Improving Agricultural Injury Surveillance: A Comparison of Incidence and Type of Injury Event Among Three Data Sources

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Background *Agriculture ranks as one of the most hazardous industries in the nation. Ongoing injury surveillance is key to identifying and preventing major sources of injury.*

Objective *The objective of this study was to compare the total number and types of injuries identified from community reporting versus two newly available medical data systems. These new systems are important because they are less time consuming and expensive to maintain.*

Method *Farm injury case records from 2007 were collected for 10 NY counties from the following sources: ambulance reports, hospital data, and community surveillance data.*

Results *For the 107 ambulance report cases, horses (35%), tractors (15%), and livestock (10%) were the three leading injury sources. For the 261 hospital cases, the leading sources were hand tools (24%), farmstead machinery (23%), and buildings/structures/surfaces (22%). Tractor injuries (37%) were the most common source of injuries identified by the 44 community surveillance cases. Struck by object was the most frequent injury event type for hospital and surveillance data (34%, 30%). Falls were the highest category for ambulance reports (36%) and were also common for hospital data (29%). Nine of the 11 fatal cases were found through community surveillance.*

Conclusion *Ambulance reports and hospital data contribute a large number of additional farm injury cases to existing surveillance data. From these cases, horse injuries, falls, and hand tool injuries appear to play a larger role in farm injuries. Future research should explore how to best use these electronic resources for agricultural injury surveillance.* Am. J. Ind. Med. 54:586–596, 2011. *© 2011 Wiley-Liss, Inc.*

KEY WORDS: agriculture; farm injury; injury surveillance; pre-hospital care reports (PCRs); hospital discharge data

INTRODUCTION

Agriculture consistently ranks as one of the most hazardous industries in the nation. In 2008, the "farmer, rancher" occupation had a fatality rate that was 10 times the all-occupation rate [40.3 vs. 3.7 per 100,000 workers; BLS, 2008a]. Bureau of Labor Statistics (BLS) survey data on non-fatal farm injury report a rate 4.9 per 100 workers (which excludes farms with fewer than 11 workers), higher than the all-industry rate 4.0 per 100 workers [BLS,

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2008a]. Within agriculture, tractor roll-overs, machinery entanglements, and animal incidents have been identified as leading sources of fatality [Myers and Hard, 1995; Murphy and Ambe, 1998; Goldcamp, 2010], and children, older farmers, and those with impaired hearing have been found to be at particularly high risk [Hwang et al., 2001; Hagel et al., 2004; Lim et al., 2004; Amshoff and Reed, 2005].

The BLS, maintains the Census of Fatal Occupational Injury (CFOI) which identify occupational fatalities and classify them by industry and occupation. No such census exists for non-fatal injury. Instead, BLS conducts the Survey of Occupational Injury and Illness (SOII) annually. This survey collects data on a wide range of industries; however, it specifically excludes farm operations with 10 or fewer employees. Since small farms employ the majority of the U.S.'s agricultural workforce [USDA, 2008], one needs to be concerned with the representativeness of the data. NIOSH has responded to this information gap by periodically working with the National Agricultural Statistics Service (NASS) to conduct farm injury surveys using a national sample [Myers et al., 2009; Goldcamp, 2010]. However, the question as to whether ongoing non-fatal farm injury surveillance through existing administrative datasets could be established in a cost-effective manner has not been thoroughly explored.

In addition to providing a continuous source of data, the ideal agricultural injury surveillance system would provide a higher level of descriptive detail than is currently available to agricultural professionals either through CFOI or the surveys of non-fatal agricultural injury. According to International Statistical Classification of Diseases and Related Health Problems (ICD9) rules, tractors are coded as part of the larger machinery category unless they are involved in a collision on the roadway, in which case they are coded as vehicles. In one study looking at the National Traumatic Occupational Fatality data, it was found that 10% of tractor deaths were coded as vehicle-related (roadway crash) [Sorock et al., 1997].

The coding system used by the BLS includes two key variables from injury epidemiology: injury source (e.g., ''machine,'' ''animal,'' ''structure,'' etc.,) and the nature of the event itself (e.g., ''fall,'' ''crushing,'' ''struck,'' etc.,). Generally speaking, ''injury source,'' and ''injury event type'' can be combined to describe the injury event with enough detail to make intervention possible, however, the lack of key descriptor choices, such as ''tractor,'' for injury source or ''roll-over'' for injury event type limits its usefulness for agricultural health and safety.

