Validation of a parent survey for reporting child injuries

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ABSTRACT

Objective To evaluate the validity of a parent-reported survey to identify children's moderate and serious injuries in seven specific body regions using medical records as the 'gold standard'.

Methods A prospective validation study was conducted in three urban paediatric emergency departments (EDs). 798 parents of 859 children treated for injuries at participating EDs between August 2010 and July 2011 completed either a telephone interview or self-administered paper survey at 2 weeks post-ED visit. Parents were asked to report child injuries to seven body regions: head, face, neck/spine/back, thorax, abdomen, upper extremities and lower extremities. Injury data were abstracted from medical records using a standardised protocol. Body region injury severity levels of none/minor, moderate or serious were assigned to each subject based on the Abbreviated Injury Scale.

Results The overall sensitivity, reflecting parents' ability to identify a documented moderate or greater severity injury, was 0.95 (95% CI 0.92 to 0.97). Sensitivities were >0.90 for the face, upper extremity and lower extremity regions; 0.80–0.90 for head, abdomen and neck/back/spine regions; and <0.60 for the thorax region. The overall sensitivity for identification of a serious injury was 0.71 (0.60 to 0.80).

Conclusions This survey enables parents to accurately identify moderate and greater severity injuries to body regions, though it does not accurately identify serious injuries in most body regions except the extremities. The survey could serve as a screening tool to identify moderate and greater severity injuries in population-based surveillance systems, or as the primary outcome of interest in injury prevention studies.

INTRODUCTION

Despite many recent achievements, injury continues to be a leading cause of morbidity and mortality among children and adolescents.[1] Further progress in reducing the burden of injuries to children will require accurate, timely and cost-effective collection of information about the prevalence of injuries, ranging from minor to serious, and across diverse populations, as well as the ability to evaluate outcomes of injury prevention interventions.

Medical record abstraction is considered the 'gold standard' method of ascertaining accurate information about the nature and severity of injuries. For example, a detailed medical record review is required to classify injury severity according to the Abbreviated Injury Scale (AIS).[2] However, using medical record data in large-scale population-based studies may require the cooperation of multiple institutions, making this a time-consuming and costly process. Further, existing inpatient and emergency department (ED) hospital discharge data sources such as the Kids' Inpatient Database and Nationwide Emergency Department Sample,[3] which include information abstracted from medical records, are limited to children with more serious injuries requiring medical care.

A survey that enables parents to accurately characterise their child's injuries by body region and along a spectrum of severities may be a practical and cost-effective alternative to medical record abstraction. Several survey instruments for obtaining child injury information have been developed but have only been used in an interviewer-administered format,[4] administered to limited age groups[5 6] or lack sufficiently detailed information to enable specific assessments of injury severity in specific body regions.[4 7 8] Thus, the objective of this study was to evaluate a survey tool designed to collect accurate information from parents on the severity of their children's injuries to seven specific body regions through both telephone and self-administered formats. Specifically, we assessed the ability of parents to describe injuries with sufficient detail to enable identification of injuries, both overall and by body region, using two thresholds common to injury research: (1) moderate and greater severity injuries (in general, corresponding to an AIS severity score of 2 or greater) and (2) serious injuries (in general, corresponding to an AIS severity score of 3 or greater).

METHODS

Study design and sample

Recruitment of subjects for this prospective, multi-site validation study occurred in three geographically diverse, urban paediatric EDs between August 2010 and July 2011. Children presenting to the EDs up to 2 weeks after an injury were assessed by ED staff for eligibility. A child was eligible if he/she had a confirmed injury (excluding minor injuries such as skin contusions and small lacerations; and excluding suspected child abuse), had an English-speaking parent or legal guardian present, and was younger than 18 years of age. In addition, all children presenting to EDs who were passengers in motor vehicle crashes (MVCs), regardless of whether they had a confirmed injury, were eligible given our particular interest in administering this survey instrument to drivers involved in crashes with child passengers. Basic medical information, including ED disposition and source of injury (MVC or other mechanism), was collected and information on multiple children from a single family was collected as relevant. In general, children were recruited during the hours when

research staff was present in the ED (generally daily from 08:00 to midnight).

