,11] Roberts et al assessed environmental factors associated with the injury event and reported that the "absence of a physical separation of the driveway from the children's play area" was associated with an increased risk of injury as well.[11]

With regard to vehicle types, Nadler et al found that over half of driveway incidents in their trauma registry involved a sport utility vehicle (SUV) or truck.[6] Similarly, Brison et al reported that 76% of nontraffic fatalities involving children less than 5 years of age were caused by vans or light trucks.[4] Agran et al found that 40% of cases involved a van, truck, or 4-wheel drive (4WD) vehicle.[9]

To date, only 2 studies have attempted to estimate the risk of back-over injury associated with vehicle type, both studies relying on vehicle registration information as a measure of exposure. Murphy et al's review demonstrated that 28% of driveway crashes in Auckland, New Zealand, involved a truck, van, or 4WD, whereas these vehicle types represented only 6% of vehicles registered in the region.[12]

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Holland reported that 42% of back-over injuries in New South Wales, Australia, involved 4WD or light commercial vehicles, yet these vehicle classes characterize only 30% of the vehicles registered in the region.[8]

Previous reports have largely been case reviews drawn from a single source (eg, a trauma registry), making it difficult to estimate the incidence of driveway back-overs. Additionally, studies to date have expressed differences in injury rates by vehicle type using crude percentages and have not assessed the relative risk of back-over injury resulting from larger versus smaller passenger vehicles in the United States.

The objectives of this study are threefold. First, we sought to accurately estimate the statewide incidence of severe driveway back-over injuries to children using multiple surveillance sources. Second, we attempted to estimate the relative risk of driveway back-over injury by type of vehicle using Utah vehicle registration information. Finally, we compared the severity of resulting injury among children treated at the regions only level-1 pediatric trauma center by type of vehicle. We hypothesized that the incidence and severity of back-over injury associated with SUVs, minivans, and pickup trucks would be significantly higher than that observed for passenger cars.

METHODS

Study Design

We conducted an epidemiological investigation of the incidence of driveway back-over events occurring between January 1, 1998 and December 31, 2003. Injury events involving a child less than 10 years of age injured by a vehicle traveling in a reverse direction in a driveway were included in the study. This study was reviewed and approved by the University of Utah Health Sciences Center Institutional Review Board for Human Subjects Research.

Identification of the Study Sample

Children involved in driveway back-over events were identified using 2 data sources. Initially, State of Utah Investigating Officer's Report of Traffic Accident forms (DI-9) were searched to identify back-over injuries. Completed DI-9 forms occurring on private property are submitted to the Utah State Department of Health. These police reports were manually searched for pedestrians less than 10 years of age who were struck by a motor vehicle on a residential driveway. "Driveway" was defined as a private road giving access from a public way to a residential unit. Exclusion criteria ruled out children 10 years of age or older, children struck by vehicles traveling in the forward direction, children struck on parking lots (including apartment complex parking lots), on private streets, on school grounds, or on other nonresidential driveway private property areas, and/or were riding scooters, bicycles, or tricycles. Note that the police are not required by law to complete the DI-9 form for motor vehicle crashes occurring on private property in Utah.[14]

As a second, independent source of children injured in driveway back-over events, we reviewed Emergency Department (ED) logs and trauma registry records for all patients treated at Primary Children's Medical Center, the only tertiary care children's medical and trauma center in the state of Utah. We identified victims of pedestrian versus motor vehicle collisions occurring in residential driveways using e-codes (ie, E814, E822 [.7]) and EMS report/medical record narratives. Similar exclusion criteria to those described earlier were employed, also excluding all injuries sustained in adjacent states and treated at Primary Children's Medical Center. Children present in both databases were identified using incident date, age, gender of child, and home zip code.