An additional challenge within agricultural injury surveillance, both fatal and non-fatal, relates to definition. From a farm safety perspective the terms, ''occupational injury'' and ''farm injury'' may not mean the same thing. The farm is a unique workplace in that for many workers and family members it is also a home. Therefore, some of the fatalities that the researcher is interested in from a prevention point of view occur during leisure activities or to bystanders on the farm. The CFOI attempts to address this limitation by including child fatalities that occur while performing farm chores. For the researcher focused on farm injury prevention, these distinctions are important, particularly since the farm is a varied work and home environment.

In order to bring clarity of definition to injuries on the farm, in 1993 Dennis Murphy and coworkers developed a classification system for all activities classified as ''agricultural'' within the Standard Industrial Classification (SIC) system, and also includes other types of activities that could be occurring while on the farm [Murphy et al., 1993; Yoder and Murphy, 2000]. While not every category (Table I) fits every researchers definition of farm injury (e.g., our definition in the current study excludes FAIC 2 and FAIC 3), it provides a firm logical basis for inclusion and exclusion, and makes it possible to compare studies with like definitions of farm injury. This coding scheme has become the standard for American Society of Agricultural and Biological Engineers [ASABE, 2007].

In recent years two new sources of injury data have become available in New York that offer the potential for establishing a highly detailed and low-cost farm injury surveillance system. First, ambulance records are now centrally collected and data entered by mandate of the state health department. While many Emergency Medical Services (EMS) services use paper ambulance report forms which are then data entered at the state level, there is a transition to electronic records underway that will make this data source still easier to manage in the future. There are two ways in which a farm injury can be identified from the ambulance report: either by having ''farm''

TABLE I. Farm and Agriculture Industrial Classification Codes

FAIC-01. Farm Production Work
FAIC-02. Forestry and Logging (excluded from current analysis)[a]
FAIC-03. Fishing, Hunting, and Trapping (excluded from current analysis)[a]
FAIC-04. Agricultural and Forestry Support Services
FAIC-05. Worksite Exposure: Workers, Outside Services
FAIC-06. Farm Hazard Exposure: Equipment, Tools, and Products
FAIC-07. Farm Hazard Exposure: Structures and Landscape
FAIC-08. Farm Hazard Exposure: Animals
FAIC-09. Farm Hazard Exposure: Roadway Accident
FAIC-10. Undetermined. Cases which appear to be farm or agriculturally related but which insufficient information exists to assign the case to a particular FAIC category

[a]Categories 2 and 3 have been excluded from the current analysis, because although they fit within the Standard Industry Classification system definition of agriculture, they do not fit the researchers' definition of "farm."

indicated on the injury location type field, or through the narrative description of the event. The benefits of narrative free text have been utilized for farm and forestry fatality research as early as the early 1990s [Jenkins and Hard, 1992; Stout and Jenkins, 1995]. Studies in Utah [Mann et al., 2005] and North Carolina [Wofford et al., 1994] have used EMS ambulance reports as an injury surveillance data source in non-agricultural research.

Second, while hospital discharge data has been available for several years (established in 1979) through the Statewide Planning and Research Cooperative System (SPARCS), it only began providing statewide hospital emergency department data as of 2003 [SPARCS, 2007]. As with the ambulance reports there is an injury event location type field, with ''farm,'' as an option, as well as a descriptive external cause of injury code, making it possible to identify and classify farm injury events.

Medical chart data [Struttmann and Reed, 2002; Franklin and Davies, 2003; Greenlee et al., 2005; Earle-Richardson et al., 2008] and ambulance reports [Forst and Erskine, 2009] have been used for farm injury research; while hospital discharge data have been used in other, related fields [Alamgir et al., 2006; McKenzie et al., 2009; McGreevy et al., 2010]. The only published studies pertaining to the utilization of both ambulance reports and hospital discharge data was research studying the effectiveness of medical response [Grossman et al., 1995; Blackwell et al., 2009], and was not used for epidemiologic purposes.

Objective

The current analysis is a qualitative comparison of three different methods of agricultural injury surveillance: hospital discharge data, ambulance report data, and telephone contact with county safety officials (supplemented with newspaper tracking and state health department contacts). The three methods are compared on the number of cases identified as well as the amount of detail provided.

