METHODOLOGIC ISSUES

Child bicyclist injuries: are we obtaining enough information in the emergency department chart?

E K Moll, A J Donoghue, E R Alpern, J Kleppel, D R Durbin, F K Winston

Injury Prevention 2002;8:165–169

See end of article for authors' affiliations

Correspondence to:
Dr Flaura K Winston, The Children's Hospital of Philadelphia, 34th Street and Civic Center Boulevard, 3535 TraumaLink, 10th Floor, Philadelphia, PA 19104, USA;
flaura@mail.med.upenn.edu

Objective: The purpose of this study was to assess the range of information relevant to bicyclist injury research that is available on routinely completed emergency department medical records.

Methods: A retrospective chart review of emergency department medical records was conducted on children who were injured as bicyclists and treated at an urban level I pediatric trauma center. A range of variables relevant to bicyclist injury research and prevention was developed and organized according to the Haddon matrix. Routinely completed free text emergency department medical records were assessed for the presence of each of the targeted elements. In addition, medical records of seriously injured patients (for whom a more structured medical record is routinely used) were compared to free form records of less seriously injured patients to identify differences in documentation that may be related to the structure of the medical record.

Results: Information related to previous medical history (96% of records), diagnosis (89%), documentation of pre-hospital care (82%), and child traumatic contact points (81%) were documented in the majority of medical records. Information relevant to prevention efforts was less commonly documented: identification of motor vehicle/object involved in crash (58%), the precipitating event (24%), the location of the crash (23%), and documentation of helmet use (23%). Records of seriously injured patients demonstrated significantly higher documentation rates for pre-hospital care and child traumatic contact points, and significantly lower documentation rates for previous medical history, child kinematics, main body parts impacted, and location of injury event.

Conclusions: Routinely completed free text emergency department medical records contain limited information that could be used by injury researchers in effective surveillance. In particular information relating to the circumstances of the crash event that might be used to design or target prevention efforts is typically lacking. Routine use of more structured medical records has the potential to improve documentation of key information.

Bicyclist injury remains one of the leading causes of death and acquired disability for children in the United States.¹ In 1998, nearly 362 000 child bicyclists sought care for injuries in emergency departments in the United States.² Effective sources of surveillance data on bicyclist injuries are not easily available. Police accident reports and hospital trauma registries are often used to track injury trends, but many bicyclist injuries are not reported to police,³ and the minority of children treated in the emergency department for bicycle related injuries are admitted to the hospital.³ The emergency department has been identified as a crucial site for

identifying new and emerging trends in injury⁴ and has long been a source for injury surveillance for the United States Consumer Product Safety Commission (CPSC).⁵ Therefore, the emergency department medical record is a potentially ideal source for surveillance information on bicyclist, as well as other types of injuries.

Advisory groups from the National Center for Injury Prevention and Control and the American Academy of Pediatrics have called for the prospective, standardized collection of key clinical data elements for patients in the emergency department.^{5–6} Government agencies, such as the Centers for

Table 1 Listing of data elements, categorized according to the Haddon matrix

	Child	Bicycle (agent of injury)	Environment
Pre-event	<ul style="list-style-type: none"> Previous medical history Previous injury history Previous riding experience Risk taking behavior Precipitating event Conspicuity of child (clothing, reflectors, etc) 	<ul style="list-style-type: none"> Bicycle condition Fit of bicycle to child Conspicuity of bicycle (reflectors) Type of bicycle 	<ul style="list-style-type: none"> Condition of road/traffic Where child was biking Street type Exact address of incident
Event	<ul style="list-style-type: none"> Main body parts impacted Indication of protective device used Crash type Kinematics of child (how child moved upon impact) Child traumatic contact points 	<ul style="list-style-type: none"> Bicycle speed Bicycle part impacted 	<ul style="list-style-type: none"> Surface landed on Motor vehicle/object involved? Motor vehicle/object description Motor vehicle/object speed
Post-event	<ul style="list-style-type: none"> Diagnosis Post-crash activity (child action after crash) 	<ul style="list-style-type: none"> Damage to bicycle Description of damage 	<ul style="list-style-type: none"> Pre-hospital care Description of pre-hospital care

