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Use of Statewide Electronic Emergency Department Data for Occupational Injury Surveillance: A Feasibility Study in Massachusetts

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Background *Statewide datasets of emergency department (ED) visits may be useful for occupational injury surveillance. Using data from 12 hospitals, we evaluated two indicators of work-relatedness in reported ED data and the availability of employment information in medical charts.*

Methods *Workers' compensation as payer and/or "yes" in an injury-at-work field were used to define probable work-related (PWR) injury visits in the Massachusetts ED dataset. Charts were reviewed for a sample of 1,002 PWR and 250 probable non-work-related (PNWR) cases.*

Results *Using chart information as the gold standard, indicators of work-relatedness had a sensitivity of 82%, specificity of 97%, and predictive value positive of 86%. Employer name was in charts for 89% of PWR and 42% of PNWR cases. Occupation was available for 34% of PWR cases.*

Conclusion *Electronic ED data are useful for state surveillance of occupational injuries. Improvements in attribution of work-relatedness and collection of available employer identifiers and occupational information would enhance its usefulness. The performance of indicators of work-relatedness in ED datasets should be examined in different states.* Am. J. Ind. Med. 55:344–352, 2012. *© 2011 Wiley Periodicals, Inc.*

KEY WORDS: occupational injury; surveillance; emergency department data

INTRODUCTION

Nonfatal occupational injuries are a significant public health problem in the United States, imposing substantial human and economic costs [CDC, 2007]. Surveillance of occupational injuries is essential to guide educational and regulatory interventions, inform development of new lower risk technologies, establish research priorities and monitor progress in meeting injury reduction goals. Occupational injury surveillance is important at both the national and state levels. National data are needed to establish national priorities and programs, however, relying on national statistics can obscure safety concerns that may be specific to a particular state. State data are needed to inform state and local occupational injury prevention priorities [Council of State and Territorial Epidemiologists, 2001]. Additionally, publication of state data can be a

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powerful means of gaining the support of local policy makers and the public for needed interventions.

Whereas a comprehensive national system for surveillance of fatal occupational injuries at the state and national levels has been in place since the early 1990s, surveillance of nonfatal occupational injuries in the United States remains fragmented and has significant gaps. [Institute of Medicine and National Research Council, 2009]. National and state estimates of nonfatal injuries based on the Survey of Occupational Injuries and Illnesses (SOII) are published annually by the Bureau of Labor Statistics. However, the national estimates exclude the self employed, household workers, workers on small farms, and, until recently, public sector workers [Ruser, 2008], who together comprise approximately 22% of the workforce [Leigh et al., 2004].[1] Estimates of under reporting of injuries and illnesses in this survey, which is based on data collected from a stratified sample of business establishments, range widely from 20% to 70% [Conway and Svenson, 1998; Leigh et al., 2004; Rosenman et al., 2006; Boden and Ozonoff, 2008]. There is also concern about differential reporting depending on characteristics of the worker, the injury or the work establishment [Azaroff et al., 2002, 2004; Friedman and Forst, 2006]. Workers' compensation (WC) records have been used very successfully for surveillance of nonfatal occupational injuries in some states, but these too exclude certain sectors of the workforce and are subject to systematic biases in workers' filing for compensation by worker, injury, and establishment characteristics [Morse et al., 2000; Shannon and Lowe, 2002; Fan et al., 2006; Nicholson et al., 2008]. In many states, WC databases are either not available, not usable for injury surveillance purposes, or, as in Massachusetts, limited to claims for lost time injuries only. The number of workdays that must be lost to be eligible for wage benefits, as well as the benefits themselves, vary from state to state. In Massachusetts, for example, workers' must miss at least 5 or more workdays to be eligible for wage benefits, thus the available WC data do not provide information about injuries resulting in fewer lost days, generally the less serious injuries.