METHODS

Sampling Scheme

Ten New York State counties were sampled: Cattaraugus, Cayuga, Chautauqua, Erie, Jefferson, Otsego, Oneida, Steuben, St. Lawrence, and Washington (Fig. 1). These counties were selected on the basis of having the largest number of farms, largest agricultural population size, greatest number of farm fatalities over a 5-year period, and the greatest number of state-reported EMS ''farm'' location ambulance runs in 2001. In combination, these 10 counties account for 11,560 (31.8%) of the state's 36,352 farms, and 27% of the state's

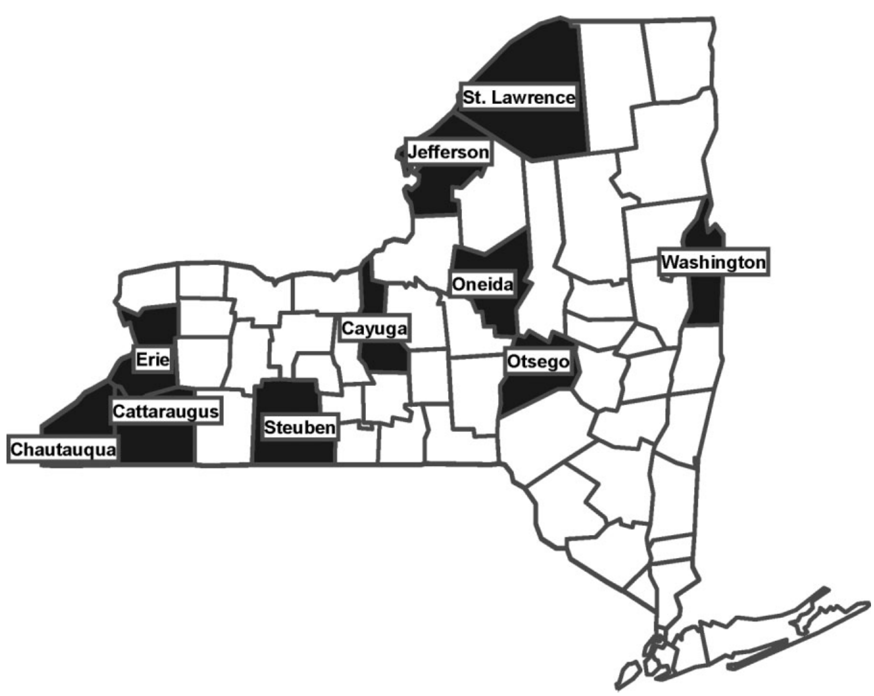

FIGURE 1. Ten county NY study region.

agricultural workforce (hired farm labor + operators) [USDA, 2008].

Definition of Farm Injury

Agricultural injury was defined as any event resulting in the transfer of energy: (a) from a farm source (e.g., tractor, farm animal), (b) while in a farm location, or (c) while doing a farm-work-related activity, that results in physical injury requiring immediate medical attention. Fatal injuries are further defined as those resulting in death, either immediately or later, but as a direct result of the injury event. The only exclusion to this definition is injury occurring on (b) while in a farm location, from an unambiguously non-farm source, such as a skateboard, family pet, cook stove, and the like.

Identification of injuries using ambulance reports

Researchers contracted with the centralized data processing agency for the NYSDOH Bureau of Emergency Medical Services. This agency is responsible for data entering all pre-hospital ambulance reports in the state. Although many of the data fields are computer entered at this facility, the narrative free-text fields are not. Because a review of these free text fields was necessary to ascertain agricultural injury status, the de-identified hard copies of these forms were sent to the New York Center for Agricultural Medicine and Health/Northeast Center for Agricultural and Occupational Health (NYCAMH/NEC) for this purpose.

Initial screening of ambulance reports for case assessment Initially, to be eligible for consideration as an agricultural injury case, the ambulance report must have been created on or after January 1, 2007. In addition, the report must also refer to an event resulting in an injury to one or more persons and must have occurred within the limits of the 10 study counties. Ambulance reports meeting these preliminary criteria had the following fields entered into an electronic database: date, form number, EMS agency, location code, call times, injury location type (‘‘farm’’), age and gender of patient, mechanism of injury, presenting problem, and disposition code. In addition, the following free-text fields are included: chief complaint, subjective assessment, objective physical assessment, and comments.

Final assessment of agricultural injury cases using ambulance reports Final case identification was a multistep process. First, it was necessary to see if one of the following conditions were met: (a) the ‘‘farm’’ location check box was filled in; (b) the free text fields contained any of farm key words; or (c) the dispatch description contained farm key words.

