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Using Emergency Department Surveillance Data to Assess Occupational Injury and Illness Reporting by Workers

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Objective *Researchers from the National Institute for Occupational Safety and Health (NIOSH) share detailed methodologies from conducting two follow-back studies initiated in 2010 that were designed to assess whether workers reported their injuries and illnesses to their employers and to identify worker incentives and disincentives for reporting work-related injuries to employers.*

Methodology *Study respondents were sampled from the National Electronic Injury Surveillance System occupational supplement (NEISS-Work), an emergency department-based surveillance system. Telephone interviews were used to collect information directly from workers.*

Outcomes *Among persons treated in emergency departments who could be identified as working at the time of injury or illness, most reported their injury or illness to their employer. Our studies did not assess if these reported injuries and illnesses were recorded on the Occupational Safety and Health logs.*

Discussion *Our approach suggests that emergency department-based surveillance data are limited in their utility to investigate underreporting among workers.* Am. J. Ind. Med. 59:600–609, 2016.

KEY WORDS: survey methodology; occupational injuries; occupational illnesses; surveillance; telephone interviews

INTRODUCTION

Since the passage of the Occupational Safety and Health (OSH) Act of 1970 [Public Law 91-596], a number of federal agencies have been vital in regulating and researching workplace safety and health in the United States (U.S.). The Occupational Safety and Health Administration (OSHA) within the Department of Labor (DOL) was created by the OSH Act to protect worker safety and health through regulation and enforcement. Concurrently, the National Institute for Occupational Safety and Health (NIOSH) within the Centers for Disease Control and Prevention (CDC) was created and tasked with conducting research and making recommendations for the prevention of work-related injuries and illnesses. Finally, the Secretary of Labor was charged with developing a comprehensive statistical system to collect data on work-related injuries and illnesses (Public Law 91-596) which led to the existing Bureau of Labor Statistics (BLS) initiating a cooperative statistical system in 1972 to collect such injuries and illnesses [BLS, 2012a]. To be successful in their individual missions of protecting and improving worker safety and health, all three agencies rely on accurate identification and enumeration of occupational

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injuries and illnesses in the U.S. to target research, regulation, and prevention efforts.

Over the last 45 years, OSHA, NIOSH, and the BLS have all used the BLS Survey of Occupational Injuries and Illnesses (SOII) [BLS, 2012a] to identify and track high-risk industries and occupations. This national survey captures injuries and illnesses from OSHA logs for about 250,000 private industry employers as well as state and local government agencies [Wiatrowski, 2014a]. During the most recent decade, BLS reported that the rate of nonfatal occupational injuries and illnesses based on SOII declined from 2003 through 2008 (5.0 to 3.9 cases per 100 full-time workers) [BLS, 2008]. This was not the first time that data from SOII had indicated such a decline, and OSHA had cited the decline as evidence of the effectiveness of their employer recordkeeping guidelines and regulatory enforcement programs [U.S. House of Representatives, 2008]. However, in 2008, the U.S. House of Representatives' Committee on Education and Labor called this decline into question based on several non-governmental research studies and media reports suggesting that nonfatal occupational injuries and illnesses that should have been collected through SOII were being missed, not implying a decrease in rates but rather a significant underestimate of employer reporting [Rosenman et al., 2006; Boden and Ozonoff, 2008; U.S. House of Representatives, 2008].