Table 2 Frequency of documentation of trauma history elements and 95% confidence interval (* indicates one sided 97.5% confidence interval)

Haddon matrix cell	Element	Completion frequency (%)
Pre-event/child	Previous medical history	96 (93 to 98)
	Precipitating event	24 (19 to 30)
	Previous riding experience	7 (4 to 10)
	Previous injury history	4 (2 to 7)
	Risk taking behavior	0 (0 to 0.01)*
	Conspicuity of child	0 (0 to 0.01)*
Pre-event/bicycle	Type of bicycle	1 (0.2 to 3)
	Bicycle condition	0.4 (0 to 2)
	Conspicuity of bicycle	0 (0 to 0.01)*
	Fit of bicycle to child	0 (0 to 0.01)*
Pre-event/environment	Exact address of incident	23 (18 to 28)
	Where child was biking	4 (2 to 7)
	Street type	1 (0 to 3)
	Condition of road/traffic	0 (0 to 0.01)*
Event/child	Child traumatic contact points	81 (76 to 85)
	Main body part impacted	63 (57 to 69)
	Kinematics of child	49 (43 to 55)
	Indication of protective device used	23 (18 to 28)
	Crash type	1 (0.5 to 4)
Event/bicycle	Bicycle part impacted	5 (2 to 8)
	Bicycle speed	1 (0 to 3)
Event/environment	Indication of motor vehicle/object involvement	58 (52 to 64)
	Motor vehicle/object speed	15 (11 to 19)
	Motor vehicle/object description	1 (0.4 to 4)
	Surface landed on	0 (0 to 0.01)*
Post-event/child	Diagnosis	89 (85 to 93)
	Post-crash activity	23 (18 to 29)
Post-event/bicycle	Indication of damage to bicycle	2 (1 to 5)
	Description of damage	0.4 (0 to 2)
Post-event/environment	Indication of pre-hospital care	82 (76 to 86)
	Description of pre-hospital care	27 (22 to 33)

Disease Control and Prevention, have recognized the importance of emergency department surveillance of traumatic injuries and have published recommendations for data elements to be obtained on emergency department patients for these conditions.⁷ As more programs are utilizing information from the emergency department medical record to design and evaluate injury prevention programs,⁸ it is important to assess the information present in routinely completed emergency department medical records. The purpose of this study was to assess the range of information potentially relevant to the prevention of bicyclist injuries that is routinely documented on a free text emergency department medical record. In addition, we sought to explore potential benefits associated with the use of a more structured medical record by determining differences in patterns of documentation between free text and structured medical records.

METHODS

Experts in medicine, engineering, crash investigation, injury surveillance, and epidemiology generated a comprehensive listing of 31 data elements relevant to bicyclist injury research and prevention that could likely be reported by history. This expert group, which included the authors and experts from the United States CPSC, used the Haddon matrix⁹ to categorize the various elements identified. The Haddon matrix is a public health tool designed for the development of injury countermeasures and includes nine cells that divide the time sequence of an event into three stages (pre-event, event, and

post-event) and the principal factors of the injury into three components (the agent of injury, the person, and the environment). The 31 elements identified were categorized into the nine Haddon matrix cells as demonstrated in table 1.

A retrospective chart review was conducted on emergency department records of children ages 5–18 years who sought care for bicycle related injuries in the emergency department of an urban level one pediatric trauma center between March 1995 and July 1998. This center serves as the primary source of emergency medical care for children of west and southwest Philadelphia, a predominantly poor, minority population. In addition, it is a major referral center for children from southeastern Pennsylvania and southern New Jersey. Cases were identified through an existing emergency department based injury surveillance system that utilized surveys of pre-hospital care providers and children to obtain information regarding the circumstances of injury.¹⁰ Participants were enrolled in accordance with a study protocol approved by the Institutional Review Board of the hospital.

