Using hospitalization data for injury surveillance in agriculture, forestry and fishing: a crosswalk between ICD10CM external cause of injury coding and The Occupational Injury and Illness Classification System

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Abstract

Background: While statistics related to occupational injuries exist at state and national levels, there are notable difficulties with using these to understand non-fatal injuries trends in agriculture, forestry, and commercial fishing. This paper describes the development and testing of a crosswalk between ICD-10-CM external cause of injury codes (E-codes) for agriculture, forestry, and fishing (AFF) and the Occupational Injury and Illness Classification System (OIICS). By using this crosswalk, researchers can efficiently process hospitalization data and quickly assemble relevant cases of AFF injuries useful for epidemiological tracking.

Methods: All 6810 ICD-10-CM E-codes were double-reviewed and tagged for AFF-relatedness. Those related to AFF were then coded into a crosswalk to OIICS. The crosswalk was tested on hospital data (inpatient, outpatient, and emergency department) from New York, Massachusetts, and Vermont using SAS9.3. Injury records were characterized by type of event, source of injury, and by general demographics using descriptive epidemiology.

Results: Of the 6810 E-codes available in the ICD-10-CM scheme, 263 different E-codes were ultimately classified as 1 = true case, 2 = traumatic/acute and suspected AFF, or 3 = AFF and suspected traumatic/acute. The crosswalk mapping identified 9969 patient records either confirmed to be or suspected to be an AFF injury out of a total of 38,412,241 records in the datasets, combined. Of these, 963 were true cases of agricultural injury. The remaining 9006 were suspected AFF cases, where the E-code was not specific enough to assign certainty to the record’s work-relatedness. For the true agricultural cases, the most frequent combinations presented were contact with agricultural/garden equipment (301), non-roadway incident involving off-road vehicle (222), and struck by cow or other bovine (150). For suspected agricultural cases, the majority (68.2%) represent animal-related injuries.

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Background
Since the inception of the Occupational Safety and Health Act of 1970 (Occupational Safety and Health Act of 1970, 1970), the rates of occupational morbidity and mortality have declined in many industries. However, taken together, the agriculture, forestry, and fishing (AFF) industry sector has persistently higher rates of fatal occupational injury, when compared to the all-worker fatality rate. (Civilian occupations with high fatal work injury rates, 2018, 2019) The injury pyramid concept demonstrates that for every fatal injury event, there are many serious non-fatal injuries requiring emergency medical care, and beyond that, many injuries that require first-aid care. (WHO, 2015) While statistics related to occupational injuries exist at state and national levels, there are notable difficulties using these to understand non-fatal injuries trends in the AFF sector. In the United States, the primary source of non-fatal injury and illness data, the Survey of Occupational Injuries and Illnesses (SOII), excludes agricultural operations and Illnesses (SOII), excludes agricultural operations

Conclusions: The crosswalk provides a reproducible, low-cost, rapid means to identify and code AFF injuries from hospital data. The use of this crosswalk is best suited to identifying true agricultural cases; however, capturing suspected cases of agriculture, forestry, and fishing injury also provides valuable data.

Keywords: Hospitalization data, E-code, OIICS, Occupational injury, Agriculture, Forestry, Fishing,
are an important companion to PCRs, as minimal overlap in patient records exists between the data sources. (Scott et al., 2017a) Even more, in 2015, the United States upgraded hospital data coding to the tenth version of the International Classification of Diseases – Clinical Modification (ICD-10-CM), vastly improving options for describing injuries using the expanded E-codes. (CDC, 2015c) The transition from the ninth clinical modification of ICD to the tenth saw the addition of many injury options in the external causes of morbidity codes between V00-Y99. (Hedegaard et al., 2016)