In the next step, de-identified copies of ambulance reports meeting this initial keyword inclusion criteria were retained for further review by a panel of four (two researchers, a physician with experience in agricultural health, and a former dairy farmer). This panel was charged with determining whether these key words occurred within the context of an actual case. Do to this, the panel assessed 1: whether the injury occurred while doing farm work or engaged in a farm activity, or 2: whether the injury occurred while on a farm location or 3: whether the injury occurred on a roadway and involved farm equipment and/or farm animals. Injury events occurring on the farm due to leisure sources (e.g., bicycle, skateboard, and family pets) were excluded.

Coding of injuries identified using ambulance reports One researcher reviewed the narrative from these identified cases and classified the activity the person was engaged in at the time of the injury into one of the Farming Classification System (FAIC) categories shown in Table I.

A second researcher then independently repeated this procedure. Cases where disagreement between researchers was found were referred to a panel (physician, farmer, and 3rd researcher) for final determination. Coding schemes for injury source and event type followed the 2009 NORA agriculture, forestry, and fishing typology [NIOSH, 2008].

Identification of injuries using hospital discharge data

De-identified electronic records of medical visits in the 10 study counties during 2007 in which an injury occurred with the ‘‘injury locale’’ of ‘‘farm’’ were obtained from the New York State Department of Health, SPARCS. This included records for both inpatient and emergency department visits. These cases were then reviewed and screened in a manner analogous to that described above for the ambulance reports. For those records deemed to be an agricultural injury case, researchers then developed a coding translation algorithm to obtain a set of codes consistent with those used for the ambulance reports.

Identification of injuries by county safety officials (supplemented with newspaper tracking and state health department contacts)

Recruitment of EMS personnel, 911 dispatchers, coroners, medical examiners, law enforcement officials, and Fatality Assessment and Control Evaluation (FACE) staff as surveillance contacts was conducted between November 2006 and March 2007 via telephone and email. Commitment was obtained from a total of 36 community contacts with a minimum of three contacts in any single county.

Research staff placed telephone calls on a monthly basis to each county contact for all of 2007. If the official was not reached on the first attempt, a series of four subsequent telephone calls were made at varying times of the day over a 2-week period. If the subject was not reached the end of this 2-week period, email messages were sent with a mailed letter to follow from the project's principal investigator. When a contact was reached, he or she was asked to report any farm-related injuries or fatalities occurring in their counties over the past 30 days. If the contact had none to report, a time and date for the next month's call is agreed upon and the call is ended.

For each farm-related injury reported, project staff recorded pertinent details. This included: the date and time of the accident, the number of victims involved, whether it resulted in a fatality, the gender and age of the victim, and the mode of transportation. In addition, information about the activity the victim was engaged in, the location on the farm, the nature of the injury, and the cause of the injury were recorded. No personally identifying information was recorded.

Because several officials were contacted within each county, it was common to receive multiple reports of the same incident. Identification of duplicates was based on matching date and time of the incident, age and gender of the victim, and details about the event. All duplicates were eliminated.

State FACE Program contacts were not called monthly, but informed research staff whenever they encountered a farm fatality anywhere in the state. Their primary sources of data were death certificates and online newspaper review.

In addition, a total of 32 print and online newspapers not followed by the state health department from the study counties were scanned for articles containing any of the following keywords: "accident," "tractor," and "farm." Information about the event was extracted from these articles and compiled.

Estimating the size of the agricultural population in the 10 study counties There is no published estimate of the size of the agricultural population, both working and household numbers, for individual New York counties. Even at the state and national level, estimates vary widely depending on the purpose, definition, and collection of the agricultural population estimate (J. Myers, personal communication, September 30, 2010). This is largely due to the fact that individuals at risk of injury on the farm include workers (paid and unpaid), as well as residents, and also the fact that employed workers are not necessarily year-around or full-time [NASS, 2008]. In the current analysis, an estimate was made of the agricultural population in the 10 counties at risk for agricultural injury. However, because population information is so limited, a number of educated guesses had to made regarding components of the overall population.

Two published sources provide some guidance [Deboy et al., 2008; NASS, 2008]. The National Academy of Sciences report recommends using the federal census (or the related monthly American Community Survey), while Deboy and coworkers use a number of sources and determine a range rather than a single estimate. For our purposes, it is necessary to rely on the Census of Agriculture, because it is the only source where production agriculture estimates are provided at the county level [NASS, 2008]. The main criticism of the Census of Agriculture applicable to New York State is the fact that migrant and seasonal farm workers may work more than one job in a calendar year, meaning that the farm-based reports of hired labor may over count these workers [Deboy et al., 2008; NASS, 2008]. The hired labor component of our estimate is adjusted to compensate for this overestimation.