Components of the emergency department based medical record that were reviewed included all physician and nursing notes, triage sheets, and, if applicable to the case, semistructured trauma team evaluations and inter-hospital transport team records. The semistructured evaluation forms include prompts for information such as previous medical history, pre-hospital care information, mechanism of injury, and exact location of injury. For each emergency department medical record, the documentation was reviewed for information on the 31 elements and the presence or absence of each element

Table 3 Overall completion rates with 95% confidence interval for each ideal trauma history cell

	Child (%)	Bike (%)	Environment (%)
Pre-event	22 (20 to 24)	0.4 (0.1 to 1)	7 (6 to 9)
Event	43 (41 to 46)	3 (1 to 4)	19 (16 to 21)
Post-event	56 (52 to 61)	1 (0.5 to 3)	54 (50 to 59)

was determined. In order to ensure consistency in determining the documentation of elements, one clinician/researcher (AD) abstracted all of the records. Another researcher with experience in medical record coding (EM) independently reviewed 20% of the records in order to ensure the reliability of data abstraction.

The proportion (with 95% confidence intervals) of medical records that had documented information was determined for each of the 31 data elements. Analyses were conducted on an individual element level and as grouped in each of the cells of the Haddon matrix. A consecutive sample of at least 260 cases was necessary to estimate 95% confidence intervals of $\pm 3\%$ to 6% on point estimates of data completion ranging from 10%–50%.

In addition, medical records of seriously injured children for whom the trauma team was alerted ("trauma-stat") were compared to records of children who were not trauma-stat patients. Differences in documentation patterns were assessed using the χ^2 or exact test as indicated.

RESULTS

Altogether 278 cases of injured child bicyclists were identified from March 1995 to July 1998. The study sample was identified from a cohort of injured pediatric bicyclists who were 74% male and 74% African-American. The study sample included a range of injury severity with over 25% of children having sustained clinically significant injuries (maximum abbreviated injury scale score ≥ 2) and 29% were admitted to the hospital from the emergency department. A total of 268 of 278 records assessed had all components of the emergency department medical record [triage sheet, nurse notes, physician notes, trauma evaluation sheets (for trauma-stat patients only), and interhospital transfer records (if child was transferred from another hospital)] available for review. The assessment of inter-rater reliability of the medical record abstraction revealed excellent overall agreement (88% agreement, $\kappa = 0.71$, $p < 0.0001$). The majority of 31 elements (96%) had $>80\%$ agreement as to whether the element was documented or not. Only 24 of the 31 categories had sufficient variability to calculate the κ statistic. Of those elements with sufficient variability, 63% had a κ indicating moderate or better

agreement ($\kappa \geq 0.4$). All of those elements with $\kappa < 0.4$, however did have $>80\%$ agreement.

Element level analysis

The proportion of medical records containing each of the 31 targeted data elements is presented in table 2. Elements most commonly documented (present in over 80% of records) included: previous medical history, diagnosis, indication as to whether pre-hospital care was given, and child traumatic contact points (documentation of minor injuries—for example, an abdominal wall contusion, that may provide insight into the mechanism of more serious injuries—for example, a handlebar related liver laceration). Of note, several elements that would be considered central to effective injury surveillance were not routinely documented. These included identification of motor vehicle/object involved in crash (58%), the precipitating event (24%), the location of the crash (23%), and documentation of helmet use (23%). Several of the elements were not present in any records at all (risk taking behavior of child, conspicuity of child, conspicuity of bike, fit of bike for child, condition of the road, and surface the child landed on after the crash).

Haddon cell groupings

Table 3 further presents the per cent completion rates of data elements grouped by Haddon matrix cell. Overall, the Haddon matrix cells with the highest completion rates were the post-event/child information (56%) and the post-event/environmental information (54%). Pre-event/child information was present 22% of the time. Cells pertaining to bicycle characteristics were not well documented ($\leq 3\%$) in any time phase of the matrix.