When multiple sources are used for a surveillance system, data need to be coded in a consistent manner that allows the records to be aggregated and compared in a meaningful way. One frequently used scheme in occupational health and safety (Murphy et al., 2019; Scott, 2016; Gorucu et al., 2015a; Wuellner & Bonauto, 2014; Sears et al., 2013) is the Bureau of Labor Statistics Occupational Injury and Illness Classification System (OIICS). (BLS, 2015b) The OIICS scheme is comprised of four components, each with hierarchical structures: 1) nature of the injury or illness, 2) event or exposure, 3) source of the injury or illness, and 4) the part of the body affected. Marsh and Jackson (Marsh & Jackson, 2013) suggested that there would be a benefit in having a crosswalk that could easily be used to map OIICS and ICD. However, while the Centers for Disease Control and Prevention (CDC) National Center for Injury Prevention and Control along with the National Center for Health Statistics published a report proposing a framework to present injury data using ICD-10-CM, they did not discuss OIICS. (Hedegaard et al., 2016) Creating a way to map codes between ICD-10-CM and OIICS has tremendous value for occupational health surveillance allowing for data to be merged.

This paper describes the development and testing of a crosswalk between ICD-10-CM E-codes and OIICS for AFF. By using this crosswalk, researchers can efficiently process hospitalization data and quickly assemble relevant cases of AFF injuries useful for epidemiological tracking. Doing so will improve the timeliness of existing surveillance systems, as this system not only identifies true and potential cases, but automatically codes the type of event, source of injury, and industry.

**Methods**

**Development of the crosswalk**

All 6810 ICD-10-CM external cause of injury codes (V0001XA to Y999) were imported into a Microsoft Access database, specially built for this review. Every code was reviewed by two occupational health and safety specialists for their AFF relatedness. These specialists have extensive training in occupational surveillance methodologies and have experience coding thousands of agriculture, forestry, and fishing-related injury records from health datasets. Previous research has demonstrated a high level of coder interrater reliability. (Scott, 2016) Each coder independently assigned a yes, no, or unsure to each ICD-10-CM E-code. The general metrics for these decisions were based on established definitions used for AFF injury surveillance at our center. Once this initial review was completed, the coders discussed any discrepancies between their choices and decided on a final determination. If the discrepancy could not be resolved, it was brought to the entire research team for review. In a final step, a lead reviewer (Principal Investigator) evaluated the 6810 records and verified the final choices made by the coding duo, making changes as necessary. In addition, the lead reviewer assigned one of nine choices to each ICD-10-CM E-code (Table 1), which determined the specific AFF industry and the degree of confidence in assigning work-relatedness (A. true case, B. traumatic/acute - industry suspected, and C. suspected traumatic/acute – industry known). For example, ICD-10-CM E-code ‘V840XXA - Driver of special agricultural vehicle injured in traffic accident, initial encounter’ would be indicative of a ‘true case’. Driving specialized agricultural equipment is typically viewed as an occupational task. Conversely, the E-code ‘W5532XA - Struck by other hoof stock, initial encounter’ would be coded as a ‘suspected case’ for the fact that we cannot be certain that the inflicted injury occurred due to a work-related event.

After ICD-10-CM E-codes were identified and vetted, OIICS scheme was applied to them. This process was also completed by two reviewers: one primary coder and one lead coder. While the OIICS scheme contains four parts—type of event, source(s) of injury, part of body, and nature of injury—we focused on using only the type of event and source(s) of injury in applying OIICS to the ICD-10-CM E-codes. The nature of the injury and part of body information is understood directly from ICD-10-CM diagnostic codes, and therefore not necessary to recode. In addition, the type of event and source of

| Case Determination                     | Sector          |
|---------------------------------------|-----------------|
| 0: not a case                          | N/A             |
| 1: true case, Agriculture              | Agriculture     |
| 1: true case, Forestry                 | Forestry        |
| 1: true case, Fishing                  | Fishing         |
| 2: traumatic/acute, suspected Agriculture | Agriculture     |
| 2: traumatic/acute, suspected Forestry | Forestry        |
| 2: traumatic/acute, suspected Fishing  | Fishing         |
| 3: Agriculture, suspected traumatic/acute | Agriculture   |
| 3: Forestry, suspected traumatic/acute | Forestry        |
| 3: Fishing, suspected traumatic/acute  | Fishing         |

Table 1 Coding Choices for Case Determination

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injury codes are most critical for injury prevention activities.

