THE JOURNAL OF RURAL HEALTH

ORIGINAL ARTICLE

National Public Health Data Systems in the United States: Applications to Child Agricultural Injury Surveillance

Barbara Marlenga, PhD;[1] Richard L. Berg, MS;[2] & William Pickett, PhD[3]

1 National Children's Center for Rural and Agricultural Health and Safety, National Farm Medicine Center, Marshfield Clinic Research Institute, Marshfield, Wisconsin
2 Biomedical Informatics Research Center, Marshfield Clinic Research Institute, Marshfield, Wisconsin
3 Department of Public Health Sciences, Queen's University, Kingston, Ontario, Canada

Disclosures: The authors have indicated that they have no potential conflicts of interest or financial relationships relevant to this article to disclose.

Funding: This research was conducted with support from the Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health grant 2U54OH009568. Content reproduced from the National Highway Traffic Safety Administration, National Emergency Medical Services Information System Database remains the property of the National Highway Traffic Safety Administration. The National Highway Traffic Safety Administration is not responsible for any claims arising from works based on the original data, text, tables, or figures. Content reproduced from the Committee on Trauma, American College of Surgeons, National Trauma Data Bank applications remains the full and exclusive copyrighted property of the American College of Surgeons. The American College of Surgeons is not responsible for any ancillary or derivative works based on the original data, text, tables, or figures.

Acknowledgments: The authors wish to thank N. Clay Mann, Principal Investigator for the NEMSIS Technical Assistance Center, University of Utah, for his support and assistance with the National EMS Database, and Ashley Bergeron, MPH from the Wisconsin Department of Health Services for providing EMS narrative data and injury description data from the Wisconsin Trauma Registry.

For further information, contact: Barbara Marlenga, PhD, National Children's Center for Rural and Agricultural Health and Safety, Marshfield Clinic Research Institute, 1000 North Oak Avenue, Marshfield, WI 54449; e-mail: marlenga.barbara@mcrf.mfldclin.edu.

doi: 10.1111/jrh.12292

Abstract

Purpose: The United States has no comprehensive national surveillance system for fatal or nonfatal child agricultural injuries. Thus, important knowledge gaps exist about recurrent injury patterns that could provide targeted focus for prevention efforts. The purpose of this study was to explore existing US public health data systems to determine their utility with respect to informing child agricultural injury surveillance and primary prevention.

Methods: Public health data systems were selected if they: (1) were national in scope, (2) were active and ongoing, (3) included physical injuries, and (4) contained a "farm" location variable. Data systems explored included National Emergency Medical Services Information System, National Trauma Data Bank, National Electronic Injury Surveillance System-All Injury Program, and National Vital Statistics System-Multiple Cause File.

Findings: Each data system contained substantial information per case with the number of fields ranging from 77 to 127. Beyond basic demographic information about the injured child, there were many injury descriptors, but few commonalities across systems. The most striking finding was the uniform absence of information on injury circumstances; that is, *why* and *how* the injury occurred, which is fundamental to planning and evaluating prevention initiatives.

Conclusions: Although these public health data systems captured many details regarding medical aspects of the injury, they included little information on circumstances leading to injury, thus limiting their utility for child agricultural injury surveillance and primary prevention initiatives. We recommend any child agricultural injury data collection tool formally incorporate a structured narrative so underlying circumstances leading to injury events are documented.

Key words accidents, child/adolescent injury, farm injury, public health surveillance.

Childhood injuries that occur in agricultural settings represent a major public health problem in the United States[1,2] and other countries.[3,4] Primary prevention efforts aimed at minimizing the occurrence of these injuries and their traumatic consequences are best informed by evidence derived from ongoing injury surveillance programs. However, in the United States there is no comprehensive and coordinated national surveillance system for fatal and nonfatal child agricultural injuries, and in most cases there are no mandatory requirements for the reporting of these injury events. What we know about child agricultural injuries and fatalities at a national level comes from periodic injury surveys,[5] periodic analyses of young worker fatalities,[6] and infrequent reviews of death certificate data.[7] These periodic analyses provide snapshots of injury counts and basic information on injury types, but limited information on the etiology and consequences of child agricultural injuries. Such information is essential to the planning of targeted interventions aimed at leading injury prevention priorities, and it is a fundamental component of more general injury prevention initiatives.[8] This has led to important gaps in evidence about leading causes of child agricultural injury and their immediate- and longer-term consequences, thus hindering primary, secondary, and tertiary prevention efforts.