Trauma-stat patients

Records of trauma-stat patients ($n = 41$) demonstrated significantly better ($p < 0.05$) completion rates for documentation of pre-hospital care, description of pre-hospital care and child traumatic contact points. Records of trauma-stat patients demonstrated significantly worse ($p < 0.05$) completion rates for documentation of previous medical history, child kinematics, main body parts impacted, and exact address of the incident (table 4). All other data elements had similar documentation rates between the trauma-stat and non-trauma-stat groups.

DISCUSSION

While the emergency department is uniquely positioned as a source of injury surveillance data, this study demonstrated that medical records routinely completed during the care of children after bicyclist trauma frequently lacked information that is important to injury surveillance and prevention efforts. Because the primary purpose of the medical record is to document care of the patient, documentation of more medically

Table 4 Elements in the ideal trauma history that were significantly different for trauma-stat ($n=41$) patients versus non-trauma-stat patients ($n=227$)

Ideal trauma history element	Trauma-stat completion frequency (%)	Non-trauma-stat completion frequency (%)	p Value
Trauma-stat records less complete			
Previous medical history	85 (71 to 94)	98 (95 to 99)	0.002
Exact address of incident	5 (0.6 to 17)	26 (21 to 32)	0.002
Kinematics	32 (18 to 48)	52 (45 to 59)	0.018
Main body parts impacted (on bike, ground, etc)	46 (31 to 63)	66 (60 to 72)	0.021
Trauma-stat records more complete			
Indication of pre-hospital care	93 (80 to 98)	80 (74 to 85)	0.05
Description of pre-hospital care	56 (40 to 72)	22 (17 to 28)	<0.001
Child traumatic contact points	95 (83 to 99)	78 (72 to 84)	0.009

relevant information was generally better than documentation of information regarding the location and circumstances of the event.

Previous emergency department based injury surveillance systems have relied on questionnaires or surveys in addition to the medical record to gather this type of data. However, these systems have been plagued by low inclusion rates, staff objections to increased workload, and bias in inclusion rates based on injury severity.¹¹⁻¹² These limitations commonly lead to a lack of sustainability in these surveillance systems.¹³ Use of the medical record as the primary source of surveillance data collection would alleviate many of these limitations and more effectively integrate data collection into the routine workings of the ED.

The documentation of selected trauma history elements improved with the use of the semistructured trauma flow sheet. One hypothesized reason for the increased frequency of some elements is that there are prompts posed on these semistructured forms that probe physicians and nurses to include this information on the record. For example, items such as motor vehicle involvement, bicycle helmet use, pre-hospital care, and child traumatic contact points are prompted for in the "trauma-stat" flow sheet. A previous study has shown formatted histories for emergency department visits were associated with higher physician satisfaction with the documentation process.¹⁴ A similar study of ambulatory care providers found that the structured medical record form improved provider performance and recording of the process of care.¹⁵ The decreased documentation of other elements may be inherent to the trauma-stat patient population. Often, parents of these more seriously injured children are not immediately available to provide a previous medical history or exact address of the incident. This possibility points to the need to link emergency department records of seriously injured children to inpatient medical data or trauma registries to complete the picture of the incident.

The data for this study were gathered by retrospective chart review, which limits our conclusions to the availability of written documentation. We do not know if a physician or nurse asked for the information but did not document it on the medical chart. However, injury surveillance and research is often done from chart abstraction and therefore any information asked but not documented is realistically inaccessible.