Determination of the number of farm operators and hired managers For the current analysis, county estimates of the number of farm operators in the 10 New York study counties (Table 46. Selected Operation and Operator Characteristics: 2007) were derived. To calculate this number, primary operators (6,052) were fully included in the calculation, whereas the number of secondary operators was divided by 2 (5,508/2 = 2,754) (with their primary occupation being off the farm, they were estimated to have less time at risk on the farm). For 2007 there were 8,806 operators (6,054 + 2,754 = 8,806). Operators are defined as "that person responsible for day-to-day management decisions, including a hired manager, or a self-employed operator" [Deboy et al., 2008].

Determination of the number of farm hired labor workers As with operators, hired labor estimates were taken from the Census of Agriculture (Table VII. Hired Farm Labor Workers and Payroll: 2007). For the 10 counties, 14,690 hired farm workers were identified. This includes full-time workers and seasonal or contract labor. In order to correct for temporary jobs, likely to result in over counting of workers, researchers counted the subset of workers whose jobs were listed as "<150 days." For the 10 counties, there were a total of 8,986 workers in these kinds of jobs. Because two of these jobs could feasibly be filled by the same worker, 8,986 was reduced to 4,493. The resulting farm worker estimate is then reduced to 10,197 hired farm labor workers.

In addition to the paid workforce, the population at risk in this study includes unpaid workers (typically family members) and smaller children who may be injured on the farm when not working. Consequently the best available data was used to estimate the additional number of individuals at risk from these two groups.

Determination of the number of unpaid farm laborers The Census of Agriculture discontinued collection of data on this group of workers after 2001. In the absence of a 2007 count, counts from 2000 and 2001 were used to determine the mean proportion of all workers who were unpaid farm laborers for those 2 years. Once this proportion was calculated, it could then be applied to the total paid worker estimate for 2007 to estimate the number of unpaid workers. In years 2000 and 2001 the ratios of unpaid to paid labor were $11/(29.5 + 21.8) = 0.214$ and $9.3/(31.5 + 22.5) = 0.172$, respectively. The average of these two ratios (0.193) when multiplied by the total paid labor force (operators + hired labor workers) for 2007 (19,003) yields an estimate of the total number of unpaid farm laborers of 3,668.

Estimation of the number of children under 14 The decision was made to limit the estimation of children at risk on the farm to those under 14 years of age because it was determined anecdotally (through a number of farm sources), that children 14 and over in New York who are typically present in the farm environment (and thus at risk for injury) when they do substantial work on the farm. In this case, youth 14 and over would already be counted either as paid farm employees, or more likely in the "unpaid workers" category. Excluding youth 14 years and over prevents double counting of this group. While many children under 14 years also do farm chores, they do significantly smaller tasks, therefore are not likely to be reported as either paid or unpaid workers.

In order to estimate the number of children under 14 (at risk of injury while playing or doing chores but not counted in the "unpaid labor" group), the reported number of farms was multiplied by 0.38. This multiplier is derived from another study in the rural New York region [Lewis et al., 2000] indicating that there is an average of 0.38 children under the age of 14 on New York State farms. When the 4,935 reported farms (with $10,000 or more in yearly sales) in the 10 counties was multiplied by 0.38, the result is an additional 1,875 individuals.

Estimation of total population at risk Taking the sum of 19,003 paid workers, 3,668 unpaid employees, and 1,875 children under the age of 14 yields an estimate of the total population at risk within these 10 counties of 24,546.

The research protocol was approved by the Bassett Medical Center Institutional Review Board.

RESULTS

Ambulance Report Records

For the 107 cases identified by ambulance reports, the mean age was 38.5 years (SD = 29.0) with a minimum of 2 and a maximum of 84 years. Among these victims, 58.1% were male, with Otsego County having the highest number of reported cases (16). The most cases were reported in June (23) with the least (1) being reported in February and March.

Hospital Records

There were a total of 261 hospital cases, 39 from inpatient admissions, and 222 from hospital emergency department visits. The mean age for the hospital cases was 35.8 years (SD = 19.3), with a minimum of 1 year of age and maximum of 87. Of these, 71.3% were male, with the majority of cases (50) coming from Oneida County. The peak reporting month was September (32) with a minimum of 11 cases reported in March.

Community Surveillance Records

A slightly higher mean age of 44.8 (SD = 21.2) was found for the 44 cases identified by community surveillance, with a minimum of 15 and a maximum of 85. Cayuga and Washington Counties had the highest number (10) with the overwhelming majority of the 44 cases being male (84.1%). The highest and lowest frequencies of injury events were reported in June (8) and December (0), respectively.