Three major issues affect the accurate enumeration of nonfatal occupational injuries and illnesses through SOII. The first issue is the case inclusion and exclusion criteria for SOII. Based on OSHA employer recordkeeping guidelines, the BLS SOII captures injuries and illnesses that private industry employers in the U.S. are required to maintain in their workplace records [BLS, 2012a]. While not covered by OSHA, state and local government entities voluntarily provide records for inclusion in SOII [Wiatrowski, 2014a]. Certain types of workers are not covered under OSHA recordkeeping guidelines and thus, are not included in SOII, such as self-employed workers, private household workers, federal workers, and workers on farms with fewer than 11 employees [Ruser, 2010]. Based on calculations conducted by NIOSH using the U.S. employment data from the BLS Quarterly Census of Employment and Wages (QCEW), we estimate that these SOII exclusions represent approximately 9% of the workforce [BLS, 2014] and are commonly referred to as undercounts rather than underreports due to the SOII scope of coverage. A second issue is the capture of occupational illnesses. Illnesses with long latency periods, like cancer, can be difficult to relate directly to workplace activities, and are therefore rarely identified and counted [Ruser, 2010; Spieler and Wagner, 2014]. Over 90% of the cases captured in SOII represent occupational injuries that are acute and easily identifiable [Wiatrowski, 2014a]. The illnesses that are included in SOII are also generally acute events such as contact dermatitis or poisonings [Wiatrowski, 2014a]. A final issue is whether cases that meet SOII inclusion criteria are reported to SOII. If an injury/illness should have been included but was not, it results in underreporting. This failure in employer recordkeeping can represent a simple mistake at best, or an intentional omission at worst [Foley et al., 2014]. There are many facets to enumerating nonfatal occupational injuries and illnesses that other studies have described in great detail [Azaroff et al., 2002, 2004; Ruser, 2010]. Studies have suggested that the SOII undercounts and/or underreports nonfatal occupational injuries and illnesses by 10–70% [Rosenman et al., 2006; Boden and Ozonoff, 2008; Oleinick and Zaidman, 2010; Boden, 2014].

Based on various non-governmental studies, media reports, and Congressional concern, Congress began providing OSHA, NIOSH, and BLS with funding in 2009 to conduct projects that would investigate underreporting issues and provide for a better understanding of underreporting [U.S. House of Representatives, 2009]. The funding set the stage for the development of multi-faceted research to further assess and understand the quality and completeness of U.S. occupational injury and illness surveillance systems. The three agencies took different approaches based on their individual missions and goals.

OSHA used the funding to assess current employer recordkeeping guidelines. OSHA staff initially conducted a 2-year program to investigate the extent and causes of underreporting related to employer recordkeeping [OSHA, 2010]. Investigations included record reviews, interviews of workers and management, and workplace inspections. In addition to these investigations, OSHA also conducted comprehensive training with compliance staff to identify and correct violations of recordkeeping regulations. Outcomes of these efforts are being used by OSHA to improve employer identification and recording of workplace injuries and illnesses [OSHA, 2010].

BLS used the funding to build on existing research by conducting in-depth assessments of the quality of SOII data [Wiatrowski, 2014b]. BLS partnered with several state agencies and one contractor to conduct studies that involved: (i) matching data from SOII and workers' compensation; (ii) assessing the feasibility of using multiple data sources, such as SOII, workers' compensation records, and hospital emergency room records to identify cases of carpal tunnel syndrome and amputations; and (iii) interviewing employers about their injury and illness recordkeeping practices for identifying and recording cases on their OSHA logs and workers' compensation claims [Wiatrowski, 2014b]. Findings have suggested that employer recordkeeping issues may be more problematic with multi-establishment companies and for certain types of injuries/illnesses that are more difficult to relate to work (e.g., hearing loss), and that some cases may be missed due to the timing of the survey [Ruser, 2010]. BLS will use the findings of this research to

ensure that the SOII is accurately capturing cases within the scope and the mission of the system [Ruser, 2010]. Additionally, BLS is currently undertaking research into the feasibility of collecting injury and illness data directly from workers, which will allow additional assessment of the SOII case capture [BLS, 2015].

While OSHA and BLS primarily focused on employer recordkeeping and reporting, NIOSH used Congressional and internal funding to conduct two studies to assess and understand the extent to which workers reported occupational injuries and illnesses to their employers using data captured through an emergency department (ED) surveillance system. This article describes the methodology used to design and conduct the two studies. Detailed results from one of these studies are being released concurrently with this article [Bhandari et al., 2016; Tonozzi et al., 2016].