In 1988, approximately one-third of occupational injuries were treated in emergency departments (EDs) [CDC, 1998]. It is not known what proportion is treated in EDs today, nevertheless, ED records are an important complement to employer-based sources of information. They can provide surveillance data on a wide spectrum of medically treated occupational injuries among individuals in all industry sectors as well as the self-employed. Because they can allow for follow-back with injured individuals, they can serve as a case ascertainment source for more intensive study of targeted injuries or populations. And because they can capture injuries among the population at large, they can provide a means to assess the contribution of occupational injury to the overall injury burden.

At the national level, both the National Hospital Ambulatory Care Survey (NHAMCS) and the National Electronic Injury Surveillance System occupational supplement (NEISS-Work) have been used for surveillance of occupational injuries. Each of these systems collects data on ED visits from a sample of US hospitals identifying work-related injuries from self-reported information in the medical charts.[2] Based on the 2006 NHAMACS survey, 9.6% of ED visits for injuries by the working age population, approximately 3.8 million ED visits, were for work-related injuries. Information about work-relatedness was missing for about 9% of the visits [National Center for Health Statistics, 2008]. Analysis of NEISS-Work data for 2004 identified an estimated 3.4 million nonfatal ED-treated work-related injuries and illness nationwide, of which 90–95% were injuries [CDC, 2007]. A NEISS hospital audit in 2000 that targeted all injury and illness cases found indications that the abstractors missed the work relationship for about 17% of the work-related cases [AdvanceMed. 2001]. The sensitivity, specificity, and predictive value of NEISS-Work and NHAMACS with respect to occupational injuries have not been formally evaluated. Notably, data from neither NEISS nor NHAMACS can be disaggregated by geography, limiting its utility for surveillance at the state level.

Approximately half of the states now have statewide databases of ED records for administrative or other purposes [CDC, 2008]. These are potentially useful for surveillance of occupational injuries at the state and local levels. In 1997, the Massachusetts Department of Public Health (MDPH) implemented the Massachusetts Emergency Department Injury Surveillance System (EDISS), a statewide, electronic E-coded surveillance system to track the incidence and causes of all injuries treated in a representative sample of hospital EDs. The present study was undertaken using data reported to EDISS to assess the feasibility of using statewide electronic E-coded ED data for surveillance of occupational injuries. We evaluated the sensitivity, specificity, and predictive value of two indicators of work-relatedness of injury reported to EDISS and determined the availability of information about employer, industry, and occupation in both the medical charts and

[1] In 2008 SOII expanded its scope to include state and municipal workers nationwide. Prior to that time, SOII collected data on state and municipal workers in only select states.

[2] Since 2007, NHAMACS no longer asks "Is this visit work-related?" but relies on payment by workers' compensation as an indicator of work-relatedness.

the electronic data systems of the EDISS hospitals. The completeness and accuracy of International Classification of Disease External Cause of Injury codes (E codes) reported to EDISS were also evaluated. These findings have been reported elsewhere [Hunt et al., 2007].

METHODS

EDISS collected ED data from a sample, stratified by geography and patient volume, of 12 hospitals from a total of 79 Massachusetts acute care hospitals for a 40-month period during 1998–2001. Electronic administrative data were collected by EDISS on all nonfatal, nonadmitted visits that were assigned an ICD Ninth Revision Clinical Modification (ICD-9-CM) diagnostic code (in any of six fields) in the range of 800–999, and/or any ICD-9-CM E code in the range of E800–E999. The ICD-9-CM codes submitted to EDISS were assigned by trained coders at the hospitals. The information reported included patient demographics, diagnostic codes, E codes, and payer. ED visits that resulted in patient admissions to the hospital were not reported to the surveillance system. Statewide data on inpatient hospitalizations, which capture the more serious injuries, are maintained in a separate state dataset. Statewide estimates of counts and rates of injury visits and the proportion of injury visits for which WC was designated as payer based on weighted data from the EDISS hospitals in 2001 were similar to findings based on ED data collected from all hospitals in 2002.