Among the three methods, the largest number of injury events by far (261) was obtained from the hospital data. This was followed by the ambulance report method (107) and the community surveillance (44). Using the estimate of the population at risk of 24,546 it is possible to estimate annual incidence for fatal and non-fatal injuries for these 10 counties of 10.6 per 10,000 for hospital data,

Estimated Size of the 10-county New York farm worker and bystander population, 2007

Owner operators	Hired farm laborers	Unpaid farm laborers	Children under 14 years on farm	Total 10-county farm population estimate
8,806	10,197	3,668	1,875	24,546

4.4 per 10,000 for ambulance report data, and 1.8 per 10,000 for community surveillance. For non-fatal injury alone, the rates are nearly identical: 10.6 (hospital), 4.3 (ambulance report), and 1.4 (community surveillance), per 10,000, respectively.

In addition to the discrepancies in the number of events that were obtained from the three methods, there were also large differences in the degree of detail that could be obtained from each. Unfortunately, with the de-identified hospital data, case matching was not possible. Table II shows the cases identified by each of the three surveillance systems, classified by the Farming Classification System, and it can be seen that the vast majority of hospital farm injury cases (in the de-identified data set, at least) could not be categorized as to activity at the time of the injury. The table also shows that a majority of ambulance report-identified cases did not occur while working. These consisted primarily of animal-related injuries (mainly horses).

Table III indicates the age distribution for each data source. In Table IV the injury source (e.g., machinery, horses, and structures) is shown for each of the three methods. For ambulance reports, horses (35%), tractors (15%), and livestock (10%) were the three leading sources. For hospital data the leading sources were hand tools (24%), farmstead machinery (23%), and buildings/structures/surfaces (22%). It should be noted that the ‘‘farmstead machinery’’ category for the hospital data system includes tractors, since there is no external cause of injury code that specifically names tractor as the injury source. Tractor injuries (37%) were by far the most common source of injuries identified by the community surveillance.

As shown in Table V, the most common injury event was being struck by an object. This was highest for hospital data (34%), highest for surveillance (30%), and second highest for ambulance reports (29%). Falls were the highest category for ambulance reports (36%) and were also common for hospital data (29%).

In all, there were 11 fatal case reports identified. Of these, nine were identified only through community surveillance with hospital data and ambulance reports each identifying one unique case.

DISCUSSION

In the past, agricultural health and safety researchers have attempted to track injury events through basic ‘‘word-of-mouth’’ systems; that is, by establishing informal reporting networks of hospitals, law enforcement, and corners to notify us when an agricultural injury or fatality occurs. With a large investment of manpower to maintain it, these systems have proved relatively successful in tracking farm fatalities. As new data sources have become available, researchers were interested in seeing how much larger the total pool of farm injury cases would be and what effect this might have on leading injury event types.

We had expected the ambulance report and hospital data to identify more cases than community surveillance, but we were surprised by the magnitude of the difference (107 and 261 vs. 44, respectively). We were also surprised to see that different leading injury event types were found with the addition of the two new data sources (specifically horse-related injuries, falls, and hand-tool injuries). As this was an initial comparison using de-identified hospital data, it was not possible to case match to determine the extent of case overlap, however, there was enough data (through event date, county, and injury event type), to determine that between the ambulance report cases and the community surveillance cases, there were only eight duplicate cases. We were surprised by this finding, because it indicates that neither system is sufficient on its own. Future research will use more highly detailed hospital records so that case-matching through all three data sources will be possible. With this information it will be possible to finally determine whether the more labor-intensive community surveillance method can be discarded.

TABLE II. Cases by FAIC Code

Farm and Agricultural Injury Classification (FAIC) Code	Ambulance report	Hospital data	Surveillance
1—Farm Production Work	37	0	23
4—Agricultural and Forestry Support Services	1	0	0
5—Farm Hazard Exposure, Outside Services	1	0	0
6—Farm Hazard Exposure, Non-workers: Equipment, Tools, Objects, and Products	9	0	3
7—Farm Hazard Exposure, Non-workers: Structures and Landscape	2	0	1
8—Farm Hazard Exposure, Non-workers: Animals	41	7	3
9—Farm Hazard Exposure: Roadway Collision	3	0	10
10—Unclassifiable "farm"	13	254	4
Total	107	261	44