METHODOLOGY

Use of Pre-Existing Surveillance Data

NIOSH routinely collects data on nonfatal occupational injuries and illnesses treated in U.S. EDs through the occupational supplement of the National Electronic Injury Surveillance System (NEISS-Work). Data for NEISS-Work are collected in collaboration with the Consumer Product Safety Commission (CPSC)[1] through a clustered sample of visits from a stratified probability sample of approximately 67 U.S. hospital EDs. The EDs are stratified based on the total number of annual ED visits and are categorized into five corresponding groups (small, medium, large, very large, and children's). The total number of reporting hospitals varies by month and year due to hospital nonparticipation or nonresponse issues including hospital closures and mergers. Work-related cases for NEISS-Work are identified by hospital coders who review all available parts of ED records (e.g., admissions, billing, nurse triage notes, doctor's dictation) to identify civilian, non-institutionalized workers who were working for pay or compensation, working on a farm, or volunteering for an organized group [Jackson, 2001; Derk et al., 2007]. Coders are instructed to use all available information from the medical records to determine if injuries/illnesses are work-related. Available information may include a specific injury at work question, expected source of payer, or narrative documentation indicating work-relatedness. The determination of work-relatedness is not solely reliant on any one type of information (e.g., expected payer of worker's compensation). Once cases are identified, coders abstract injury, illness, demographic, and employment information on all individuals identified with an ED-treated work-related injury/illness. The hospital coders typically submit the abstracted cases to CPSC within 2–5 days of treatment. Cases are reviewed for work-relatedness and other data quality issues by both CPSC and NIOSH. While the BLS SOII is employer based and has certain restrictions related to employer and worker type, NEISS-Work is worker-based and is not restricted by employer type, industry, or employer size.

NEISS-Work data are primarily used to obtain national estimates of work-related injuries and illnesses and to track trends of these estimates for prevention purposes. However, the NEISS-Work also provides NIOSH with a means to conduct follow-back telephone interviews of injured or ill workers treated in EDs. Through the use of two such follow-back studies, NIOSH attempted to assess the prevalence of underreporting among patients seeking treatment at an ED for a work-related injury, illness, or exposure. One of these studies, called the "Barriers to Occupational Injury Reporting by Workers" study or "Barriers" study henceforth, collected information on whether workers reported their work-related injuries to their employer and workers' incentives and disincentives for reporting. The second study, called the "Underreporting of Occupational Injuries and Illnesses by Workers" study or "Congressional" study henceforth, collected information on occupational injury, illness, and exposure reporting with a focus on populations not captured in SOII (e.g., self-employed workers) as well as on underlying chronic conditions related to occupational injuries and illnesses.

Barriers Study—Questionnaire Development and Testing

Funded through the NIOSH internal National Occupational Research Agenda, the Barriers survey was a pilot study originally initiated to determine if follow-back surveys based on NEISS-Work could be used to obtain and compare data on worker attitudes and behaviors related to injury reporting as well as the incentives and disincentives that workers faced when reporting such injuries to their employer.

Our goal was to determine the feasibility of collecting and comparing data for two distinct populations: workers who presented to an ED with a work-related injury identified through the NEISS-Work data and workers treated for non-work-related injuries identified through the All Injury Program (NEISS-AIP), a similar NEISS dataset collected collaboratively by the CPSC and the CDC National Center for Injury Prevention and Control (NCIPC) using the same hospital sample as NEISS-Work [CPSC, 2000]. The initial goal to collect data on 600 employed persons (300 persons with work-related injuries and 300 persons with non-work-related

[1] NIOSH collects the occupational injury data through collaboration with the Consumer Product Safety Commission (CPSC). However, there are no implied or expressed endorsements of the results presented herein by the CPSC.

injuries) was set based on available funding. We were interested in identifying similarities and differences in beliefs, attitudes, and behavioral intent related to occupational injury reporting among those who had recently experienced work-related injuries and those who had experienced non-work-related injuries. However, 6 months into data collection it became clear that persons with non-work-related injuries could not be clearly identified, recruited, or engaged. Therefore, this component of the study was discontinued and the limited data that were collected were not explored.

To develop survey questions, priority topic areas for assessing occupational injury reporting were identified based on input from an expert panel knowledgeable in areas of occupational injury and illness surveillance and under-reporting and from an extensive literature review. The survey was developed by NIOSH and reviewed by topic experts including the expert panel and individual workers. In addition, formal expert review using a Question Appraisal System (QAS) [Willis and Lessler, 1999] and cognitive testing using think-aloud and verbal probing techniques [Tourangeau, 1984; Willis, 1999] were conducted. Cognitive testing was conducted with a sample of subjects from NEISS-Work who met the Barriers study criteria. The final version of the survey was approved in 2012 by both the Office of Management and Budget (OMB) and the NIOSH Institutional Review Board (IRB).