Two indicators of work-relatedness were included in data reported to EDISS: the designation of WC as the payer and an injury-at-work (IAW) yes/no field. Payer information was submitted by all 12 participating EDISS hospitals, however, WC was not a payer option at two of the hospitals. Data in the IAW field were submitted by only four hospitals, including the two with no WC payer option. EDISS cases with *either* WC designated as payer *or* an IAW value of ''yes,'' or both, were considered probable work-related (PWR). If neither of these criteria were met, the cases were considered probable nonwork-related (PNWR).

A study sample of 1,048 PWR and 262 PNWR cases was drawn from injury visits by persons aged 14–75 years to hospital EDs during March 1, 1999–February 29, 2000, and reported to EDISS using stratified proportional sampling (PROC SURVEYSELECT SAS V 8; SAS, Inc, Cary, NC). PWR cases were over-sampled in a 4:1 ratio because the primary research interest was in work-related injuries.

Chart reviews for sampled cases were performed by expert data abstractors who collected the following information: employer's name and address (up to 2), employer's industry (up to 2), patient's occupation (up to 2), and the location of each of these within the medical record for the visit; the presence of an ''IAW'' field in the medical record and the information in that field, and the primary payer listed for the visit. Abstractors were also instructed to provide their assessment of ''work-relatedness'' of the injury based on narrative information in the chart, independent of the payer, and information in the ''IAW'' field. Consistent with national guidelines (NIOSH, 2001), an injury was considered work-related if it occurred while the patient was working for pay or compensation, while arriving at or leaving work but on employer premises, working on a farm, or as a volunteer for an organized group. Self-inflicted injures at work were excluded. Possible responses for this assessment were 1) work-related, not active military, 2) work-related, active military, 3) not work-related, 4) unsure if work-related (with space for explanation), and 5) unspecified. Sports and motor vehicle-related injuries not specifically identified in the records as work-related were considered to be not work-related. Cases for which data abstracters designated work-relatedness as ''unsure'' were reviewed by occupational health experts, and, where possible, reassigned as work-related or not work-related. Injuries consistent with occupational titles but not clearly specified as work-related in the narrative, for example, fall from roof by roofer were designated work-related.

The sensitivity, specificity, predictive value positive (PVP) and predictive value negative (PVN) of the two indicators of work-relatedness (payer = WC and IAW = yes) were calculated using the record abstractors' assessment of work-relatedness as the gold standard. These measures were calculated for WC + IAW and WC only. The two hospitals that did not include WC as a payment option were excluded in calculating measures for WC only. Due to the infrequent and inconsistent use of the IAW field across hospitals, these measures were not calculated for IAW indicator alone. Separate measures were calculated for three age groups (14–24, 25–54, and 55–75 years) and by sex. The availability of employment information was assessed using simple frequencies.

Since the study sample was disproportionately (i.e., 4 PWR cases to 1 PNWR case) drawn from the EDISS sample, PWR and PNWR cases were weighted to reflect the distribution of the EDISS sample. Weights were the inverse of the probability of being sampled, and sampling probabilities were determined using the distribution of the final study sample. Because the analysis of sensitivity, specificity, and predictive value was performed for each gender and three age groups, weights were also computed separately to make each subsample analogous to that of the whole EDISS sample. Statistical significance of differences in proportions was determined using a Wald statistic. Variances were adjusted to reflect the unweighted counts.

To assess the feasibility of routinely collecting employment information available in the charts as part of the surveillance system, telephone interviews were completed with medical record or information technology staff at each of the 12 EDISS hospitals. Respondents were asked if the electronic records for patients treated in EDs had separate fields for employer name, industry, or occupation, and, if so, whether this information was collected as part of the patient registration process.

The study was approved by the Human Research Review Committee for the MDPH. Because this was a data validation and assessment study using existing data sources, informed consent was not required.