Measurement

Yearly back-over incidence was calculated using US census population projections from the 1990 and 2000 census data, identifying the number of children under 10 years of age living in Utah. Under 10 years of age was chosen as a cutoff based on a subanalysis recently published by the Centers for Disease Control and Prevention.[7] To estimate the relative risk of injury associated with differing vehicle types, information was sought from R. L. Polk Inc, providing an estimate of the total number of registered vehicles in the state of Utah, by type, on July 1 of each study year.[15] Vehicle types were collapsed into 4 categories for the purposes of this study; passenger car, SUV, minivan, and pickup truck. For analyses related to injury severity, SUVs, minivans, and pickup trucks were collapsed into "light trucks and vans" (LTVs) to enhance comparability with previously published studies.

Information provided through police reporting included a description of the injury event and victim, vehicle type, and a rudimentary measure of injury severity based on KABCO.[14] The KABCO scheme allows nonmedically trained persons to make on-scene injury severity assessments, where K = killed; A = incapacitating injury; B = nonincapacitating injury; C = possible injury; and O = no injury.

For children seeking medical attention at the pediatric trauma center, ED records and trauma registry information were abstracted for age, gender, height, weight, injury severity coding, outcome, and vehicle type. ED records were included in the review because patients with superficial injuries may be treated and released. We chose hospital admission, intensive care unit (ICU) admission, mean "new" Injury Severity Score (NISS), Abbreviated Injury Score by body region, and surgery with general anesthesia as indicators of injury severity. NISS, which more accurately characterizes severe injuries focused in one body area, was calculated using methods described by Osler et al.[16] To estimate injury severity for all children, NISS scores were also categorized into KABCO classifications: NISS 1–3 = Nonincapacitating injury, NISS 4-66 = Incapacitating injury and NISS 75 (or hospital death) = Fatal injury.

Analysis

Regarding the incidence and relative risk of injury, case estimates were based on the total observed number of unique cases in either data source. Crude observed incidence

was calculated using either US Census population projections for children (<10 yrs) in Utah or the total number registered vehicles in the state of Utah for the years of interest. To augment the assessment of incidence, the estimated number of cases *not* captured in either database was generated using a 2-sample capture–recapture technique. Capture–recapture methods provide estimates of the number of unascertained cases from the analysis of overlapping incomplete lists of cases from independent sources.[17] Capture–recapture methods have been used to aid in the estimation of incidence for head and spinal cord injuries,[18] myocardial infarction,[19] diabetes,[20] stroke,[21] and many other diagnostic conditions.

The relative risk of driveway back-over injury by type of vehicle was assessed by comparing crude injury incidence using methods described by Martin and Austin.[22,23] In sum, this method generates the optimal conditional maximum likelihood analysis using a polynomial multiplication technique. To assess the differences in the severity of injury by type of vehicle, univariate statistics and bivariate comparisons (ie, Pearson χ^2 test, unpaired t test) were generated. Interval-level variables demonstrating an overly skewed distribution (eg, NISS and LOS) were evaluated using a Mann-Whitney U test. A P value of ≤ 0.05 was considered significant for all analyses. Ninety-five percent confidence bands for crude incidence rates are based on a Poisson distribution or a normal approximation, depending on the observed number of cases utilized in each specific analysis.[24] Data analyses were performed using SPSS version 13.0.0 statistical software (SPSS Inc, Chicago, IL).

RESULTS

Characteristics of Study Samples

A review of data from police reports in the state of Utah during 1998 through 2003 yielded 102 children meeting inclusion criteria who were injured by a vehicle traveling in a reverse direction in a driveway. The median age of victims was 2 years with males representing 55% of the sample. Injury severity, as assessed using KABCO, indicated that 45% of children suffered only cuts and bruises or less severe injuries, suggesting a "near back-over" event, whereas the remaining sample suffered substantial injuries with 10% of the sample dying at the scene. The driver of the vehicle was most likely a family member (48%) or neighbor (24%) and was relatively young (median age 30 years).

A review of ED logs and trauma registry records from the state's level-1 pediatric trauma center identified 100 children meeting study criteria, 73 of which were not found in the database produced from review of police reports. Among those admitted to the hospital (n = 85), the median length of stay was 5 days with 40% receiving ICU care and 29% undergoing surgery with general anesthesia. Two children died during hospital care, 1 in the ED from a left ventricular laceration and the other after 6 days in the ICU from multiple intracranial injuries.