TABLE III. Age Distribution of Cases

Age	Ambulance report (%)	Hospital data (%)	Community surveillance (%)
0–13	10 (9)	35 (13)	0 (0)
14–19	18 (17)	24 (9)	6 (14)
20–34	16 (15)	74 (28)	8 (18)
35–54	35 (33)	84 (32)	11 (25)
55–64	12 (11)	20 (8)	6 (14)
>65	12 (11)	24 (9)	8 (18)
Cases missing	4 (4)	0 (0)	5 (11)

While the community surveillance identified the smallest number of non-fatal cases of farm injury, it was by far the largest source for fatal injury cases. It seems likely that this is because fatalities are more newsworthy, and generally involve a greater number of local health and safety officials. Thus, newspapers and informal networks of county health and emergency officials would be aware of them. It is interesting to note that while 10 farm fatalities (gathered from 11 reports) were identified during 2007 in the 10 study counties, the federal BLS estimate for the entire state (62 counties) that year was only 7 [BLS, 2008b].

Although more will be learned when more detail on the hospital data is obtained and cases can be matched, some potential patterns of interest in all three data sets can be observed. The ambulance report data seem to indicate a high frequency of horse-related injuries, while hospital data (at least among classifiable cases) suggest falls and hand tool injuries are relatively common. None of these three hazards have been priority prevention topics for the NYCAMH/NEC in recent years. As research continues, these hazards will be looked for as potential emerging issues for attention.

TABLE IV. Source of Injury by Surveillance Method

	Ambulance report (%[a])	Hospital data (%[a])	Surveillance (%[a])
Tractor	15 (15)	[b]	16 (37)
Farmstead machinery	3 (3)	30 (23)	2 (5)
Non-powered cart or wagon	5 (5)	0 (0)	0 (0)
Livestock (cow/heifer/goat/bull)	10 (10)	0 (0)	4 (9)
Horse	34 (35)	7 (5)	4 (9)
Trees/crops	4 (4)	0 (0)	0 (0)
Hand tool	2 (2)	31 (24)	0 (0)
Building/structure/surface	3 (3)	29 (22)	2 (5)
Truck/auto	3 (3)	9 (7)	7 (16)
ATV/MUV	5 (5)	0 (0)	1 (2)
Other	13 (13)	23 (18)	7 (16)
Unknown	10	132	1
Total	107	261	44

[a]Unknowns excluded from percentage calculation.
[b]For Hospital Data, tractors are included with farmstead machinery.

TABLE V. Type of Injury Event by Surveillance Method

	Ambulance report (%[a])	Hospital data (%[a])	Surveillance (%[a])
Caught In/Between/Under	12 (11)	0 (0)	3 (7)
Tractor Rollover	6 (6)	0 (0)	8 (19)
Contact by Sharp Object	2 (2)	24 (18)	1 (2)
Entanglements	2 (2)	0 (0)	3 (7)
Falls (From height or Ground)	37 (36)	39 (29)	5 (12)
Over exertion	2 (2)	17 (13)	0 (0)
Run over	4 (4)	0 (0)	7 (16)
Struck By	30 (29)	45 (34)	13 (30)
Other	9 (9)	9 (7)	3 (7)
Unknown	3	127	1
Total	107	261	44

[a]Unknowns excluded from percentage calculation.

A growing number of non-fatal farm injury studies identify falls [Pratt et al., 1992; McCurdy et al., 2004; Rautiainen et al., 2004], hand tools [Mariger et al., 2009], and horses [Miller et al., 2004; Erkal et al., 2009; Forst and Erskine, 2009] as leading injury sources. However, tractor and machinery-related injuries continue to predominate in both fatal and non-fatal injury [Myers and Hard, 1995; Nordstrom et al., 1995; Pickett et al., 1995, 2001; Dimich-Ward et al., 2004].

Our data showed horse injuries to be an important issue in our region, ambulance data included a fatality and other serious injuries; however, a quick look at the North American literature confirms that horse-related injury is both common and frequently serious. The Centers for Disease Control estimates that there are approximately 100,000 horse-related injuries annually [Ball et al., 2007]. A large 10-year retrospective study found that nearly 30% of riders who ride six or more time per year had been treated by a physician for a horse-related injury within the past 2 years [Loder, 2008]. In another study of 700 riders found that 81% had had a horse-related injury during their riding career and 52% required medical care [Mayberry et al., 2007]. There is also data indicating that many of these injuries are serious. For example, in a Canadian study, horse riding was found to have the highest mortality rate of sports (1 per million) [Ball et al., 2007]. One study in Alberta, Canada found the incidence of hospitalization for horse-related injury to be higher than that of motorcycle riding [0.49 vs. 0.14 per 1,000 hr of riding; Ball et al., 2007].