Testing the crosswalk on hospital data
The statistical software SAS 9.3 (Cary, NC) was used to complete the analyses using hospital data from three states: Massachusetts, Vermont, and New York (from 2016 and/or 2017). Hospital data included emergency department, outpatient, and inpatient records. New York data combined emergency department and outpatient records into a single undistinguishable file. There was no overlap for an individual patient visit in the state's database for a given year. While the three levels represent various levels of patient care and severity, all are coded in ICD-10-CM and it was valuable to test the crosswalk in each type of data. These states and years of data were used because they were the most recent ICD-10-CM coded data the research team had data use approval for at the time of the analysis. Data from the ICD-10-CM E-codes identified were written into a SAS program that scanned and flagged each hospital record containing an appropriate ICD-10-CM E-code. The program appended the appropriate OIICS codes to the hospital record.

Any hospital records that contained two or more ICD-10-CM E-codes of interest were set aside for additional review. Combinations of ICD-10-CM injury codes sometimes changed the industry or the degree of confidence in work-relatedness. Analysis of the records identified as in scope were completed in Microsoft Excel (Professional Plus, 2016, Redmond, WA) using pivot tables, along with the summation, mean, minimum, and maximum functions. Since the Vermont data presented age as a range (Sears et al., 2013; BLS, 2015b; Marsh & Jackson, 2013; Leigh et al., 2014; OSHA, 2015), the analysis used the median age imputed from this range, e.g., 42 to calculate average age. Cases were not restricted to age since youth workers are not uncommon in agriculture.

All protocols were approved by the Institutional Review Board of the Mary Imogene Bassett Hospital (Bassett Medical Center).

Results
Development of the crosswalk
Of the 6810 E-codes available in the ICD-10-CM scheme, 263 were ultimately determined to be 1, 2, or 3 (true case, traumatic/acute, suspected AFF, or AFF and suspected traumatic/acute). Table 2 shows the results of the individual E-codes mapped to the AFF industries. Table 3 shows the results of mapping combination E-codes (more than one E-code in a given hospital record) to the AFF industries.

Table 2 Single ICD-10-CM E-Codes Mapped to AFF Industry

| Industry | Case Determination          | Number of Single E-Codes |
|----------|-----------------------------|--------------------------|
| Agriculture | True Case               | 49                       |
| Agriculture | Traumatic/Acute, Suspected Agriculture | 139                      |
| Forestry  | Traumatic/Acute, Suspected Forestry | 1                        |
| Fishing   | Traumatic/Acute, Suspected Fishing | 74                       |

Testing the crosswalk on hospital data
The targeted ICD-10-CM E-codes identified 9969 patient records that potentially contained an AFF injury out of a total of 38,412,241 records in the dataset. The categorization of these records can be seen in Table 4. Of these, 963 are ultimately confirmed to be true agricultural injuries. The remaining 9006 are termed suspected cases of AFF injury, meaning that the E-code was not specific enough to assign certainty to the work-relatedness. It was not possible to make any confirmed determinations of a true case of forestry or fishing from these E-codes alone.

Descriptive epidemiology of identified patient records
Table 5 highlights the type of event and source of injury combinations that were identified for each group of cases (true agricultural cases, suspected agricultural cases, suspected fishing cases, and suspected forestry cases). For true agricultural cases, the most frequent combinations presented were contact with agricultural/garden equipment (301), non-roadway incident involving off-road vehicle (222), and struck by cow or other bovine (150). For suspected agricultural cases, the majority (68.2%) represent animal-related injuries. The majority (87.3%) of suspected fishing cases could not be classified to the type of event and source of injury. Further, all 1247 suspected forestry cases (100%) did not have identifiable types of events or sources of injury, but instead were identified due to the forestry incident location E-code. The percentage of men involved in these incidents were highest for true agricultural cases (84%), and lowest for suspected agricultural cases (44%). The average age was the lowest for true agricultural cases at 46.