Combining the 2 databases, we identified a total of 175 unique events involving a child injured in a driveway by a vehicle traveling in reverse. Overall, the median age of children was 2.5 years and 57% of victims were male. Assuming a uniform distribution of expected events, there was no difference in the frequency of injury by day of the week ($\chi^2(6) = 5.80$, $P = 0.45$), however, driveway injuries were significantly more likely during summer months ($\chi^2(11) = 28.36$, $P < 0.01$) and more likely to occur in the late afternoon hours (3 PM to 7 PM [52% of cases], $\chi^2(16) = 30.4$, $P = 0.02$). The type of vehicle associated with the incident could be identified for all but 9 cases using information contained in police reports and/or medical records.

Incidence of Back-over Injury

The total number of *reported* driveway injuries from 1998 through 2003 represents an injury incidence of 7.09 per 100,000 persons (< 10 years old) per year in the State of Utah (95% CI = 1.88, 12.29). This incidence, however, represents a minimal estimate because it is based solely on cases identified by a completed police report or by presentation to the state pediatric trauma center. A derived estimate of the total number of unascertained driveway back-over injuries occurring in Utah from 1998 to 2003 differed based on the capture–recapture technique used. An analysis based on a maximum likelihood estimator (MLE) indicates that 197 (95% CI = 101, 293) cases remain unascertained.[17] Using a method considered insensitive to small samples (unlike a MLE), the estimated number of unascertained cases is 190 (95% CI = 94, 286).[25] Unascertained cases would include back-over incidence not requiring medical attention (ie, near misses) and cases seeking medical attention in local hospitals, clinics, and private offices (or cases not properly documented by the police or the trauma center). A summation of unreported (n ~ 190) and reported (n = 175) cases indicates that 365 driveway back-over events may have occurred during the time period of interest representing an incidence of 14.78 (95% CI = 7.25, 22.31) per 100,000 persons (≤ 10 years old) in the State of Utah.

Relative Risk of Injury by Vehicle Type

On the basis of the reported number of vehicle registrations in the State of Utah, passenger cars demonstrated an average back-over injury incidence of 1.62 per 100,000 registered vehicles per year over the course of the study period (95% CI = 1.36, 2.00). Table 1 indicates that the overall injury incidence for trucks (2.45/100,000/year), SUVs (2.11/100,000/year), and vans (3.92/100,000/year) were all higher than that for passenger cars. Using the injury incidence associated with passenger cars as a comparison group, trucks demonstrated a 53% higher injury rate ($P = 0.01$) whereas children were 2.4 times more likely to experience a back-over injury with exposure to a van ($P < 0.001$) than exposure to a passenger car. The difference in injury rates between SUVs and passenger cars was not statistically significant ($P = 0.19$). These reported relative risks of injury are based on actual cases and do not incorporate estimated cases based on the capture–recapture model.

TABLE 1. Incident Rates and Relative Risk of Back-over Injury by Vehicle Type

Vehicle Type	IR*	95% CI†	RR_{MH}‡	P
Truck	2.45	1.91, 3.12	1.52	0.01
SUV	2.11	1.19, 3.41	1.30	0.19
Minivan	3.92	2.48, 6.02	2.41	<0.001

*Incidence is per 100,000 registered vehicles per year.
†Exact Fisher 95% confidence interval based on a Poisson distribution.
‡Rate ratio based on a conditional maximum likelihood analysis.[18,19]
§Back-over injuries associated with passenger cars used as comparison group.