The study by Ball and coworkers was able to collect detailed description information on 78 horse-related injury events. Although these were adult cases, the mechanism of injury is similar to what is seen among our data of both children and adults: the most common occurrence is "being thrown (or falling) from the horse." In the Ball et al. study, this event was most commonly attributed to the horse being frightened or "spooked," (35% of cases), or the horse not being fully trained for the riders demands (27%). While published studies conflict as to whether lack of experience is a risk factor for injury, they concur on the finding that the most serious injuries happen more frequently to more experienced riders.

The data also indicate that severe head and spinal injury is associated with not wearing a helmet, and most impressively, that the use of helmets has been associated with a fivefold reduction in head injuries [Ball et al., 2007]. There appears to be ample room for more work in this area, as published rates of helmet use range from 9% to 40% [Clarke et al., 2008].

One of the main challenges for prevention of this widespread and potentially serious injury problem is that while horse riding for leisure is generally rural activity, it is not considered by many to be within the purview of agricultural health and safety because it is leisure activity and may occur at a rural residence rather than an actual farm. On the other hand, many injuries happen to workers on equestrian farms, some on Amish and Mennonite farms where horses are an important part of production agriculture, and others as recreation on other types of farms. Frequently it is not possible to distinguish one type of incident from another. This is much the same difficulty that is encountered with all-terrain-vehicles, which may be used for work or leisure, on a farm or off. In our view these two categories of injury should be included in agricultural injury research and prevention, particularly because they are found in the farm environment disproportionately to other settings, and because they are a threat to the safety of farm youth. The fact that prevention might justifiably be extended to all rural youth is not a reason to exclude it from farm safety programming. We recommend future research be conducted on horse injury in both the farm and non-farm rural population, with an emphasis on helmet use and whether the event was work-related or recreational.

The rate obtained for these severe non-fatal injuries (a range of 6.2–16.8 cases per 10,000) lies between published fatality rates of 11.6 and 38.5 per 100,000 [Pickett et al., 1999; BLS, 2009], and those obtained for all classes (both those requiring immediate medical attention and less serious injuries) of non-fatal injury (from 0.5 to 16.6/100 workers) [Rautiainen et al., 2004; Myers et al., 2009; Goldcamp, 2010]. This is an extremely wide range, and since methods of estimation are not comparable, comparisons should be made with caution.

This research suggests the feasibility of utilizing four fully electronic sources of farm injury data for surveillance in the future: ambulance reports, other hospital (inpatient and emergency department) record data, electronic newspaper clippings and electronic death certificate records. However, further research is needed to case-match from different sources, to validate the denominator estimate and to further study case underascertainment. The importance of combining several sources to overcome the shortcoming of each system has been demonstrated in the past, as shown with death certificates and newspaper clippings [Hayden et al., 1995].

Limitations

The main limitations in the current research are the lack of detail on many of the hospital cases, and our current inability to conduct case matching. However, researchers are pursuing a more detailed, restricted access database that will allow case matching and may also make it possible to categorize more of the 127 source and type "unknown" records.

Another limitation in attempting to establish an entirely electronic farm injury surveillance system is that New York's ambulance report system was not entirely electronic. For some of the descriptive data fields, it was necessary to review ambulance records manually.

Currently, there is a project underway (National Emergency Medical Services Information System) based in North Carolina and Utah that is establishing a nationwide electronic record system of ambulance data [Dawson, 2006; NEMSIS, 2011]. The authors are working with the developers of this system to assure that key fields necessary for farm injury case identification and classification are retained as states move to this system. In particular, it will be important to assure that the injury locale cannot be left blank, and that event description field choices include the major farm categories, such as "tractor," "horse," "livestock," and "hand tool." It is hoped that the addition of those fields to the electronic reporting system, to which all 50 states have signed on, will result in a higher proportion of classifiable records for the future.

Preliminary Conclusions

It appears that ambulance reports and hospital data contribute a substantial number of additional injury cases to those provided by traditional data sources. The fact that these are largely electronic systems, and exist in several states offers the opportunity for multi-state farm injury surveillance that can play a critical role in prevention planning and program evaluation in the future. The next challenge for the project will be to establish automated systems that are inexpensive and sustainable, and that can be implemented across a multi-state region. If this can be accomplished, this system could be replicated in other regions.

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