In 2015, the National Institute for Occupational Safety and Health (NIOSH), the primary source of these periodic analyses, suspended its national injury surveillance efforts in agriculture, making this public health gap potentially even more substantial.[9] NIOSH simultaneously requested public input to explore new strategies for conducting injury surveillance that are more efficient and cost-effective.[9] In response, we developed a study to systematically examine possible options for the routine surveillance of agricultural injuries in children in the United States. The purpose of this study was to explore the most promising public health data systems to determine how these existing systems can help fill gaps by identifying injury events missed by other methods and/or providing more details about risks, activities, and circumstances surrounding child agricultural injury events. This information, in turn, can help guide primary prevention efforts. Primary prevention is defined as preventing an injury event from occurring by reducing or eliminating the exposure, or through the use of protective equipment.[10] Our focus is on children aged 0-17 years.

Methods

Selection of Public Health Data Systems

Public health data systems that could potentially be applied to surveillance of child agricultural injuries were initially identified from expert review[11] and through discussions with epidemiologists working with the NIOSH Childhood Agricultural Injury Prevention Initiative. From these recommendations, public health data systems were selected if they: (1) were national in scope, (2) were active and ongoing, (3) included physical injuries, and (4) contained a "farm" location variable. See Table 1 for a list and description of the 4 public health data systems we believed were most promising. The data systems included the National Emergency Medical Services Information System (NEMSIS),[12] the National Trauma Data Bank (NTDB),[13] the National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP),[14] and the National Vital Statistics System-Multiple Cause File (NVSS).[15] For this report, we included data for calendar years 2009 and 2012 from each source; 2012 was the most recent year available across all sources when the study began (2014), and 2009 (also available for all sources) provides some longitudinal perspective. After initial review of national data sets, we obtained emergency medical services (EMS) and trauma registry narratives from the State of Wisconsin to determine what additional details might be contained in state data. For this specific purpose, we requested the most recent years available (2012 and 2013).

Procedures

The study protocol was reviewed and approved by the Marshfield Clinic Research Institute, Institutional Review Board. Data use agreements and permissions were secured as required.

NEMSIS

Data sets, along with codebooks and other documentation, were obtained free of charge from the NEMSIS technical assistance center after a data use agreement was secured.[12] The field "Incident Location Type" was used to identify incidents coded as "Farm." We worked closely with the principal investigator of NEMSIS to understand nuances in these data, and with his input, we developed an algorithm (available upon request) to identify traumatic injuries among farm children. Narrative data were only available at the state level, so after signing a data use agreement with the State of Wisconsin Division of Public Health, we obtained EMS narratives.

NTDB

Data sets, codebooks, and other documentation were purchased from NTDB through the American College of Surgeons after a data use agreement was signed.[13] All

Table 1 Description of Public Health Data Systems Used in This Study

Public Health Data Systems	Description
NEMSIS[12]	Ambulance run data are collected using nationally standardized data elements and entered into a central repository. Currently, 49 states contribute data to the repository and case-level data can be obtained going back as far as 2006. Participation is voluntary, and as such, NEMSIS data represent a convenience sample, not a fully population-based resource.
NTDB[13]	The largest aggregation of US trauma registry data. It includes trauma cases with clearly defined injury diagnostic codes that resulted in hospital admission, hospital transfer, or death. Participation is voluntary, and as such, NTDB data represent a convenience sample, not a fully population-based resource.
NEISS-AIP[14]	Data are collected on all nonfatal injuries and poisonings treated in US hospital emergency departments whether or not it was associated with consumer products. The hospitals (n = 66) are a stratified probability sample of all US hospitals that have at least 6 beds and provide 24-hour emergency department services. The hospitals include urban, suburban, rural, and children's hospitals. The sample, as designed, can be used to obtain national estimates of injury incidence.
NVSS[15]	Complete count of all deaths in the United States. Select data are submitted from state vital statistics offices to be merged into a national file.

cases represented injury events, and farm injuries were identified using ICD-9, E-code 849.1 "place of occurrence, farm." Narrative data were only available at the state level, so after securing a data use agreement with the State of Wisconsin Division of Public Health, we obtained trauma registry narratives.

NEISS-AIP

The NEISS-AIP public use data files and codebook were downloaded from its website.[14] All cases represented injury. The field "Locale where Injured" was used to identify incidents coded as "Farm." We communicated with the NEISS-AIP principal investigator regarding injury narratives that were mentioned in the codebook but were not in the data files. Unfortunately, the narratives were not available because of nondisclosure rules agreed upon by all federal participants who fund the NEISS-AIP system.

NVSS

The NVSS public use data files and codebook were downloaded from its website.[15] For NVSS, the "Place of Injury" field was used to identify injuries and to subset those where place was coded as "Farm."