RESULTS

There were 108,328 injury visits by persons aged 14–75 reported to EDISS for the study period. Of these, 17,820 were identified as PWR cases using the two indicators of work-relatedness; 12,921 were identified solely through the designation of WC as payer, 2,530 solely through the designation of IAW, and 2,369 through both.

The use of IAW field differed substantially across hospitals. Eight of the hospitals used only the designation of WC in the payer field and never completed the IAW field. In two hospitals, WC was never used as payer option and work-related injury visits were indicated only by the IAW field. In the two hospitals where both indicators were used, 245 out of 2,772 PWR injury visits (8.8%) were identified by the IAW field only. While it would be expected that all WC cases should also have been designated as IAW, 158 (5.7%) of the PWR cases in these two hospitals were identified only by designation of WC as payer.

Of the initial 1,310 cases selected for the study sample, 1,252 (95.5%) had charts available for review and were retained as the final study sample. The proportion of PNWR cases in the final study sample that were male was significantly less than the proportion in EDISS ($P = 0.046$), otherwise, the age and sex distributions in the final study sample and in EDISS as a whole were similar (Table I).

The distribution of injury visits in the study sample by work-relatedness as determined by EDISS indicators and chart review are shown in Table II, along with the weighted counts used to calculate sensitivity, specificity, PVP, and PVN. Cases with unsure work-relatedness in the chart review were combined with cases identified as non-work-related in chart review in making these calculations.

The estimated sensitivity of the two EDISS indicators combined was 82.4%, indicating that the EDISS indicators failed to capture 17.6% of the injuries designated as work-related based on review of the charts (Table III). The estimated PVP of the EDISS indicators was 85.7%. For a significant proportion of the EDISS PWR cases reviewed (13.5%), information about the work-relatedness of the injury in the charts (other than the payer and IAW fields) was ambiguous and work-relatedness was rated as ''unsure.'' In less than 1% of the 1,002 EDISS PWR cases reviewed was their evidence in the charts that contradicted the EDISS work-related indicators. False positives were therefore due primarily to the ambiguous information rather than the presence of contradictory information about work-relatedness in the charts. The specificity of the EDISS indicators was very high 97.2%, indicting that only 2.8% of injury visits identified as PNWR in the charts were misclassified as work-related using the payer and IAW information reported to EDISS.

TABLE I. Distribution of Injury Visits by Sex and Age Group and Work-Relatedness, All Cases Reported to the Emergency Department Injury Surveillance System (EDISS) and the Study Sample, Massachusetts, March, 1999—February, 2000

	EDISS			Study sample		
	All injury visits (%)	PNWR injury visits (%)	PWR injury visits (%)	All injury visits (%)	PNWR injury visits (%)	PWR injury visits (%)
Gender						
Male	60,264 (55.6)	48,069 (53.1)	12,195 (68.4)	821 (65.6)	117 (46.8)[a]	704 (70.3)
Female	48,064 (44.4)	42,439 (46.9)	5,625 (31.6)	431 (34.4)	133 (53.2)	298 (29.7)
Age (years)						
14–24	32,151 (29.7)	27,886 (30.8)	4,265 (24.0)	314 (25.1)	77 (30.8)	237 (23.7)
25–54	61,811 (57.1)	49,446 (54.6)	12,365 (69.4)	842 (67.3)	137 (54.8)	705 (70.4)
55–75	14,366 (13.3)	13,176 (14.6)	1,190 (6.7)	96 (7.7)	36 (14.4)	60 (6.0)
Total	108,328	90,508	17,820	1,252	250	1,002

PWR, probable work-related; PNWR, probable not work-related.

[a]The proportion of PWNR males in the study sample is significantly less than the proportion in EDISS, $P = 0.046$.