Severity of Injury by Vehicle Type

Using comparable KABCO scores for all children (n = 175), injury events involving LTVs were more likely to produce incapacitating injuries than those resulting from events associated with passenger cars ($\chi^2(4) = 14.53$, $P < 0.01$) (Fig. 1). Among children seeking hospital care, 37% of the children were moderate to severely injured (NISS > 16). The mean NISS for children backed over by LTVs (16.0 + 14.9) was higher than for children backed over by passenger cars (11.7 + 14.7), but the 2 distributions were not significantly different ($P = 0.08$) (Table 2). No differences were noted among abbreviated injury scores by body region. However, children injured by LTVs were more likely to be admitted to the hospital (OR = 3.11, 95% CI = 1.14, 8.46), more likely to be admitted to the ICU (OR = 3.54, 95% CI = 1.19, 10.55), and more likely to undergo surgery (OR = 3.80, 95% CI = 1.02, 14.20) than children injured by passenger cars. A comparison of the overall hospital length of stay for children injured by LTVs (6.7 ± 12.2 days) versus passenger car (3.9 ± 5.7 days) was not statistically significant (P = 0.16). No significant difference was found in the gender, age, height, or weight of hospitalized children backed over by passenger cars versus LTVs.

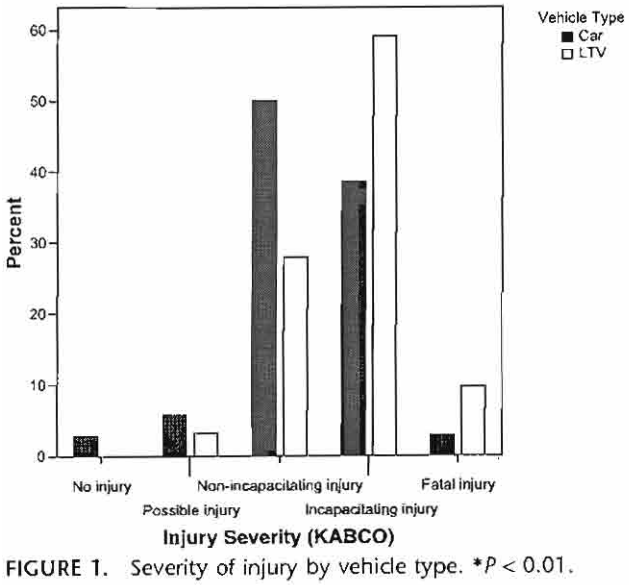

FIGURE 1. Severity of injury by vehicle type. *$P < 0.01$.

TABLE 2. Patient Characteristics and Hospital Outcomes by Vehicle Type

Variable	Passenger Car (n = 28)	LTV (n = 64)	P
Inpatient (%)	60.7	85.9	0.02
Male (%)	53.6	56.3	0.63
Mean age (years)	3.2 ± 1.5*	3.3 ± 2.0	0.79
Mean weight (kg)	16.8 ± 11.3	16.0 ± 7.8	0.88
Mean height (cm)	95.1 ± 13.4	91.9 ± 16.6	0.43
Hospital admit (%)	60.7	85.9	0.01
Surgery (%)	11.1	32.2	0.03
ICU Admit (%)	17.9	43.5	0.01
Mean NISS	11.7 ± 14.7	16.0 ± 14.9	0.08

*Standard deviation.

DISCUSSION

To the best of our knowledge, this study represents the first effort to estimate the relative risk of back-over injury to children associated with differing types of vehicles commonly found in driveways. Findings suggest that children are significantly more likely to be backed-over by a heavier, high-profile vehicle than by a passenger car. Our study also validates other studies indicating that children backed over in residential driveways by LTVs (pickup trucks, SUVs, minivans) are more severely injured when compared to injured children backed-over by passenger cars.[3,4,6]

Differences in the incidence of injury associated with vehicle types is particularly interesting because many anecdotal reports have suggested that attributes of high-profile vehicles may put children at greater risk of unintentional injury while traveling in the reverse direction.[26,27] Our subanalysis did not detect a significant increase in the number of back-over injuries due to classified SUVs compared with passenger cars. This lack of significance may be because of the fact that among the types of high-profile vehicles assessed, our classification of SUV may have represented the types of LTVs least likely to be owned by families with children.