Data Analyses

The analyses for this study are descriptive, and we present summaries of case numbers and basic demographics. The location codes used to identify farm cases were available for about 90% of NEMSIS and NTDB cases but only about 70% of NEISS-AIP and NVSS cases (data not shown). Simple statistics are presented without weighting or adjustment for missing farm location codes. The state of Wisconsin trauma and EMS narratives were reviewed systematically for details of the injury circumstances.

For our purposes here, we do not make comparisons among data sources or across time. As obtained, only 2 of the data systems allow fully population-based estimates (NEISS-AIP and NVSS),[14,15] while the other 2 depend on voluntary participation (NEMSIS and NTDB).[12,13] Furthermore, there are differences in injury definition, which may be important to resolve in studies that pool or compare data across sources. For example, NTDB does not include poisoning as an injury, while the other data sources do.

Results

Table 2 shows the total number of records in each data set for the years 2009 and 2012, the total number of children aged 0-17 years, and the number of child farm injuries. The NTDB contained the largest numbers of child farm injury cases (746 total), and NVSS had the fewest (70 total). Each of the data systems included substantial information on each case, with the number of coded fields ranging from about 77 (NEISS-AIP) to 127 (NTDB).

The demographics of child farm injury cases by data system are shown in Table 3. In general, the largest percentage of injured farm children were 0-6 years old, male, white, and not Hispanic/Latino.

Beyond demographics, the 4 data systems included a wide variety of injury descriptors, but there were few commonalities across systems. Figure 1 summarizes the presence or absence of basic data elements for child agricultural injury surveillance and primary prevention by data system. The most striking finding was the uniform absence of information on the circumstances of injury. The data systems included a great deal of information

Figure 1 Availability of Basic Data Elements for Child Agricultural Injury Surveillance and Primary Prevention across Public Health Data Systems.

	NEMSIS	NTDB	NEISS-AIP	NVSS
Data Element				
Who was injured?				
Age	X	X	X	X
Gender	X	X	X	X
Relationship to farm owner				
When did it happen?				
Date (month, day, year)	Month, Year	Year	X	Month, Year
Time of day	X			
Where did it happen?				
Location on the farm (e.g. farm yard, field, barn, etc.)	Response Location: "Farm"	Location E-code: Farm	Locale where injured: "Farm"	Place of injury: "Farm"
Zip or other postal code				
State				
U.S. census region	X	X		
Urbanicity Code	X			
What was the agent/source of injury?				
e.g. Tractor, animal, ground surfaces, etc.	Some cause of injury E-codes	ICD-9 E-codes (not specific source)	Specific information on some sources of injury	ICD-10 (not specific source)
What was the mechanism of injury?				
Machinery (e.g. runover, rollover, entanglement, pinned/struck by, etc.)		X	Specific information on some types of injury	X
Non-machinery (e.g. fall from height, struck by animal, suffocation, etc.)		X	Specific information on some types of injury	X
How did it happen? What were the circumstances? (Ideally answered with an injury narrative)				
What was the child doing just prior to the injury?				
Where did the injury happen?				
How did the injury happen?				
What went wrong that led to the injury?				
What was the quality of supervision?				
What protective equipment was used/not used prior to injury?				
What was the nature and anatomical site of injury?				
e.g. Fractured right arm, crush injury to chest, amputation left leg below knee, etc.	Anatomical location, organ system, primary symptom	Nature of injury and body region	Diagnosis and primary body part	
How severe was the injury?				
Fatal	X	If DOA, death in ED, or death in hospital		X
Hospitalized		X	X	
Medical treatment only	Hospital destination; treated and released; treated and transferred care		Treated/ released; transferred/ released; observation	
No treatment	No treatment; refused care			

X = element present; Blank = element missing; Text = details with respect to element availability

Table 2 Event Records by Public Health Data System

System	2009				2012			
	Total Records	Children 0-17 Years	Injury Records	Farm	Total Records	Children 0-17 Years	Injury Records	Farm
NEMSIS (~90 data fields)	6,216,520	425,101	71,905	191	19,831,189	1,196,785	189,089	555
NTDB (~127 data fields)	682,036	96,387	[b]	755	833,311	109,517	[b]	804
NEISS-AIP (~77 data fields)	522,417	178,137	[b]	158	546,616	175,517	[b]	172
NVSS (~116 data fields)	2,441,219	41,830	6,458[a]	40	2,547,864	37,597	6,115[a]	30

[a]Deaths.

[b]All records represent injury.