TABLE II. Distribution of Injury Visits in the Study Sample and (Weighted Estimates of All Injury Visits) Reported to the Emergency Department Injury Surveillance System (EDISS) by Work-Relatedness as Determined by EDISS Indicators and Chart Review, Massachusetts, March, 1999–February, 2000

	Chart work-related			
	Yes	No	Unsure	Total
EDISS probable work-related				
Yes	859 (15,273)	8 (142)	135 (2,400)	1002 (17,815)
No	9 (3,258)	223 (80,733)	18 (6,517)	250 (90,508)
Total	868 (18,531)	231 (80,875)	153 (8,917)	1252 (108,323)

The sensitivity of the EDISS indicators was significantly higher for females than males ($P < 0.001$) and for the 25–54 year age group compared to the older and younger groups ($P < 0.05$). Specificity and PVN were similar across sexes and age groups. PVP was significantly lower in the oldest age group compared with the other two age groups indicating that older workers were less likely than workers of other ages to have notation of work-relatedness in their charts ($P < 0.05$).

When using the designation of WC alone as the indicator of work-relatedness, the overall estimates of sensitivity, specificity, PVP, and PVN were very similar to those using the two EDISS indicators combined (Table IV). The difference in sensitivity by sex was no longer apparent, and in contrast to the findings for the two indicators combined, sensitivity was lower for workers in the 14- to 25-year-old age group than the two older age groups. Among the 17,820 total PWR injuries reported to EDISS, use of payer WC as the only indictor of work-relatedness would have identified 2,530 (14%) fewer work-related cases over all participating hospitals, but only 164 (1%) fewer in those hospitals where WC was a payment option.

Employer name was available in the charts for 89% of the PWR cases in the study sample, compared to 42% of the PNWR cases ($P < 0.001$). When the PNWR cases reported as ''not working'' were excluded, employer name was available for 55% (106/193), still less often than for the PWR cases. Applying the sampling weights, it is estimated that 50% of all cases reported to EDISS during the study period had information about employer name in the medical records. Street address and zip code of the employer were available for 77% and 35% of the PWR cases and PNWR cases (including those not working), respectively (Table V). Trained industry coders were able to assign Standard Industrial Classification codes to 98% of the PWR and 55% of the PNWR cases with employer name information (88% and 42% of all PWR and PNWR cases, respectively).

Information about the industry in which the injured individual was employed, independent of employer name, was available for only 13% of the PWR cases and 4% of the PNWR cases. Information about occupation was somewhat more likely to be available with 34% of the PWR cases and 18% of the PNWR having information about occupation in the medical charts.

Among cases for which information on employer was available, it was most often found on the Face Sheets (88%) followed by industrial accident reports (20%). For those cases with industry and occupation information available, this information was most often found on Face Sheets (industry: 67%; occupation: 80%) and in summary reports (industry: 15%; occupation: 10%). Clinical notes had information about employer, industry, or occupation in less than 1% of all cases and less than 7% of cases for which some employer, industry, or occupation information was available.

Telephone interviews conducted during 2004 with admitting or registration staff at the 12 EDISS hospitals revealed that all 12 hospitals had separate fields for employer name, for occupation, and for IAW in their electronic administrative/billing record data systems. None had a separate field for industry. In all hospitals, the

TABLE III. Estimated Sensitivity, Specificity, Predictive Value Positive and Negative of Indicators of Work-Relatedness Reported to the Emergency Department Injury Surveillance System by Sex and Age Groups, Massachusetts, March 1999–February, 2000

	% Sensitivity (95% CI)	% Specificity (95% CI)	% Predictive value positive (95% CI)	% Predictive value negative (95% CI)
All injury cases	82.4 (79.7–84.8)	97.2 (95.6–98.9)	85.7 (83.6–87.9)	96.4 (94.1–98.7)
Male	78.6[a] (75.3–81.8)	96.5 (94.0–99.0)	86.5 (84.0–89.0)	94.0 (89.7–98.3)
Female	88.1[a] (84.1–92.1)	97.9 (95.8–100.0)	83.9 (79.7–88.0)	98.5 (96.4–100.0)
Age 14–24	72.5[b] (66.5–78.4)	98.3 (95.8–100.0)	89.5 (85.5–93.4)	94.8 (89.8–99.7)
Age 25–54	85.4[b] (82.6–88.2)	96.4 (94.0–98.8)	85.5 (82.9–88.1)	96.3 (93.2–99.5)
Age 55–75	70.5[b] (57.1–83.8)	97.6 (93.5–100.0)	73.3[c] (62.1–84.5)	97.2 (91.8–100.0)

95% CI, 95% confidence interval.