Upon a child's enrolment, information was sent to study staff at the coordinating site. The enrolled parent was then randomly assigned—using a block randomisation scheme (blocks of 10) created via random number generator—to receive either a self-administered paper survey by mail or a telephone interview. Up to two surveys were mailed (at 2 and 4 weeks after the ED visit), along with a self-addressed stamped envelope, to those allocated to the self-administered survey. For parents allocated to the telephone interview, we initiated contact at 2 weeks post-enrolment. We made up to six contact attempts, varying the day of the week and the time of day when calls were placed. Parents who did not respond to the survey via the mode initially assigned within 4 weeks were switched to the alternate mode and given an additional 4 weeks to respond. The number of contact attempts and time periods for survey distribution were chosen based on known extinguishing recall of injury details over time.[9 10] Figure 1 summarises the flow of enrolled subjects through the study.[11]

Medical record abstraction and injury scaling

ED and inpatient electronic medical records were accessed for each child whose parent completed the survey and abstracted using a standardised protocol. Abstraction data were collected using REDCap (Research Electronic Data Capture) hosted at the coordinating site.[12] A single investigator (MRZ) trained and certified in AIS coding reviewed the abstracted data and scaled all injuries using the most recent version of the AIS manual (AIS 2005 (Update 2008)).[2] Each injury was assigned a unique AIS identifier code based on its anatomy, body region (head, face, neck/back/spine, thorax, abdomen, upper extremity and lower extremity) and severity. Each body region was assigned an injury severity level of 'no/minor', 'moderate' or 'serious', defined as the maximum injury severity level for all injuries in that body region. Subsequently, an overall injury severity level was assigned to each patient, defined as the maximum injury severity level across all body regions. In general, we defined a moderate injury as an injury with an AIS severity score of 2. Additionally, facial fractures and concussions were considered moderate injuries. A serious injury was defined as an injury with an AIS severity score of 3 or greater. In addition, the following were also considered serious injuries: for the facial, thorax and abdomen regions, the presence of two or more moderate injuries; and for the abdomen region, documentation of surgery to repair any organs. All other injuries with an AIS 1 severity (eg, sprains, finger and toe fractures, lacerations, and skin contusions) were considered minor injuries.

Parent survey

The survey instrument is a substantially updated version of a prior telephone-based survey validated for similar use and applied in a large, 10-year study of over 34 000 children in MVCs.[4 13] Modifications from the original survey included updating classification of injury severity based on the most recent AIS Manual (AIS 2005 (Update 2008)), and the addition of questions or response choices that enabled characterisation of serious injuries in addition to those of moderate severity.[2] The survey was structured to collect information about injuries according to the seven aforementioned AIS body regions and to enable coding of a body region specific and overall injury severity level for each subject. Questions were developed regarding either specific injuries (eg, '*Did a doctor say (CHILD)'s skull was cracked or fractured?*') or treatment received by the injured child (eg, '*Did (CHILD) have surgery to fix any of the internal organs of the abdomen?*'). Injury severity (ie no/minor, moderate, serious) was defined using the same method as described above for injuries documented in the medical record. Basic demographic information was also collected, including child age and gender and parent age, gender, highest completed education, and race/ethnicity. The survey instrument is available from the authors.

Statistical analysis

Frequencies and percentages were used to summarise categorical variables, and p values were calculated using Pearson's χ^2 tests. Sensitivity (the probability the survey identifies a medically documented injury of a given severity threshold) and specificity (the probability the survey does not identify an injury when no medically documented injury exists) were estimated, along with exact 95% CIs using standard measures for proportions. For moderate or greater severity injuries, sensitivity and specificity were calculated both overall and by the aforementioned seven body regions. For serious injuries, sensitivity and specificity of the instrument were determined both overall and, due to a