The telephone interview included both multiple choice and open-ended questions. These questions covered items such as injury characteristics, employment and workplace characteristics, reporting of injury at workplace and at ED, expected payer, and whether the respondent required any additional medical care. To allow for comparisons between those with work-related injuries and those with non-work-related injuries, questions about a hypothetical work injury scenario based on the Theory of Planned Behavior [Ajzen, 1991] were incorporated.

Sample design accounted for the underlying stratified hospital sample and attempted to optimize the ability to obtain valid estimates. Eligible persons were 20–64 years old with acute physical injuries who felt well enough to return to work in <4 days (Table I). The age range was chosen to minimize the influence of working students (those <20) and semi-retired individuals (those >64). Workers <20 and >64 only accounted for a small proportion (~7%) of workers treated in EDs [CDC, 2016]. Respondents were further restricted to those who experienced acute injuries and felt well enough to work in <4 days. Because workers' compensation becomes more critical if lost wages are sought in addition to medical benefits, these restrictions were implemented to minimize the influence of workers' compensation payments on reporting by standardizing the potential for workers not to tell their employer about their work-related injury. To identify common worker incentives and disincentives for reporting occupational injuries to employers as well as to medical care providers, we excluded those employed on a farm or ranch, self-employed workers, and day laborers. In order to reduce recall bias, cases with a treatment date over 30 days old at the time of sampling were also excluded. Because this was a pilot and because funding was limited, the survey was conducted in English only.

TABLE I. Overview of the Barriers and Congressional Study Populations

Barriers	Congressional
Worker inclusions	
Persons 20–64 years old	Persons 20–64 years old
Employed for wage or salary at the time of injury	Employed for wage or salary, working on a farm or ranch, or self-employed
Sought ED treatment for a work-related or non-work-related injury	Sought ED treatment for a work-related injury, illness, exposure, or pain
Work restriction	
Felt well enough to return to work in <4 days	No restrictions related to return to work
Language requirements	
English	English or Spanish
Worker exclusions	
Persons employed on a farm or ranch	Day laborers
Self-employed	Volunteers
Day laborers	
Volunteers	

Congressional Study—Questionnaire Development and Testing

As directed and funded through the Congressional appropriation, the original intent of the Congressional survey was to assess reporting behaviors of workers that are injured, ill, or exposed to a harmful substance at work. The appropriation directed NIOSH to assess all workers including those otherwise not included in SOII, such as self-employed and farm workers, and to specifically capture information on any underlying chronic conditions that were potentially related to work.

Design of the Congressional survey was based on an extensive literature review, as well as priority topics identified by the Barriers study expert panel. As questions for the survey were developed, an extensive set of frequently asked questions (FAQs) was compiled to assist interview respondents. These FAQs addressed challenges that NIOSH project staff confronted during survey development including how to define and differentiate terms like injury, illness,

exposure, and pain; how to identify and define chronic health problems; how to differentiate certain employment situations such as self-employed, temporary, on-call, and contract; and how to ask these different worker types comparable questions to assess whether they reported work-related injuries or illnesses to their employer or to their client in the case of self-employed workers.

A draft questionnaire was reviewed by an external peer review panel and internal NIOSH experts with experience in questionnaire development. In addition, it was tested using simulated scenarios to assess skip patterns, flow, and question/answer comprehensiveness. The questionnaire was then tested using a two-step process that involved QAS [Willis and Lessler, 1999] as well as cognitive testing [Tourangeau, 1984; Willis, 1999]. The final version of the questionnaire was translated into Spanish by two Spanish speakers with extensive translation experience. However, the Spanish version was not tested, only back-translated by a native Spanish speaker. The final version of this questionnaire was approved in 2012 by both the OMB and the NIOSH IRB.