[a]Sensitivity is significantly different across genders $P < 0.001$.

[b]Sensitivity in the 22–55 age group is significantly different from the other two age categories; $P < 0.05$ in pair-wise comparisons.

[c]Predictive value positive in the 55–75 age group is significantly different from the two younger age groups; $P < 0.05$ in par-wide comparisons.

TABLE IV. Estimated Sensitivity, Specificity, Predictive Value Positive and Negative of Payment by Workers' Compensation as an Indicator of Work-Relatedness by Sex and Age Groups, Emergency Department Injury Surveillance System, Massachusetts, March 1999—February, 2000

	% Sensitivity (95% CI)	% Specificity (95% CI)	% Predictive value positive (95% CI)	% Predictive value negative (95% CI)
All injury cases	83.0 (80.3–85.7)	97.4 (95.6–99.2)	87.2 (85.0–89.4)	96.4 (94.0–98.8)
Male	80.7 (77.3–84.1)	96.9 (94.1–99.6)	88.6 (86.0–91.2)	94.3 (89.8–98.8)
Female	84.9 (80.2–89.7)	98.0 (95.8–100.0)	84.2 (79.7–88.7)	98.1 (95.7–100.0)
Age 14–24	74.4[a] (68.0–80.7)	98.7 (96.3–100.0)	91.8[b] (87.9–95.6)	95.3 (90.3–100.0)
Age 25–55	85.1[a] (82.0–88.1)	96.8 (94.3–99.3)	87.1[b] (84.4–89.8)	96.2 (92.9–99.5)
Age 55–75	97.4[a] (92.5–100.0)	97.2 (92.4–100.0)	70.4[b] (58.2–82.5)	99.8 (98.3–100.0)

95% CI, 95% confidence interval.
[a]Sensitivity is significantly different across age categories; $P < 0.003$ in pair-wise comparisons.
[b]Predictive value positive in 55–75 age group is significantly different from the two younger age groups; $P < 0.01$ in pair-wise comparisons.

employment information was collected by admitting staff as part of the patient registration process. In four hospitals the collection of employer name was considered mandatory.

DISCUSSION

The feasibility of using statewide electronic ED data for occupational injury surveillance depends on, first, on our ability to distinguish ED visits resulting from injuries due to work activities, and secondarily, on our ability to stratify the data by industry and/or occupation. The foregoing analysis has shown that the use of payment by WC insurance as an indicator of work-relatedness captured 83% of work-related injuries identified as such in the medical records of the 12 EDISS hospitals. A separate IAW variable was used rarely and apparently inconsistently. Employer name, while not contained in the EDISS dataset of ED visits, appeared to be readily available in medical charts for most work-related cases.

TABLE V. Availability of Employer Information in Medical Charts of Study Sample and All Cases (Estimated) Reported to the Emergency Department Injury Surveillance System, Massachusetts, March, 1999—February, 2000

	PWR injuries N (%)	PNWR injuries N (%)	All EDISS estimated[a] (%)
Employer Name	890	106	
	89%	42%	50%
Employer Street Address	768	91	
	77%	36%	43%
Employer City/Town	772	88	
	77%	35%	42%
Employer State	700	83	
	70%	33%	39%
Employer Zip code	423	35	
	42%	14%	19%
Total	1002	250	
	100%	100%	100%

[a]Proportion of all EDISS cases estimated using proportions of PWR and PNWR cases and sampling weights.