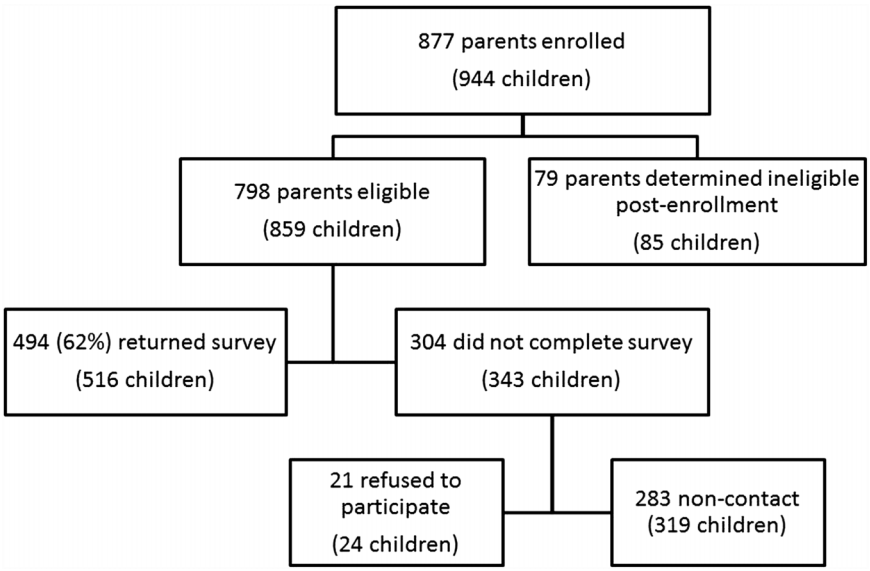

Figure 1 Flowchart of parent and child subjects through the study.

more limited sample size, for three large body region groups: head/face, trunk (thorax, abdomen and neck/spine/back) and extremities (upper and lower combined). For body region specific calculations of specificity, children classified as 'uninjured' according to the medical record included children who may have had an injury to another body region. For the overall calculation of specificity, only those subjects (n=112) who had no injuries to any body region were classified as uninjured (ie, children presenting after an MVC with no injury). All statistical analyses were conducted using SAS V.9.2 software (SAS Institute Inc., Cary, North Carolina, USA). This study was approved by each site's Institutional Review Board.

RESULTS

Response rates

Of the 798 eligible parents (859 children) enrolled in the study, 494 completed the survey (on behalf of 516 children) for an overall response rate of 61.9% (figure 1). Survey response rates were similar for subjects initially allocated to the telephone mode (63.4%) and self-administered survey (60.5%, p=0.41). Response rates among eligible subjects also did not differ by parent age and gender (p=0.08 and p=0.80, respectively) nor by the child's age (p=0.25) and gender (p=0.71). There was also no difference by child's ED disposition (discharged vs admitted vs other, p=0.14), which was used as a proxy for injury severity given that medical records were not abstracted for non-responders. Response rates did significantly vary across enrolling sites (site 1: 66.0%, site 2: 58.1%, site 3: 50.0%; p<0.01), by parent education (less than bachelor's degree: 53.4%, bachelor's degree or higher: 79.3%; p<0.01) and parent race/ethnicity (non-Hispanic Asian: 78.9%, non-Hispanic White: 72.1%, Hispanic: 57.8%, non-Hispanic Black: 51.4%; p<0.01).

Characteristics of survey respondents

Distributions of relevant parent- and child-level variables for those who responded to the survey are shown in tables 1 and 2, respectively.

Of parent respondents initially allocated to the telephone mode, 82.8% completed the survey using that mode, while 57.6% of those initially allocated to the self-administered survey completed the survey using that mode. The majority of respondents were female subjects and almost three-fourths were 25–44-years-old. In addition, over half were Non-Hispanic White and nearly half had their bachelor's degree. In all, 17 parents completed the survey for more than one child (13 for two children, three for three children and one for four children); all 39 children were involved in MVCs and only three (from different parents) had a confirmed moderate or greater severity injury. Of the 516 children whose parents completed the survey, most were boys and discharged home from the ED.

The median length of time between study enrolment and survey completion was 26 days (IQR: 17–41 days) for subjects initially allocated to telephone mode and 50 days (IQR: 35–65 days) for those allocated to the self-administered mode. Distributions were similar for children who had a moderate or greater severity injury (according to the medical record) and children with no or only minor injuries (median (IQR): 43 days (27–60 days) vs 36 days (24–59 days), respectively).