The survey contained nine modules consisting of both multiple choice and open-ended questions. These questions covered many of the same items that the Barriers survey addressed, but also included questions regarding whether respondents were working for pay or compensation at the time of their injury or illness, the type of employment situation they were in, employment characteristics, and the existence of chronic conditions either related to the current ED visit or unrelated to the current visit but related to the current or some previous job. While the respondent was given the opportunity to identify a single word that best described the reason for the ED visit (injury, illness, exposure, or pain), this respondent-provided information was not used in any subsequent analyses but was only used as a question fill-in for the interview. Questions regarding chronic conditions were separate from initial questions regarding the reason for the ED visit and were only asked if the respondent went to the ED for a health problem that was made worse before the visit and that had lasted for at least 3 months prior to the ED visit. Any injury or illness could have been related to a chronic condition.

For the Congressional survey, the initial goal was to interview between 1,500 and 3,000 workers. A sample design was developed based on an assumption of 2,000 completed interviews. Similar to the Barriers study, the methodology used to create the sample design for the Congressional study accounted for the underlying stratified hospital sample and optimized the ability to obtain reportable, stable, and valid estimates that met NIOSH reporting requirements as well as the availability of project funds. Eligible persons were 20–64 years old and fluent in either English or Spanish (Table I). As was the case with the Barriers study, the age range was chosen to minimize the influence of working students (those <20) and semi-retired individuals (those >64). Respondents with any work-related injury, illness, exposure, or pain, regardless of days away from work or return to work, were included. Volunteers and day laborers were excluded because their unique work situations and their small populations made it unlikely that sufficient data could be collected to meet statistical reporting requirements. Additional reasons for excluding day laborers included the fact that they generally could not be pre-identified and would likely not have viable contact information. In addition, this particular group needed special consideration because of their unique reporting requirements, or lack thereof, their highly variable, unpredictable employment arrangements [Gonzalez, 2007], and language and cultural issues. In the end, the issues involved in developing and testing questions specific to addressing day laborers were deemed beyond the resources available and we decided to exclude them from this study. A final exclusion was cases with treatment dates over 30 days old at the time of sampling.

Sampling Strategies

For both follow-back studies, samples were derived from NEISS-Work data by CPSC. A systematic sampling scheme was designed to ensure that cases could not be sampled for more than one study. This scheme was embedded in a larger sample design that included a third NEISS-Work follow-back survey that was already collecting information on all Emergency Medical Service (EMS) providers identified through NEISS-Work. The EMS study was initiated in 2010, prior to the Barriers and Congressional studies, and continued after the underreporting studies ended data collection. The larger sample design called for cases for all three surveys to be drawn from the 67 NEISS-Work hospitals. The EMS sample was drawn first; the Barriers sample was drawn second; and the Congressional sample was selected last from the cases remaining after the first two samples were drawn. In addition to sampling cases from NEISS-Work (for work-related injury cases), the Barriers sample design also sampled cases from the NCIPC NEISS-AIP for non-work-related injuries. Cases selected for the EMS study were included in the Barriers and Congressional sampling frames if they met the respective study criteria. However, cases selected for the EMS study were not eligible to be sampled for either the Barriers or Congressional studies. Likewise, cases sampled for the Barriers study were included in the sampling frame for the Congressional study but were not eligible for sampling for the Congressional study.

For the Congressional study, all self-employed and farm workers were sampled and patients with illnesses were over-sampled because they were subgroups of particular interest for this study. Self-employed workers were identified in NEISS-Work if their worker status was

coded as self-employed or if a keyword search of the employer, business type, and occupation fields found an occurrence of "self-emp" or "self emp." Farm workers were captured if their worker status was coded as farm or ranch owner or if a keyword search of the employer, business type, and occupation fields found an occurrence of "farm" or "ranch." Illnesses were captured if they were coded by CPSC as an illness AND the coded diagnosis was "other/not stated," or if the coded diagnosis was "dermatitis; conjunctivitis."

CPSC calculated sampling rates for both studies accounting for the number of work-related cases reported by the NEISS-Work hospitals within stratum size. Once NEISS-Work data were submitted to CPSC by hospital abstractors, CPSC drew samples for both studies on a weekly basis, limiting the sample to cases treated in EDs between June 2012 and December 2013. These samples were reviewed in detail by NIOSH to confirm the sampled cases met study criteria. After conducting surveys for an initial seven month period, sampling rates were increased due to much lower than expected response rates.