The only 2 existing studies attempting to estimate the risk of back-over injuries to children associated with different types of vehicles were conducted in Australia and New Zealand.[8,12] Both studies report similar findings, a preponderance of back-over injuries associated with LTVs, whereas LTVs represented between 6% and 30% of registered vehicles. In our study, 57% of back-over injuries were because of LTVs, whereas 45% of registered vehicles in Utah, during the study period, were classified as LTVs. Differences in the proportion of registered vehicles compared to previously published work may relate to the increased pediatric population and preponderance of family, high-profile vehicles found in the state of Utah.

A recent study utilizing NIESS-AP data estimated that 3.02/100,000 children under the age of 10 are treated in US EDs annually for injuries resulting from vehicles traveling in the reverse direction.[7] Utilizing only cases presenting to the level-1 pediatric trauma center, we calculate an overall incidence of 4.01/100,000/year (95% CI = 3.33, 4.91). The risk of driveway back-over injuries in the state of Utah may be particularly high because the state contains the highest number of persons per household (mean = 3.06) and the youngest population in the United States, nearly 33% of residents are under the age of 18.[28] In addition, the popularity of "family-type" SUVs, minivans, and pickup trucks continues to increase in Utah, with 1 registered LTV for every 10 licensed drivers.[29]

We utilized a capture–recapture model to estimate the number of back-over injuries *not* documented in either of the 2 existing databases. Two-sample capture–recapture techniques assume that the population being estimated is closed (ie, constant over time) and the likelihood of ascertainment across samples is independent.[17] Authors point out that these assumptions are rarely satisfied when utilizing existing police and hospital records.[30] For example, one might surmise that police may be more likely to report a serious injury, which is more likely to present at the level-1 trauma center. Dependences of this nature will result in the capture–recapture model undercounting the true number of unascertained cases.[23]

There are a number of significant limitations to our study design that qualify the findings. The fact is we utilize the number of registered vehicles as proxy for child exposure to a vehicle. An indication of the weighty influence of this limitation may be apparent in the elevated injury incidence associated with minivans compared to trucks or SUVs in this study. One could intuitively surmise that minivans are more likely owned by families with children than owners of trucks or SUVs. The effect of this bias would be to underestimate the true injury incidence associated with vehicles less likely owned by families with children.

Second, as mentioned earlier, police personnel in the State of Utah are not required to file a report for nontraffic motor vehicle versus pedestrian collisions occurring on private property, again suggesting an underrepresentation of the actual number of back-over injuries occurring in residential driveways. There is, however, little reason to believe that reported and unreported back-over injuries would systematically differ by type of vehicle.

In conclusion, pediatric pedestrian injury due to back-over events in family driveways is a significant problem. Our study suggests that certain heavy, high-profile vehicles, such as trucks and minivans, pose an increased risk to children, demonstrating a significantly higher incidence and resulting in more severe injuries. Children injured by these vehicles are more likely to require admission to the hospital, ICU, care and surgery.

Injury prevention programs should specifically target the agent (parent driven motor vehicle), host (child), and environment (driveway, play rules) that interact to increase the risk of injury. Such prevention programs might be aimed at educating both parent drivers and young children of the dangers and low visibility in the driveway and by establishing rules for safe play around the home. Modifications to vehicles, such as extended mirrors or cameras, which increase rear visibility, along with interior audible warning signals, could increase awareness of the potential danger posed when children are behind vehicles and help prevent this increasingly important source of childhood trauma.