Table 3 Combination ICD-10-CM E-Codes Mapped to AFF Industry

| Industry | Case Determination          | Number of E-Code Combinations |
|----------|-----------------------------|-----------------------------|
| Agriculture | True Case               | 79                       |
| Agriculture | Traumatic/Acute, Suspected Agriculture | 52                      |
| Fishing   | Traumatic/Acute, Suspected Fishing | 9                        |
Discussion

Development of the crosswalk

The expansion of E-codes in the ICD-10-CM framework has vastly improved our ability to use this system for AFF injury surveillance. While the list of 263 E-codes identified as AFF-related is currently all-inclusive, the possibility exists that new combinations of these 263, within a patient’s record, may permit the determination of additional true cases in future datasets. As future data are processed, the necessity to review new combinations of E-codes will drop, as a progressively larger number of these combinations are adjudicated over time. Therefore, the individual (Table 2) and combination (Table 3) E-code crosswalk will remain beneficial until ICD-11-CM is widely adopted.

Testing the crosswalk

The crosswalk process worked equally well among the data sets from the various states; however, we acknowledge that the completeness of E-codes may vary by state. Nearly one thousand true agricultural cases have been identified using this system, which previously may have gone unknown to injury researchers, given that national sources of occupational injury data, such as SOII, are known to undercount agricultural injuries. (Leigh et al., 2014) This is especially true in the Northeast where many of the farms are small have fewer than eleven employees. (OSHA, 2015; Census of Agriculture, 2017)

Given the fact that is currently not possible to identify true cases in either forestry or fishing, the current system must be viewed as most useful for agriculture. However, E-code combinations that are identified from future hospital datasets may result in more crosswalk matches that point to true forestry or commercial fishing injuries. An example could be a patient record with ocean as the location, fishing boat as the source, and activity for civilian income leading to a case determination of ‘true fishing case’.

While the workforce in agriculture, forestry and fishing differs across the country in terms of numbers, workplace organization and technology, a strength of this approach is that it can be adopted and implemented in other regions. Over time the collective findings become more valuable as they increase in robustness.

Descriptive epidemiology

Consistent with other agricultural injury surveillance research, events involving machinery and animals were most frequently identified in the hospital data. (Landsteiner et al., 2015; Karttunen & Rautiainen, 2013; Gorucu et al., 2015b) This emphasizes that these are important areas for immediate injury prevention attention. Similarly, the large number of suspected agricultural cases involving horses calls for increased injury prevention work, be it aimed at work-related causes or recreational riding. As with much of agriculture, there are ambiguous areas where

Table 4 Records Identified Through ICD-10-CM E-codes Mapped to OIICS

| State | Massachusetts | Vermont | New York | Total |
|-------|---------------|---------|----------|-------|
| Year  | 2016 | 2017 | 2016 | 2017 |
| True Agriculture Records | 128 | 87 | 93 | 655 | 963 |
| Emergency Department | 109 | 73 | 80 | 556 |
| Outpatient | 4 | 3 | 9 | |
| Inpatient | 15 | 11 | 4 | 99 |
| Suspected Agriculture Records | 958 | 849 | 506 | 3536 | 5849 |
| Emergency Department | 890 | 794 | 446 | 3300 |
| Outpatient | 8 | 8 | 55 | |
| Inpatient | 60 | 47 | 5 | 236 |
| Suspected Forestry Records | 199 | 199 | 132 | 717 | 1247 |
| Emergency Department | 175 | 181 | 123 | 644 |
| Outpatient | 3 | 6 | 8 | |
| Inpatient | 21 | 12 | 1 | 73 |
| Suspected Fishing Records | 405 | 360 | 42 | 1103 | 1910 |
| Emergency Department | 380 | 336 | 33 | 988 |
| Outpatient | 5 | 4 | 9 | |
| Inpatient | 20 | 20 | 0 | 115 |
| State Totals | 1690 | 1495 | 773 | 6011 |
### Table 5: Type of Event and Source of Injury, Vermont, Massachusetts, & New York