Data Collection and Processing

To conduct telephone interviews, patient contact information was requested from the 67 NEISS-Work hospitals, twelve of which opted to not release this information. Once contact information was received, initial informed consent was obtained from a detailed pre-interview letter sent to potential respondents notifying them of the study, explaining their rights as a participant, and giving them an opportunity to "opt out" of the study. The pre-interview letter for the Congressional study included instructions in Spanish for any potential Spanish-speaking respondents who did not understand the letter or who needed more information.

Interviews were conducted using a Computer Assisted Telephone Interviewing (CATI) system. Prior to beginning data collection, NIOSH project staff provided detailed training to experienced telephone interviewers administering the surveys for both studies. Additionally, the interviewers were provided with a series of FAQs that defined terms identified as potentially problematic during the survey development and testing phases. The FAQs were supplemental to the prompts embedded in the CATI system. To maximize the number of completed interviews during data collection, interviewers attempted to reach potential respondents at least ten times at various times of the day. Verbal informed consent was obtained at the beginning of each interview. Responses were not electronically recorded but were only keyed via the CATI system. For narrative responses, interviewers often paraphrased answers as the respondents were talking. The interview for each study took approximately 30 min to complete, and no incentives were offered for participation.

While neither study attempted to assess the accuracy of cases identified as work-related in NEISS-Work, cases incorrectly identified as work-related were identified during various stages of the data collection process including the sample review stage, the interview stage, and the post-interview stage. NIOSH project staff conducted detailed quality procedures on all completed interview data to ensure case eligibility was correctly ascertained for the two studies. In addition, data entry errors and errors related to incorrectly maneuvering through the CATI were corrected.

Narrative data collected through the interview were also reviewed and coded as the final data were being processed. Narrative data describing employment and contributing injury factors were coded as follows: industry codes were applied using the 2002 Bureau of the Census Industry codes [BOC, 2002]; occupation codes were applied using the 2010 Bureau of the Census Occupation codes [BOC, 2010]; and source and event codes were applied based on the BLS Occupational Injury and Illness Classification System (OIICS) Version 2.01 [BLS, 2012b]. Narrative data, including a respondent's reasons for reporting an injury or illness to an employer, were assigned codes based on a qualitative content analysis which was completed by two NIOSH researchers. Each researcher read all narrative responses and identified frequently occurring descriptive categories for each narrative question based on the response content. The researchers jointly merged and modified their categories to form a single comprehensive list. Then, each researcher re-read all the narratives and assigned each narrative response to categories from the respective list. The category assignments from each researcher were then compared and any non-matching assignments were adjudicated.

Weight Adjustments

The approach to adjust the weights for the survey data was a multi-step process. CPSC calculates monthly hospital weights for the NEISS-Work data, which includes nonresponse adjustments for hospitals that did not report data to CPSC for a particular month. Because only a portion of patients from NEISS-Work were selected for each of these studies, the hospital weight was further adjusted to create a statistical base weight, which was the inverse of the patient's overall probability of selection. In separate processes for each follow-back survey, the base weights for the cases were further adjusted to account for nonresponse issues such as an inability to contact the potential respondent, refusal to participate by the patient, or refusal of the hospital to provide contact information for sampled patients. This adjustment was done in two stages: the patient base weights were first adjusted for unknown eligibility followed by an adjustment for interview

nonresponse. Using multivariate logistic regressions, response propensity analyses were used to identify variables that separated eligible completed interview cases from unknown eligibility or nonresponse cases. Unknown eligibility and interview nonresponse factors were calculated and applied to the base weights. In both cases, these factors received a 0 weight for those with unknown eligibility and nonresponses. These nonresponse-adjusted weights were then post-stratified to ensure maximum coverage of the target populations identified in the respective study sampling frame. Based on the response propensity analysis, weights for the Barriers survey were post-stratified by race categories (White, all others, unknown) and weights for the Congressional survey were post-stratified by worker status categories (paid private or government employee, all others/unknown) and age groups (20–30, 31–40, 41–50, and 51–64). Eligible population totals in the sampling frames were used as controls for both surveys and included cases that were not sampled because they had an old treatment date, and cases that were given no chance of selection because they were already sampled for one of the other studies. The reweighting process resulted in final weights that were assigned to completed cases and used to calculate national estimates.