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REFERENCES

1. United States Department of Transportation, Bureau of Transportation Statistics. Pedestrian and Bicycle Safety. Transportation Statistics Annual Report. 1999;Chapter 4:1–4.
2. Winn DG, Agran PF, Castillo DN. Pedestrian injuries to children younger than 5 years of age. *Pediatrics*. 1991;88:776–782.
3. Silen ML, Kokoska ER, Fendya DG. Back-over injuries in residential driveways: age-related patterns of injury. *Pediatrics*. 1999;104: c7–e11.
4. Brison RJ, Widklund K, Mueller BA. Fatal pedestrian injuries to young children: a different pattern of injury. *Am J Public Health*. 1988;78: 793–795.
5. Centers for Disease Control and Prevention (CDC). Injuries and deaths among children left unattended in or around motor vehicles—United States, July 2000–June 2001. MMWR 2002;51:570–572.
6. Nadler EP, Courcoulas AP, Gardner MJ. Driveway injuries in children: risk factors, morbidity, and mortality. *Pediatric*. 2001;108:326–328.
7. Centers for Disease Control and Prevention. Nonfatal motor vehicle related back-over injuries among children, United States, 2001–2003. MMWR 2005;54:144–146.
8. Holland AJA, Liang RWY, Singh SJ, et al. Driveway motor vehicle injuries in children. *MJA*. 2000;173:192–195.
9. Agran PF, Castillo DN, Winn DG. Limitations of data compiled from police reports on pediatric pedestrian and bicycle motor vehicle events. *Accid Anal Prev*. 1990;22:361–370.
10. Mayr JM, Eder C, Wernig J, et al. Vehicles reversing or rolling backwards: an underestimated hazard. *Inj Prevention*. 2001;7:327–328.
11. Roberts I, Norton R, Jackson R. Driveway-related child pedestrian injuries: a case-control study. *Pediatrics*. 1995;95:405–408.
12. Murphy F, White S, Morreau P. Driveway-related MV injuries in the pediatric population: a preventable tragedy. *New Zealand J Med*. 2002; 115:23.
13. Patrick DA, Bernard DD, Moore EE, et al. Drive-way crush injuries in young children: a highly lethal, devastating, and potentially preventable event. *J Pediatr Surg*. 1998;33:1712–1715.
14. National Highway Traffic Safety Administration. Model Minimum Uniform Crash Criteria. U.S. Department of Transportation, National Highway Traffic Safety Administration; August 2002.
15. Polk RL. Automotive intelligence. National Vehicle Population Profile. Car and light truck segment, State of Utah, 1998–2003.
16. Osler T, Baker SP, Long W. A modification of the injury severity score that both improves accuracy and simplifies scoring. *J Trauma*. 1997; 43:922–925.
17. Hook EB, Regal RR. The value of capture-recapture methods even for apparent exhaustive surveys. *Am J Epidemiol*. 1992;135:1060–1067.
18. Chiu WT, Dearwater SR, McCarty DJ, et al. Establishment of accurate incidence rates for head and spinal cord injuries in developing and developed countries: a capture-recapture approach. *J Trauma*. 1993;35: 206–211.

AQ3
19. Myocardial infarction.
20. LaPorte RE, McCarty D, Bruno G, et al. Counting diabetes in the next millennium. Application of capture-recapture technology. *Diabetes Care*. 2001;16:528–534.
21. Tilling K, Sterne JAC, Wolfe CDA. Estimation of the incidence of stroke using a capture-recapture model including covariates. *Inter J Epidemiol*. 2001;30:1351–1359.
22. Martin DO, Austin H. An efficient program for computing conditional maximum likelihood estimates and exact confidence limits for a common odds ratio. *Epidemiology*. 1991;2:359–362.
23. Martin DO, Austin H. Exact estimates for a rate ratio. *Epidemiology*. 1996;7:29–33.
24. Sahai H, Kurshid A. Statistics in Epidemiology: Methods, Techniques and Applications. CRC Press; 1996.
AQ4
25. Hook EB, Regal RR. Effect of variation in probability of ascertainment by sources ("variable catchability") upon capture-recapture estimates of prevalence.
AQ5
26. Consumer Reports. Driving Blind. October, 2003:23–25.
27. Consumer Reports. The problem of blind spots: The area behind your vehicle can be a killing zone. Available at: www.kidsandcars.org.
28. 2000 United States Census. Population Estimates Program, Population Division, U.S. Census Bureau, Washington, DC. Available at: http://www.census.gov.
29. Vehicle Inventory and Use Survey. U.S. Census Bureau, Federal Highway Administration, U.S. Department of Transportation.
AQ6
30. Jarvis SN, Lowe PJ, Avery A, et al. Children are not goldfish: mark/recapture techniques and their application to injury data. *Inj Prevention*. 2000;6:46–50.