#### Case Determination By Type of Event and Source of Injury

| Case Determination | Count |
|--------------------|-------|
| 1: True case, Agriculture | 963 |
| 130 - Animal and insect related incidents, unspecified | 62 |
| 5153 - Cattle and other bovines | 59 |
| 5157 - Swine and other porcines | 3 |
| 1313 - Other animal bites, nonvenomous | 11 |
| 5150 - Mammals, unspecified | 3 |
| 5157 - Swine and other porcines | 8 |
| 1320 - Struck by animal, unspecified | 163 |
| 5150 - Mammals, unspecified | 10 |
| 5153 - Cattle and other bovines | 150 |
| 5157 - Swine and other porcines | 3 |
| 1329 - Struck by animal, n.e.c. | 1 |
| 5159 - Mammals, n.e.c. | 1 |
| 139 - Animal and insect related incidents, n.e.c. | 8 |
| 5150 - Mammals, unspecified | 8 |
| 258 - Fall on water vehicle | 3 |
| 832 - Commercial fishing vessel | 3 |
| 260 - Roadway incident involving motorized land vehicle, unspecified | 4 |
| 869 - Off-road or industrial vehicle--powered, n.e.c | 4 |
| 270 - Nonroadway incident involving motorized land vehicle, unspecified | 223 |
| 860 - Off-road or industrial vehicle--powered, unspecified | 1 |
| 869 - Off-road or industrial vehicle--powered, n.e.c | 222 |
| 279 - Nonroadway incident involving motorized land vehicle, n.e.c | 2 |
| 860 - Off-road or industrial vehicle--powered, unspecified | 1 |
| 869 - Off-road or industrial vehicle--powered, n.e.c | 1 |
| 3199 - Agricultural and garden machinery, n.e.c. | 3 |
| 0 - Blank | 3 |
| 60 - Contact with objects and equipment, unspecified | 67 |
| 310 - Agricultural and garden machinery, unspecified | 67 |
| 621 - Struck by powered vehicle--nontransport | 6 |
| 3112 - Combines | 6 |
| 644 - Entangled in other object or equipment | 5 |
| 8634 - Power take-off (PTO) | 5 |
| 69 - Contact with objects and equipment, n.e.c. | 337 |
| 3199 - Agricultural and garden machinery, n.e.c. | 301 |
| 345 - Derricks and related equipment | 4 |
| 3469 - Elevators, hoists, aerial lifts, personnel platforms--except truck-mounted, n.e.c. | 6 |
| 8629 - Industrial vehicle, material hauling and transport--powered, n.e.c. | 26 |
| 7371 - Boarding, alighting--excluding slip, trip, fall--single episode | 28 |
| 2: Traumatic/acute, suspected Agriculture | 5849 |
| 130 - Animal and insect related incidents, unspecified | 2332 |
| 510 - Animals, unspecified | 1770 |
| 5112 - Chickens | 10 |
| 5115 - Turkeys | 3 |
| 5150 - Mammals, unspecified | 10 |
| 5153 - Cattle and other bovines | 111 |
| 5154 - Horses and other equines | 420 |
| 5157 - Swine and other porcines | 8 |
| 1313 - Other animal bites, nonvenomous | 246 |
| 5112 - Chickens | 22 |
| 5113 - Ducks | 2 |
| 5114 - Geese | 1 |
| 5115 - Turkeys | 1 |
| 5150 - Mammals, unspecified | 10 |
| 5153 - Cattle and other bovines | 3 |
| 5154 - Horses and other equines | 147 |
| 5157 - Swine and other porcines | 60 |
| 1320 - Struck by animal, unspecified | 1059 |
| 5112 - Chickens | 11 |
| 5113 - Ducks | 1 |
| 5114 - Geese | 2 |
| 5115 - Turkeys | 1 |
| 5150 - Mammals, unspecified | 57 |
| 5153 - Cattle and other bovines | 225 |
| 5154 - Horses and other equines | 742 |
| 5157 - Swine and other porcines | 20 |
| 1329 - Struck by animal, n.e.c | 136 |
| 5112 - Chickens | 1 |
| 5154 - Horses and other equines | 135 |
| 1381 - Bitten and struck by animal | 1 |
| 5154 - Horses and other equines | 1 |
| 139 - Animal and insect related incidents, n.e.c | 162 |
| 510 - Animals, unspecified | 141 |
| 515 - Mammals, except humans | 3 |
| 5150 - Mammals, unspecified | 18 |
| 2310 - Animal transportation incident, unspecified | 2 |
| 850 - Animal- or human-powered vehicle, unspecified | 2 |
| 2314 - Thrown, tipped, or fell from animal-drawn vehicle | 9 |
| 850 - Animal- or human-powered vehicle, unspecified | 9 |
| 2319 - Animal transportation incident, n.e.c. | 33 |
| 50 - Persons, plants, animals, and minerals, unspecified | 1 |
it may be difficult to assign work-relatedness; however, it is clear that an agricultural source, in this case a horse, is the cause of a disproportionate number of injury events. This is also the case with events common in agriculture injury reporting, such as falls or overexertion. (Browning et al., 1998; Wang et al., 2011) While many falls may be occupationally related, in our approach they were classified as suspected, since there is often not enough detail in a hospital record to know the purpose of the task that lead to the injury.