Table 3 Demographics of Child Agricultural Injury Cases across Public Health Data Systems

	NEMSIS		NTDB		NEISS-AIP		NVSS	
	n	%	n	%	n	%	n	%
Year of Injury								
2009	191	25.6	755	48.4	158	47.9	40	57.1
2012	555	74.4	804	51.6	172	52.1	30	42.9
Age group (years)								
0-6	118	15.8	486	31.2	89	27.0	23	32.9
7-9	76	10.2	249	16.0	43	13.0	6	8.6
10-12	147	19.7	274	17.6	62	18.8	4	5.7
13-15	227	30.4	334	21.4	73	22.1	18	25.7
16-17	178	23.9	216	13.9	63	19.1	19	27.1
Gender								
Female	385	51.6	565	36.2	128	38.8	18	25.7
Male	355	47.6	994	63.8	202	61.2	52	74.3
Not available	6	0.8						
Race								
White	527	70.6	1,364	87.5	249	75.5	69	98.6
Black/African American	24	3.2	45	2.9	7	2.1		
Native American	9	1.2	11	0.7	3	0.9	1	1.4
Asian	4	0.5	7	0.4				
Hawaiian/Pacific Islander	3	0.4	6	0.4				
Other race	22	2.9	62	4.0	16	4.8		
Not available	157	21.0	64	4.1	55	16.7		
Ethnicity								
Not Hispanic/Latino	474	63.5	954	61.2	316	95.8	62	88.6
Hispanic/Latino	20	2.7	84	5.4	14	4.2	8	11.4
Not available	252	33.8	521	33.4				

on the type of injury, medical aspects of the injury, and administratively relevant aspects of the case disposition, but there was little information about how the injury happened and the specific circumstances prior to the injury event. ICD-9 and ICD-10 codes provide only limited information on the source of the injury; NTDB ICD-9 examples include "E882: Fall from or out of building/other structure" and "E919.0: Machinery accident—agricultural machines," while NVSS ICD-10 examples include "W30: Contact with combine harvester, initial encounter" and "W23: Caught, crushed, jammed, or pinched between moving objects, initial encounter."

From the state of Wisconsin, we received 119 trauma registry narratives and 153 EMS narratives for the years 2012 and 2013 where location was "farm" and age was 0-17 years (data not shown). The trauma registry narratives were typically 1 sentence, and the EMS narratives were 1 to 2 paragraphs in length. In general, the narratives provided more specific information about source and mechanism of injury (eg, specific farm machine, height of fall,

and landing surface), but like their national data system counterpart, they provided no information about how the injury happened or the specific circumstances prior to the injury event.

Discussion

We examined 4 national data systems that have not previously been fully assessed for their utility in filling gaps in child agricultural injury surveillance and primary prevention. The data systems included ambulance runs, emergency department visits, hospital admissions, and injury deaths. These data systems captured many details about what happened to the child with respect to anatomical injuries, medical care and treatment, but few if any details about what was happening at the time of injury; that is, *why* and *how* the injury occurred.

Public health surveillance is defined as ongoing systematic collection, analysis, interpretation, and dissemination of health-related data for the purpose of prevention.[10] The ultimate goal of a surveillance system is prevention—using the data to plan new or improved prevention interventions, to monitor the effectiveness of interventions, and to discard prevention interventions that are not working. However, for surveillance data to be useful for primary prevention of child agricultural injuries, the surveillance system needs to include data on the circumstances of injury and to provide these data in a systematic and useful way. The public health data systems we examined in this study provided no information on the circumstances leading up to the injury, limiting the utility of these systems to more tertiary aspects of prevention that focus on minimization of harm post injury event.

In related work, our study team previously partnered with the National Center for Fatality Review and Prevention[16] to help refine the review and case reporting system with respect to deaths due to child agricultural injury. Child fatalities on farms from the period 2004 to 2011 were reviewed, with results similar to those for this study. The case reporting system included both a large number of coded fields and a narrative field, but the narratives were scant in terms of context and case details. Overall, the case reporting system was limited in its ability to inform child agricultural injury surveillance and primary prevention.

The main recommendation stemming from review of these public health data systems is to formally incorporate a narrative as part of any child agricultural injury data collection tool, as a means by which the underlying circumstances that lead to injury events can be documented. This narrative should be structured to serve as a guide for reporting the key details of the injury circumstances, and coders should be trained on the construction of effective narratives. The structure would come from questions like the following:

1. What was the child doing just prior to the injury?
2. Where did the injury happen?
3. How did the injury happen?
4. What went wrong that led to the injury?
5. What was the quality of supervision?
6. What protective equipment was used/not used prior to injury?