Findings based on WC as the sole indicator are most generalizable to other state ED data systems and are therefore the focus of this discussion. The observed sensitivity of the WC indicator was similar to that of 83% reported by [Sorock et al., 1993] in a study of hospitalized work-related amputations in which patient interviews were used as the gold standard. It is also consistent with the finding that payment by WC identified 20% of work-related injuries identified as such on intake in an academic health center ED [Nicholson et al., 2008]. The PVP in the present study (87.2%) was lower than the 98% reported by Sorock et al. (1993), who did not have the large fraction of cases with ambiguous information on work-relatedness. The relatively low PVP reported here was due primarily to ambiguous information about work-relatedness in the medical records for the PWR cases rather than the presence of contradictory information.

The finding that close to 10% of the cases had ambiguous information about work-relatedness is this study is similar to that seen in the 2006 NHAMCS and indicates that the narrative information in the medical chart is a less than perfect gold standard for determining work-relatedness. The medical charts capture only the information both queried and recorded by ED staff. Healthcare providers often fail to ask patients about work-relatedness of their conditions [Sama et al., 2003]. Because ED providers are focusing on treatment issues in an urgent care setting, they may be less likely than other providers to record detailed injury circumstances in the medical chart. Additionally, injured workers may not inform either administrative or clinical ED staff that their injuries occurred at work [Jackson, 2001]. According to a recent nationwide survey

of occupational healthcare providers, 53% reported being pressured by employers to downplay work-related injuries and illnesses, and 47% reported being pressured by workers to do so [Government Accounting Office, 2009]. Findings from the 2007 Behavioral Risk Factor Survey in Massachusetts suggest that an estimated 59% of workers with self-reported occupational injuries in the prior 12 months had their medical care paid for by WC. Estimates from nine other states for that same year ranged from 47% to 77% [CDC, 2010].

Patients' willingness to report their injuries as work-related or to apply for WC is likely affected by a wide range of social and economic factors: the availability of other health insurance, avoidance of hassles in applying for compensation, fear of discrimination by current or future employers based on WC or occupational injury history, legal employment status and immigration status, and personal relationship with the employer [Azaroff et al., 2004]. Workers' lack of awareness of WC as a payment option is also barrier to use and has been shown in Massachusetts to vary by race/ethnicity and country of birth [Massachusetts Department of Public Health, 2007]. It is not known how ED staff document injuries in those situations in which the provider's perception of work-relatedness of injury is inconsistent with information provided by the patient. For these reasons, the measures of sensitivity, specificity, and predictive value in this study are most appropriately interpreted as measures of the degree to which the information that is reported to EDISS reflects the information contained in medical charts rather than assessment of the ability of the EDISS to reliably detect true work-related and nonwork-related injuries treated in EDs.

It has also been observed that severity of injury is a strong predictor of a worker's likelihood of applying for WC [Rosenman et al., 2000], thus the severe injuries examined in Sorock et al. [1993] are more likely to have been paid for by WC than a series of less severe injuries. This study examined a mix work-related injuries, both severe, and not so severe and it might be expected that the sensitivity of the WC indicator would be lower than reported by Sorock et al. [1993] had information from patient interviews been available. Future studies of the sensitivity and predictive value of indicators of work-relatedness should employ external sources of information, such as patient interviews, as the gold standard and look more closely at performance by injury type and severity.

There is some evidence that young workers injured on the job are less likely to apply for WC than older workers [Fingar et al., 1992; Brooks and Davis, 1996; Biddle et al., 1998]. The lower sensitivity in younger age group may be indicative of failure of young workers to apply for WC.