Validity of parent-reported injury severity

According to the medical record, 402 (77.9%) children had a moderate or greater severity injury and 82 (15.9%) had a serious injury (table 3).

Table 1 Frequency and proportions of select parent-level characteristics (n=494 parent respondents)

Characteristic	N	%
Study site		
Site 1	328	66.4
Site 2	111	22.5
Site 3	55	11.1
Initial survey mode allocation		
Telephone	244	49.4
Completed telephone	202	
Completed hardcopy	42	
Hardcopy	250	50.6
Completed hardcopy	144	
Completed telephone	106	
Age (years)		
Younger than 25	24	4.9
25–34	167	34.4
35–44	185	38.1
45–54	89	18.4
55 or older	20	4.1
Missing	9	
Gender		
Male	91	19.3
Female	380	80.7
Missing	23	
Highest completed level of education		
High school degree/GED or less	131	26.5
Some college or associate's degree	141	28.5
Bachelor's degree or higher	222	44.9
Race/ethnicity		
Non-Hispanic White	280	56.9
Non-Hispanic Black	167	33.9
Hispanic	29	5.9
Non-Hispanic Asian	11	2.2
Other	5	1.0
Missing	2	

GED certificate,General Educational Development certificate.

For the moderate or greater severity injury threshold, the overall sensitivity, reflecting the ability of parents to identify their child's injury, was 0.95 (95% CI 0.92 to 0.97) and the overall specificity 0.83 (0.75 to 0.89). The sensitivity and specificity for each AIS body region are also shown in table 2. Sensitivities were >0.90 for the face, upper extremity and lower extremity regions; between 0.80 and 0.90 for head, abdomen and neck/back/spine regions; and <0.60 for thorax region. All body region specific specificities were 0.95 or higher.

The estimated overall sensitivity for a moderate or greater severity injury was 0.95 for both survey modes, 0.93 or higher for each category of child age (<2, 2-3, 4-8, 9-12, and 13-17), and 0.90 or higher for all quartiles of time to survey completion (<24, 25–38, 39–59 and >59 days) and for all race/ethnicity groups. Estimates were 0.97 or above for parents with more than a high school education and slightly lower (0.88) for those with high school or less education.

For the serious injury threshold, the sensitivity of the survey instrument was 0.71 (0.60, 0.80). Sensitivities varied by body region groups: for both the head/face region (0.60 (0.46, 0.75)) and trunk region (0.39 (0.17, 0.64)) sensitivities were lower than those calculated at the moderate injury severity threshold, but the sensitivity was similar for serious extremity injuries

Table 2 Frequency and proportions of select child-level characteristics (n=516 child subjects)

Characteristic	N	%
Study site		
Site 1	336	65.1
Site 2	115	22.3
Site 3	65	12.6
Age at enrolment (years)		
Less than 2	76	14.8
2–3	63	12.3
4–8	129	25.1
9–12	78	15.2
13–17	167	32.6
Missing	3	
Gender		
Male	306	59.5
Female	208	40.5
Missing	2	
ED disposition		
Discharged home	345	68.9
Hospital admission	151	30.1
Expired in ED/other	5	1.0
Missing	15	

ED, emergency department.

(0.93 (0.76, 0.99)). For the serious injury threshold, the specificity of the survey instrument was 0.95 (0.92, 0.97), with body region specific specificities $\geq$0.98.

We investigated in more detail cases in which the parent did not report a moderate or greater severity injury that was documented in the medical record. Of the 13 children with a medically documented moderate or greater severity thorax injury, parents of nine children failed to report an injury to this region (five lung contusions, two pneumothoraces and two lung contusion with pneumothoraces). Two of 12 parents with a child with a moderate or greater severity injury to the neck, back or spine (one cervical and one thoracic spine fracture) did not report any injuries to this region. Finally, although a number of medically documented serious injuries were not identified by the survey's 'serious' threshold, there were only seven instances in which a serious injury was not detected by the survey's moderate or greater severity threshold (four head and three trunk), representing 8.5% of the 82 medically documented serious injuries.