Previous research has demonstrated that injury circumstance information can be collected in an emergency department if its importance is highlighted. The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) was developed as a national injury surveillance system in order to assist in the identification of emerging hazards as well as provide information that is useful in developing injury prevention programs. Emergency department staff use specialized data collection forms to obtain information about the injury event. The emergency department medical record is also used to provide information for the surveillance system. Studies have used these data to identify injury risks and the data have also been used to assist in the development of prevention programs.¹⁶

Injury information collected in the emergency department is important not only to identify injury trends and hazards but also for designing and evaluating injury prevention programs. Information about the location of the crash, for example, could help community program developers to appropriately target injury prevention programs. In order to develop programs and evaluate their effectiveness in the community, a sustainable and reproducible system of routinely collected and standardized data on injury circumstances and modifiable factors leading to injury must be created. The use of a semistructured emergency department record could provide this important injury surveillance information for patients with a range of injuries from the most severe trauma patients

Key points

- The emergency department has been identified as an important site for injury surveillance.
- The emergency department medical record serves as a source of injury surveillance information for the United States CPSC National Electronic Injury Surveillance System.
- Current emergency department medical record documentation is insufficient to provide non-medical bicyclist injury surveillance data.
- Structured medical records encourage documentation and their expanded use should be explored in order to improve the quality of emergency department injury surveillance data.

to the patients with minor injuries. Information on the entire spectrum of injury would be valuable to learn more regarding how the circumstances of an injury event impact the resulting severity of the injury.

Future work should compare documentation on a semistructured emergency department medical record with a free form emergency department medical record on the entire spectrum of emergency department treated injuries in order to determine the ability of the medical record to serve the dual purpose of documentation of clinical care and collection of injury surveillance data. In addition, future studies should assess the collection of data relevant to other types of injury and in other hospitals, both trauma and non-trauma centers.

ACKNOWLEDGEMENTS

The authors would like to acknowledge and thank Allyson Kreshak and Douglas Holt for their work on the Injury Circumstance Evaluation study. We would like to thank The Children's Hospital of Philadelphia Emergency Department and TraumaLink: The Interdisciplinary Pediatric Injury Control Research Center for their support of this work. In addition, we would like to thank the Consumer Product Safety Commission personnel who assisted with creating the ideal trauma history.

This work was funded by in part by the Agency for Healthcare Research and Quality (formerly known as Agency for Healthcare Policy and Research) Grant number 5 U01 HD32828 as part of the Emergency Medical Services for Children Program and the Robert Wood Johnson Foundation as part of the Injury Free Coalition for Kids.

Portions of the paper were presented during a poster presentation at the American Academy of Pediatrics annual meeting in October 2000 in Chicago, IL.

Authors' affiliations

E K Moll, A J Donoghue, E R Alpern, D R Durbin, F K Winston, Department of Pediatrics, The Children's Hospital of Philadelphia, University of Pennsylvania School of Medicine, Philadelphia
J Kleppel, Department of Rehabilitative Medicine

REFERENCES

- 1 <http://www.nhtsa.dot.gov/people/ncsa/pdf/child98.pdf>. *Traffic safety facts 1998: children*. Washington, DC: National Highway Traffic Safety Administration, 1998.
- 2 <http://www.safekids.org/fact99/bike99.html>. *Bicycle injury*. Washington, DC: National SAFE KIDS Campaign, 1999.
- 3 **Stutts JC, Williamson JE, Whitley T, et al.** Bicycle accidents and injuries: a pilot study comparing hospital- and police-reported data. *Accid Anal Prev* 1990;**22**:67-78.
- 4 **Committee on Injury Prevention and Control.** *Reducing the burden of injury: advancing prevention and treatment*. Washington, DC: National Academy Press, 1999.
- 5 <http://www.cpsc.gov/cpscpub/pubs/3002.html>. *National Electronic Injury Surveillance System CPSC Document #3002*. Washington, DC: Consumer Product Safety Commission, 2000.
- 6 **Garrison HG, Runyan DW, Tintinalli JE, et al.** Emergency department surveillance: an examination of issues and a proposal for a national strategy. *Ann Emerg Med* 1994;**24**:849-56.