To account for the sample design, standard errors were calculated using a linearization method [Wolter, 2007] with SAS v9.3 proc surveyfreq, surveymeans, and surveylogistic [SAS, 2011]. Standard errors were calculated by weighting sample data by hospital size and by clustering injuries within hospitals.

SURVEY OUTCOMES

Both studies had low response rates: the Congressional study had a response rate of 20% and the Barriers study had a response rate of 25%. The studies faced typical survey challenges including obstacles in contacting, engaging, and identifying respondents (Table II).

Among those who were identified as work-related in ED records, employee underreporting to employers appeared to not be a problem. However, we could not assess the degree to which all work-related cases were identified nor could we assess if the reported injuries and illnesses were recorded on OSHA logs and reported in SOII. Detailed results of the Congressional study are being released concurrently with this article [Bhandari et al., 2016; Tonozzi et al., 2016] while the results from the Barriers study may be released at a later date.

DISCUSSION

This paper detailed the methodology of two studies that were initiated to assess underreporting among patients seeking treatment at an ED for work-related injuries, illnesses, or exposures. These studies offer insight into strengths, limitations, and other important aspects of using ED surveillance data, such as those collected through NEISS-Work, to assess whether workers reported work-related injuries, illnesses, or exposures to their employers.

TABLE II. Final Status of Sampled Workers for the Barriers and Congressional Studies

	Barriers (N = 4,455) (%)	Congressional (N = 17,679) (%)
Completed interviews[a]	9	15
Refused to participate[b]	11	23
Failure to reach	27	19
Hospital did not provide contact information	16	12
Contact information incorrect / unavailable	19	25
Ineligible/screened out	18	6

[a]Percentage of completed interviews does not represent the response rate, which was calculated using standard AAPOR methodology for minimum response rate [AAPOR, 2011].
[b]Includes 1% of respondents who completed only a small part of the interview and then discontinued the interview.

Strengths

There are several study strengths that can be attributed to the NEISS-Work sample source. First, unlike employer-based SOII, NEISS-Work relies primarily on worker reporting at the ED. Consequently, previously suggested reasons for SOII undercounts related to employers not reporting, such as avoidance of OSHA inspections, having to work through multiple layers to complete an incident report, employers misunderstanding rules of injury/illness reporting, and suppression of injury/illness reporting due to employer financial and publicity benefits [Azaroff et al., 2002; U.S. House of Representatives, 2008; GAO, 2009; Wuellner and Bonauto, 2014], should not impact NEISS-Work estimates. In addition, populations that are out-of-scope in the SOII [BLS, 2012a] and largely out-of-scope in workers' compensation data [Sengupta et al., 2014] are captured by NEISS-Work. These populations include self-employed workers, small farm workers, and private household workers. Unlike workers' compensation data, NEISS-Work also captures occupational injuries and illnesses regardless of the expected medical care payer. Finally, more than 95% of all ED-treated patients with occupational injuries and illnesses were treated and released [Derk et al., 2007], indicating NEISS-Work is likely better at capturing less severe injuries while SOII and workers' compensation data are better at capturing more severe injuries [Shannon and Lowe, 2002; Nestoriak and Pierce, 2009].

There were additional strengths related to the overall study methodology. The use of follow-back surveys afforded the opportunity to speak directly with the injured or ill

workers, eliminating potential employer biases in describing the workers' injury reporting knowledge, support, and behaviors. Furthermore, the use of a CATI system to conduct these surveys provided interviewers with on-screen instructions and facilitated data entry, including built-in quality assurance measures such as logic checks and programmed skip patterns [Choi, 2004]. Also, the rate at which weekly samples were drawn from the NEISS-Work data to identify potential respondents was designed to be flexible. Consequently, sampling rates were adjusted two times during data collection to compensate for lower than expected response rates and to increase the total number of respondents.