DISCUSSION

Parents identified moderate or greater severity injuries to seven body regions of their children with a high degree of specificity and variable degree of sensitivity. The highest sensitivities (>0.90) were reported for injures to the face and upper and lower extremities, followed by the head, abdomen and neck/back/spine regions; parents' ability to report injuries in the thorax was substantially lower. In addition, while parents generally identified serious injuries when they were present, they were less able to characterise them as serious, with the exception of serious extremity fractures. Of note, there was no evidence that accuracy of reporting varied by length of time to complete the survey or by mode of survey administration, though our findings suggest that parents prefer the telephone mode and complete the survey faster via telephone.

Our findings extend the results of prior studies evaluating the ability of parents to recall child injury information. In the validation study for the original survey upon which our instrument was based, Durbin *et al*[4] found that parents of children age <16 years could accurately identify injuries of at least moderate severity to three large body region groupings. However, the previous study was limited to a single hospital and used only telephone data collection. Several additional studies focusing on children less than 6-years-old evaluated parent recall of overall injuries and noted declining accuracy with increasing severity of injury or increasing time from injury.[5 6] In the current study, there was no evidence for variation in the accuracy of parent reporting by length of time to survey completion. The larger sample size of the current study also established parents' ability to accurately describe moderate or greater severity injuries to several specific body regions, and established the limits of

Table 3 Validity of parent-reported moderate and serious injury compared with abbreviated injury scale codes based on medical record data

	Parent-reported moderate or serious injury				Parent-reported serious injury			
	Injury in medical record	Sensitivity (95% CI)	No injury in medical record	Specificity (95% CI)	Injury in medical record	Sensitivity (95% CI)	No injury in medical record	Specificity (95% CI)
Overall	402	0.95 (0.92 to 0.97)	112	0.83 (0.75 to 0.89)	82	0.71 (0.60 to 0.80)	432	0.95 (0.92 to 0.97)
Head/face region*	170	0.94 (0.89 to 0.97)	342	0.97 (0.95 to 0.99)	43	0.60 (0.46 to 0.75)	469	0.98 (0.96 to 0.99)
Head	151	0.88 (0.82 to 0.93)	361	0.97 (0.94 to 0.98)	39			
Face	31	0.97 (0.83 to 1.00)	485	0.98 (0.97 to 0.99)	4			
Trunk region*	34	0.74 (0.56 to 0.88)	482	0.98 (0.96 to 0.99)	18	0.39 (0.17 to 0.64)	498	0.99 (0.98 to 1.00)
Thorax	13	0.54 (0.25 to 0.82)	500	1.00 (0.99 to 1.00)	8			
Abdomen	14	0.86 (0.57 to 0.98)	502	0.98 (0.97 to 0.99)	8			
Neck/back/spine	12	0.83 (0.52 to 0.98)	504	0.99 (0.98 to 1.00)	4			
Extremities*	224	0.94 (0.90 to 0.97)	292	0.97 (0.94 to 0.99)	27	0.93 (0.76 to 0.99)	489	0.98 (0.96 to 0.99)
Upper extremity	129	0.92 (0.86 to 0.96)	384	0.98 (0.97 to 0.99)	1			
Lower extremity	98	0.95 (0.88 to 0.98)	418	0.99 (0.97 to 0.99)	27			

*The total number of injuries for a given larger body region group (head/face, trunk, extremities) does not necessarily equal the sum of the number injured in specific body regions due to subjects possibly having injuries in more than one body region.

parents' ability to characterise serious injuries with the exception of serious extremity injuries.