See Table 4 for a more detailed description of each question.

We recognize that data recorded in a closed-ended format, with limited distinct codes, are generally much easier for researchers, including ourselves, to analyze than is narrative text. However, one of the most important aspects of a good surveillance system is that it has the potential to answer a large number of questions, including questions not yet formulated at the time of system conception. A single, well-defined research question can generally be addressed with a practical number of defined data fields, but increasing the number of questions may also substantially increase the number of required fields and quickly reach the practical limits for such a system. In addition, as agriculture itself changes over time, even a well-designed surveillance system limited to coded fields will likely not be optimal for important new questions. A system that includes both coded fields and a structured narrative has much broader potential.[17] This is especially true given recent developments in electronic text mining and machine learning that have reduced the need for manual review when using data from narrative text to help address questions in medical research.[18-21]

One exemplary North American model of an agricultural injury surveillance system that employs such an approach is the Canadian Agricultural Injury Reporting (CAIR),[22] formerly the Canadian Agricultural Injury Surveillance Program. In this program, trained coders in each participating province abstract information from coroners' and medical examiners' files (deaths) and hospital discharge records (hospitalized cases) in a standardized manner. In addition to a number of closed-ended data elements, the coders also develop a directed narrative, similar to that proposed above, which provides rich detail on the specific circumstances surrounding each injury event. CAIR investigators analyze these in detail, identify recurrent patterns, quantify them, and then provide these summaries to national and provincial farm safety organizations to inform priorities for ongoing as well as new and emergent prevention priorities. Existence of this system also fosters the monitoring of these

Table 4 Proposed Structured Narrative for Child Agricultural Injury Surveillance and Primary Prevention

Question	Instructions
1. What was the child doing just prior to injury?	Provide a description of the activity the child was involved in at the time of the injury and details about what farmwork or other activities were occurring by or within the vicinity of the child at the time of injury. Please be as specific as possible (eg, "the child was playing with a ball in the farm yard near his father who was operating a skid steer").
2. Where did the injury happen?	Provide a description of the location where the injury occurred. Please be as specific as possible (eg, "farm yard between the machine shed and the barn," or "farm pond 300 feet from the house").
3. How did the injury happen?	Provide a detailed description of the exact circumstances surrounding the injury event, including the mechanism of injury (eg, "runover," "pinned/struck," or "fall") as well as the source of injury (eg, "tractor," "cow," or "ground surface"). Include any other factors that may have contributed to the injury occurrence.
4. What went wrong that led to the injury?	Provide an explanation about why the injury occurred (eg, "child was not seen by the tractor operator and was run over when he darted out in into the path of the moving tractor," or "parent was doing farmwork and lost sight of the child who slipped on the muddy bank of the farm pond and drowned.")
5. What was the quality of supervision?	Provide a detailed description about the supervision. What was the age of the supervisor? What was the supervisor's relationship to the child (if any)? Was the supervisor aware of the child's location? Was the supervisor doing farmwork when the child was injured? Was there a break in the continuity of supervision? Was the supervisor within arm's reach of the child, near to the child, or far away from the child?
6. What protective equipment was used/not used prior to injury?	Provide details on the presence or absence of any protective equipment (eg, rollover protection structure on a tractor, machine guarding, fall protection harness, ATV helmet, or physical barriers such as fences).

patterns of injury over time, to provide indication as to whether prevention efforts are likely effective in practice. The directed narrative has proven to be invaluable to such efforts.[23-25]

Strengths and Limitations

To our knowledge, this is the first time these public health data systems have been examined for their potential utility in child agricultural injury surveillance. However, we have looked at utility only in a broad sense of primary prevention, and we would certainly concede that each of the data systems reviewed here may be very helpful in answering other research questions. Of note, none of the 4 systems are limited to work-related injuries; we take this as a generally positive feature, since work is integrated with many aspects of the lifestyle on farms, making the definition of "work-related" problematic. We assessed a secondary use of data systems established for other reasons, and our conclusions are limited in scope. Our review focused on child agricultural injury surveillance and primary prevention, and for that purpose we believe existing systems would be improved by capturing details of the circumstances leading to injury.

Conclusion

The use of existing public health data systems is a potentially efficient and cost-effective method for child agricultural injury surveillance. However, the data systems reviewed in this study lacked key information that is essential for primary prevention. The addition of a well-structured narrative, potentially coupled with electronic text mining and machine learning to simplify data extraction, could provide details about risks, activities, and circumstances of injury that would broadly inform and enhance child agricultural injury surveillance and primary prevention.

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