It had been hypothesized that the IAW variable would enable the system to detect work-related injuries among individuals not using WC or not covered, most notably, the self-employed. We found, however, that the use of the IAW field was inconsistent, making interpretation difficult. In the two hospitals where both indicators were used, the IAW field identified an additional 8 PWR cases, only one of whom was reported as self-employed. Standardized guidance and training for hospital staff on how this data element is defined and how it is to be completed would be necessary to improve its usefulness. To maximize its added value, this data element should be defined to include work-related injuries among all working populations, for example, farm workers and the self-employed, not just those eligible for WC, similar to the guidance that the Bureau of Labor Statistics provides for the Census of Fatal Occupational Injuries [U.S. Department of Labor, 2004]. Notably, Massachusetts has recently included an IAW field in the statewide trauma registry that now includes information on all inpatient hospitalizations for injuries, and it will be possible to compare this field with payment information in the future.

The fact that 2 of the 12 hospitals did not include WC as a payer option but appeared to rely on the IAW work variable is noteworthy and has practical implications for those using hospital data for occupational injury surveillance. The presence of WC as an option can be assessed by looking at hospital specific payer data and should be done so prior to using the payment variable to generate estimates of work-related injuries.

Industry and occupation information are commonly used as proxies for exposure to workplace hazards in occupational epidemiology. Employer information can be coded to industry or used to directly assess injury patterns among employees of individual establishments. The finding that employer name was present in the charts of most PWR cases and as a data field in all medical registration systems has important ramifications for occupational surveillance and research. Because EDISS did not include data fields for employer information, it was not possible in this study to assess the extent to which the available information is computerized and included in the electronic data systems within hospitals. However, the experience of the ongoing Massachusetts surveillance system for work-related injuries to teens, which are required to be reported under public health regulations, indicates that computerized data on employer name and address are available for over 95% of the cases treated in EDs. This suggests that it would be feasible to collect this information for ED cases electronically posing little if any additional burden on the hospitals. Confidentiality concerns and the practical issue of coding employer information for thousands of ED cases remain potential obstacles to using these data in routine surveillance. While routine collection

and coding of employer information for all work-related injuries may not be feasible, at a minimum, state agencies should have legal access to the employer name information for targeted studies or for periodic surveillance of targeted injuries.

Information about the patient's occupation was available much more often than information about the industry (34% vs. 13%) for PWR cases and was found most often (80%) on Face Sheets. The fact that there was a field for occupation but not industry the registration systems used by all hospitals in this study suggests that occupation information may be perceived as more clinically relevant or more easily ascertained from patients than industry, and that occupation information may be most likely to be collected on intake rather than in the clinical encounter. These issues remain to be explored. The practicality of coding the occupation data were it to be collected in state ED data system could remain an obstacle for the effective use of this information. However, the National Institute for Occupational Safety and Health is developing a new automated system for coding narrative industry and occupation information that will be available for application to hospital and other records [NIOSH, 2011].

Because the design of the initial EDISS sample was not taken into account in this analysis, findings in this study cannot be generalized to the state as a whole. The EDISS hospitals were found to be largely representative of hospitals statewide with respect to the distribution of injury visits by nature of injury and proportion for which WC was designated as payer. It is possible that the hospitals participating in EDISS had slightly better electronic data systems than the nonsampled hospitals, yet there is little reason to believe that this influenced the performance of the indicators of work-relatedness. As noted, WC systems do vary by state and the performance of the indicators in other states may be influenced by the state-specific characteristics of these systems.

In sum, findings from the 12 EDISS hospitals indicate that payment by WC is a good, if conservative indicator of work-relatedness for surveillance purposes, and suggest that statewide ED data systems can be an important data source for tracking occupational injuries at the state and local levels. However, it should be noted the performance of WC as an indicator of work-relatedness needs further investigation in other states with different WC systems. An IAW field could improve case ascertainment in ED date systems, however, standard definitions and training of hospital personal in use of this variable would be necessary to assure its usefulness. The collection of employer identifiers would substantially enhance the usefulness of these systems and would appear impose little burden on hospitals as this information is routinely collected. It may also be possible to collect occupation and new automated coding tools may make coding of this information feasible. These findings have important implications for current efforts to assure that information about occupation, industry, and work-relatedness is included in electronic health records [IOM, 2011].

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