The average age and gender breakdown are also consistent with previous literature. We note that the percentage of male workers is lower among suspected agricultural cases than for the other categories. In this analysis, we suspect that these are due to the relative number of horse-riding incidents, where women are more frequently injured than men. (Scott et al., 2017b)

Limitations
E-codes are not required for hospital reimbursement; therefore, less emphasis may be placed on the completion of these codes compared to codes that relate to payment. This crosswalk will only identify and categorize injury events where hospital medical care was delivered. Therefore, injuries requiring only first aid, ambulance care with refused transport, or occupational fatalities (without hospital transport) will be missed by this system. Ideally, techniques such as this one would be used in addition to other occupational injury surveillance methods, such as text search of PCRs, news clipping services, occupational injury surveys, and existing state and federal systems such as SOII or the Census of Fatal Occupational Injury.

In addition to using other sources of data to compliment hospital data, more research needs to be done to assess if E-codes are applied at the same rate to inpatient, outpatient, and emergency department records. If the application of E-code varies, this crosswalk approach may distort the true injury trends.

Using hospital data alone, we cannot definitively assign occupational status to the suspected cases nor can we always determine the exact type of event or source of

| Case Determination By Type of Event and Source of Injury | Count |
|---------------------------------------------------------|-------|
| 850 - Animal- or human-powered vehicle, unspecified     | 32    |
| 259 - Water vehicle incident, n.e.c.                   | 1     |
| 832 - Commercial fishing vessel                        | 1     |
| 510 - Animals, unspecified                             | 1     |
| 0 - Blank                                               | 1     |
| 5154 - Horses and other equines                        | 5     |
| 0 - Blank                                               | 5     |
| 5157 - Swine and other porcines                        | 1     |
| 0 - Blank                                               | 1     |
| 9999 - Nonclassifiable                                 | 1861  |
| 0 - Blank                                               | 1     |
| 9999 - Nonclassifiable                                 | 1860  |
| 2: Traumatic/acute, suspected Forestry                 | 1910  |
| 130 - Animal and insect related incidents, unspecified | 38    |
| 512 - Fish, shellfish                                  | 38    |
| 1320 - Struck by animal, unspecified                   | 26    |
| 512 - Fish, shellfish                                  | 26    |
| 250 - Water vehicle incident, unspecified              | 10    |
| 832 - Commercial fishing vessel                        | 10    |
| 2521 - Collision between water vehicles                | 3     |
| 832 - Commercial fishing vessel                        | 3     |
| 2522 - Collision between water vehicle and object      | 1     |
| 832 - Commercial fishing vessel                        | 1     |
| 253 - Explosion or fire on water vehicle               | 2     |
| 832 - Commercial fishing vessel                        | 2     |
| 254 - Capsized or sinking water vehicle                | 3     |
| 832 - Commercial fishing vessel                        | 3     |
| 256 - Fall or jump from water vehicle                  | 1     |
| 832 - Commercial fishing vessel                        | 1     |
| 257 - Machinery or equipment incident on water vehicle | 1     |
| 832 - Commercial fishing vessel                        | 1     |
| 258 - Fall on water vehicle                            | 16    |
| 832 - Commercial fishing vessel                        | 16    |
| 259 - Water vehicle incident, n.e.c.                   | 5     |
| 832 - Commercial fishing vessel                        | 5     |
| 430 - Fall to lower level, unspecified                 | 135   |
| 6691 - Piers, wharfs                                   | 135   |
| 50 - Exposure to harmful substances or environments, unspecified | 1 |
| 9999 - Nonclassifiable                                 | 1     |
| 9999 - Nonclassifiable                                 | 1668  |
| 0 - Blank                                               | 4     |
| 6691 - Piers, wharfs                                   | 1     |
| 9999 - Nonclassifiable                                 | 1663  |