Limitations

There were several limitations related to these studies. Both studies attempted to capture information on underreporting among injured, ill, and exposed workers. However, focusing on a population whose injuries and illnesses were identified as work-related within the ED may have biased the sample toward workers who did report. Almost all respondents reported that they verbally told someone in the ED that their injury or illness was work-related, indicating they were not likely trying to hide this connection. Of the small number who did not report their injuries or illnesses to their employers, very few mentioned not reporting because they did not want their employer to know about the injury/illness. In addition, the finding that approximately three-quarters of the population in both surveys were expecting workers' compensation or their employer to pay for their ED visit indicates that employers for the majority of our respondents had to know about the injury or illness. Groenewold and Baron [2013] found that 40% of work-related ED visits were expected to be paid by private insurance, Medicaid, Medicare, and workers themselves, with the remaining 60% expecting payment through workers' compensation. This suggests that workers responding to our survey were more likely to be seeking employer-based payment coverage. Based on our results, we concluded that our surveys captured very few workers trying to conceal their injury or illness from their employers because such workers would be less likely to disclose the work-relatedness to ED staff and would be less likely to seek employer-based medical payment. However, our study did not assess if the reporting of injuries, illnesses, and exposures led to the next crucial surveillance step of recording the injury, illness, or exposure on the OSHA log and reporting in SOII, if required.

Congress also directed NIOSH to use the Congressional study to identify underlying chronic conditions among workers and assess whether or not these issues were reported to employers. The primary limitation in collecting information on chronic conditions was that our population of workers was restricted to those who sought treatment in EDs for an occupational injury or illness. Luckhaupt and Calvert [2010] reported a 7.5% prevalence of work-related chronic conditions among all people who ever worked, with no significant difference noted between current and former workers. By limiting our population to workers seeking treatment in an ED, we were less likely to capture the already small population of workers with chronic conditions. The data were also constrained by the fact that the ED is not the primary venue of care for many chronic conditions [CDC/NCHS, 2014]. Other existing data sources can offer better information on work-related chronic conditions. Luckhaupt and Calvert [2010] used the National Health Interview Survey (NHIS). The National Occupational Mortality Surveillance (NOMS) also provides a source to monitor mortality trends by usual occupation or industry [CDC/NIOSH, 2015].

Finally, detailed quality reviews of the completed interviews identified issues that were not discovered during the pre-testing processes. Both studies asked respondents to self-identify whether their injury or illness was work-related. However, due to the complexity of the NEISS-Work case definition and the amount of interview time it would have required to assure respondent perception matched the intended definition of what was meant by work-related, respondents were not provided much guidance in defining work-relatedness. Therefore, additional post-interview quality assurance work was done that compared respondents' assessment of the work-relationship with their narrative injury description to determine whether their assessment matched the NEISS-Work case definition. For example, NEISS-Work includes injuries that occur in employer parking lots, but a few respondents identified such injuries as non-work-related. An additional issue identified during review of the completed Congressional survey data was related to questions that qualified respondents' injuries or illnesses as work-related by asking if it was "made worse at work." While the intent of this question was to capture workers whose existing condition was made worse specifically by activities at work, this question inadvertently captured many injuries or illnesses that simply progressed in severity over time, unrelated to work activities. This finding also necessitated individual review of all cases to determine whether or not they were appropriately identified as work-related.

CONCLUSION

Azaroff et al. [2002] described a complex series of events that must occur to insure successful documentation of occupational injuries and illnesses. While our studies suggested that employee underreporting to employers among those captured in ED records did not appear to be a problem, this is only one step in documentation. There are several steps in the process that were not assessed. We did not assess

whether all occupational injuries and illnesses were identified during ED treatment, which would impact the cases that were available for sampling. Furthermore, we did not assess if the reported injuries and illnesses were recorded on the OSHA logs or reported in SOII. Because of the low response rates and the fact that our studies did not assess every step of the documentation process, generalizability of our results is limited. Based on these findings, NEISS-Work data are limited in their utility to thoroughly explore underreporting issues. Consequently, future surveys attempting to assess underreporting among workers should consider using a data source not restricted to workers with occupational injuries or illnesses identified in medical records.

AUTHORS' CONTRIBUTIONS

Suzanne Marsh was involved in all aspects of the study including designing study and analysis, interpreting results, writing the manuscript, and addressing editorial changes. Audrey Reichard was also involved in all aspects of the study including designing study and analysis, interpreting results, writing the manuscript, and addressing editorial changes. Ruchi Bhandari was involved in reviewing and editing the manuscript. Theresa Tonozzi was involved in reviewing and editing the manuscript. All authors gave final approval of the final version and agree to be accountable for all aspects of the published work.

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DISCLAIMER

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