- 7 **National Center for Injury Prevention and Control: Data elements for emergency department systems**, release 1.0. Atlanta, GA. Centers for Disease Control and Prevention, 1997.
- 8 **Davidson LL**, Durkin MS, Kuhn L, *et al*. The impact of the Safe Kids/Health Neighborhoods Injury Prevention Program in Harlem, 1988 through 1991. *Am J Public Health* 1994;**84**:580–6.
- 9 **Baker S**, O'Neill B, Ginsburg M, *et al*. *The injury fact book*. 2nd Ed. New York, NY: Oxford University Press, 1992.
- 10 **Winston FK**, Shaw KN, Kreshak AA, *et al*. Hidden spears: handlebars as injury hazards to children. *Pediatrics* 1998;**102**:596–601.
- 11 **McClure RJ**, Burnside JL. The Australian capital territory injury surveillance and prevention project. *Acad Emerg Med* 1995;**2**:529–34.
- 12 **Stone DH**, Doraiswamy NV. The Canadian hospitals injury reporting and prevention program (CHIRPP) in the UK: a pilot study. *Inj Prev* 1996;**2**:47–51.
- 13 **Beattie TF**. An accident and emergency based child accident surveillance system: is it possible? *J Accid Emerg Med* 1996;**13**:116–18.
- 14 **Marill KA**, Gauharou ES, Nelson BK, *et al*. Prospective, randomized trial of template-assisted versus undirected written recording of physician records in the emergency department. *Ann Emerg Med* 1999;**33**:500–9.
- 15 **Duggan AK**, Starfield B, DeAngelis C. Structured encounter form: the impact on provider performance and recording of well-child care. *Pediatrics* 1990;**85**:104–13.
- 16 **Mackenzie SG**, Pless IB. CHIRPP: Canada's principal injury surveillance program. *Inj Prev* 1999;**5**:208–13.

BENCH>PRESS

New IP online submission and review system

The editor of *Injury Prevention* is pleased to inform authors and reviewers of its new online submission and review system. *Bench>Press* is a fully integrated electronic system which uses the internet to allow rapid and efficient submission of manuscripts, as well as the entire peer review process to be conducted online.

Authors can submit their manuscript in any standard word processing software. Graphic formats acceptable are: .jpg, .tiff, .gif, and .eps. Text and graphic files are automatically converted to PDF for ease of distribution and reviewing purposes. Authors are asked to approve their submission before it formally enters the reviewing process.

To access the system click on "SUBMIT YOUR MANUSCRIPT HERE" on the *Injury Prevention* homepage: <http://www.injuryprevention.com/>, or you can access *Bench>Press* directly at <http://submit-ip.bmjournals.com/>.

We are very excited with this new development and I would encourage authors and reviewers to use the online system where possible. It really is simple to use and should be a big improvement on the current peer review process. Full instructions can be found on *Bench>Press* <http://submit-ip.bmjournals.com/>, and *Injury Prevention online* at <http://www.injuryprevention.com/>. Please contact Natalie Davies, Project Manager, ndavies@bmjgroup.com for further information.

Pre-register!

We would be grateful if all *Injury Prevention* authors and reviewers pre-registered with the system. This will give you the opportunity to update your contact and expertise data, allowing us to provide you with a more efficient service.

Instructions for registering

1. Enter <http://submit-ip.bmjournals.com>.
2. Click on "Create a New Account" in the upper left hand side of the *Bench>Press* homepage.
3. Enter your email address in the space provided.
4. Please be sure to enter the email address where you received this email message. You will be given the opportunity to change this once you have created an account.
5. Choose a password for yourself and enter it in the spaces provided.
6. Complete the question of your choice to be used in the event you cannot remember your password at a later time.
7. Click on the "Save" button at the bottom of the screen.
8. Check the email account you registered under. An email will be sent to you with a verification number and URL.
9. Once you receive this verification number, click on the URL hyperlink and enter the verification number in the relevant field. This is for security reasons and to check that your account is not being used fraudulently.
10. Enter/amend your contact information, and update your expertise data.
11. Please note: You only need to create a new account once. If you submit to another BMJ Publishing Group journal you can use the same email address and password.