Note: The numeric codes are the corresponding OIICS event and source codes

| Case Determination By Type of Event and Source of Injury | Count |
|---------------------------------------------------------|-------|
| 2: Traumatic/acute, suspected Fishing                    | 1247  |
| 9999 - Nonclassifiable                                  | 1247  |
| 0 - Blank                                               | 6     |
| 9999 - Nonclassifiable                                  | 1241  |
| Grand Total                                            | 9969  |

Table 5 Type of Event and Source of Injury, Vermont, Massachusetts, & New York (Continued)

Table 5 Type of Event and Source of Injury, Vermont, Massachusetts, & New York (Continued)
injury. Inherently, the cases are captured because of the activity at the time of the injury, not because of occupation or industry information. Therefore, it is possible that injuries occurring in a farm setting, but not related to work, would be captured. However, future research should assess the E-codes found in suspected cases compared to the information in a linked ambulance record, for example.

Conclusions
The crosswalk provides a reproducible, low-cost, and rapid means to identify and code AFF injuries from hospital data. The use of this crosswalk is best suited to identifying true agricultural cases; however, capturing suspected AFF injury cases provides valuable data, as well. This system can be used on many state’s datasets and will remain useful until ICD-11-CM is widely adopted. One major benefit of the crosswalk, and using hospitalization data in general, is that we can better understand the direct costs of injury in these industries. Likewise, enough demographic variables exist in these datasets, as well, to target appropriate groups for public health interventions. This crosswalk represents a promising addition to the injury epidemiologist’s toolbox of surveillance techniques.

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s40621-021-00300-6.

Additional file 1:

Abbreviations
AFF: Agriculture, forestry, and fishing; SOI: Survey of Occupational Injuries and Illnesses; I&O: Industry and Occupation; NIOSH: National Institute for Occupational Safety and Health; PCR: Pre-hospital care reports; ICD-10-CM: International Classification of Diseases – Clinical Modification tenth version; OIICS: Occupational Injury and Illness Classification System; CDC: Centers for Disease Control and Prevention; E-codes: External cause of injury codes

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Authors’ contributions
ES devised the concept for this study, performed the lead data review, and authored the majority of the manuscript. LH provided counsel on the research protocols, developed the Access databases necessary to perform the review, and authored parts of this manuscript. JG was responsible for much of the record review, assisted by MS (acknowledgements). NK performed the statistical analysis of hospital data using SAS 9.3. PJ reviewed the overall methods and edited the manuscript. All authors approved the submitted manuscript.

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Availability of data and materials
The data that support the findings of this study are available from the New York Statewide Planning and Research Cooperative System (SPARCS), Massachusetts Center for Health Information and Analysis (CHIA), and the Vermont Green Mountain Care Board (GMCB) but restrictions apply to the availability of these data, which were used under license for the current study. Those interested in applying for these data may do so by contacting SPARCS [https://www.health.ny.gov/statistics/sparcs/forms/], CHIA [https://www.chiamass.gov/], and the GMCB [https://gmcboard.vermont.gov/webform/VIUHDDS-PUF]. The crosswalk developed by the authors is available by a written request to the corresponding author. It will also be made publically available on our website at necenter.org.

Ethics approval and consent to participate
This research was approved by the Institutional Review Board of the Mary Imogene Bassett Hospital (Bassett Medical Center).

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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