There are limitations worth noting, both of the study and the survey instrument. Estimated sensitivities and specificities in some body regions (eg, thorax) have relatively wide CIs due to small samples. Non-English speakers were ineligible and generalisation of study results to this population is likely limited. Although response rates were lower for some parent education, ethnicity and study site—possibly affecting generalisability—the overall sensitivity for reporting a moderate or greater severity injury was high for all racial/ethnic, education groups and study sites. Our detailed investigation of discordant cases revealed that there were two primary limitations of the survey itself. First, the survey demonstrated relatively low sensitivity for detecting thoracic injuries, with failure to detect a pulmonary contusion as the reason in most discordant cases. Medical record review indicated that these injuries, although classified by the AIS system as moderate or serious in nature, were small in size and did not require specific therapeutic intervention that might have served as a reminder to the parent that the injury occurred. In addition, many of the children with unreported pulmonary contusions had injuries in multiple other body regions, suggesting that caregivers may not report these injuries if the child has more serious concurrent injuries. Despite the relatively lower clinical significance of these injuries, they may still be important to detect in surveillance systems such as MVC databases, since they may indicate an important mechanism of injury for biomechanical investigation. We have identified several modifications to the survey we hope will improve the sensitivity for harder-to-capture injuries, including the addition of specific phrases that might have been used by healthcare providers and be more recognisable to parents (eg 'bruised lung' to indicate lung contusion). The second limitation of the survey was that, for certain injuries, the survey could detect the presence of the injury but could not characterise it as a serious, as opposed to a moderate, severity injury. For example, among the 51 children who had a skull fracture documented in the medical record, the survey identified 46 (90.2%) of them. However, the survey was not able to distinguish a fracture of the base of the skull—typically AIS 3 severity—from a fracture of the vault, most of which are AIS 2 severity. The level of detail necessary to distinguish between these thresholds is particularly challenging to discern from a survey, and is ultimately dependent on the extent to which healthcare providers effectively communicate such injuries to parents.

Given the test characteristics of this instrument, we recommend several potential applications in injury prevention research. First, the survey may serve as an effective screening tool to identify children with a moderate or greater severity injury from a large population-based surveillance system such as the National Automotive Sampling System-General Estimates System (NASS-GES), operated by the National Highway Traffic Safety Administration (NHTSA).[14] NASS-GES is one of NHTSA's primary means of monitoring traffic safety in the USA. It relies on data from police accident reports abstracted from a representative sample of police-reported crashes occurring on US public roadways. While containing a large number of children, the police accident reports do not have sufficiently reliable and detailed information to identify injured children, limiting its utility as a tool for child passenger safety research. The currently evaluated survey could be used as a means of collecting supplemental child information on a sample of cases that would enable the identification of children with moderate or greater severity injuries to undergo more detailed and costly data collection as needed. When applied to a broad population of children in MVCs (the majority of whom will be uninjured and will not seek medical attention), the survey's overall specificity is likely to be higher than the 0.83 reported in this study (which was limited to children with no/minor injuries who presented to an ED). A second application of the survey is to serve as the primary mechanism of determining injury outcomes, either overall or body region specific, in targeted evaluations of injury prevention interventions, obviating the need for costly and time-consuming medical record review. Given the lower performance of the instrument for detecting serious injuries (with the exception of extremity fractures), we would not recommend use of the survey for primary outcome determination of serious injuries.

What is already known on the subject

- Injury continues to be a leading cause of morbidity and mortality among children and adolescents.
- While medical records provide detailed information on the nature and severity of paediatric injuries, abstraction is costly, time intensive and challenging to implement for large populations.
- A survey that allows parents to identify children's injuries would be an important tool for injury screening and prevention efforts.

What this study adds

- A bi-modal (telephone-administered and mailed hard copy) survey enabled parents to identify their children's moderate or greater severity injuries to several body regions with high sensitivity and specificity.
- Parents identified the presence of most serious injuries, but were less able to characterise them as serious (with the exception of extremity injuries).
- This survey may be a useful tool for surveillance to identify children with moderate or greater severity injuries to undergo more detailed and costly data collection, or as a study outcome measure to determine injury outcomes for targeted injury prevention programmes.

CONCLUSIONS

This instrument enables parents to accurately characterise their child's injuries by body region and to accurately identify moderate or greater severity injuries by either phone or a self-administered survey. Whether used as a tool to assess primary outcomes of injury prevention efforts or a screening instrument in existing surveillance systems, this survey may be particularly valuable in a wide range of paediatric injury prevention research.

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Competing interests None.

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Collaborators Milwaukee Children's Hospital, University of California-Davis

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