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Risk factors and incidence of sharps injuries to nurses
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Abstract (500 words or less)

Exposures to bloodborne pathogens through injuries with used sharps ("needlesticks") are a leading occupational health risk for nurses and other health care workers. Despite declines in sharps injuries through the 1990s attributable in large part to the development and adoption of specially designed devices that reduce exposure to bare sharps, injuries continue to occur. This study examined survey data from almost 40,000 nurses delivering care in hospitals, home health agencies and nursing homes in 4 major states (California, Florida, New Jersey and Pennsylvania) that were collected in 2006-2007. The aim was to determine current patterns in terms of sharps injuries, procedures exposing nurses to risk, and use of safety-engineered devices, and explore associations how characteristics of hospitals such as their size, staffing levels, and working environments influence risk. Across the 4 states, approximately 7% of the direct care nurses reported experiencing one or more sharps injuries with a used needle in the prior year, and 3% reported one or more injuries with a sharp device other than a needle. Hospital nurses' injury rates were lowest in Florida and comparable across the other three states. From 80 to 90% of the hospital nurse respondents reported that safety engineered equipment were in routine use in their institutions and higher reported use of safety devices at the hospital level was generally associated with lowered injury risk. Nurses working in operating rooms had three times higher risk of injuries. Nurses with less than 5 years of experience appeared to be at particular risk of injuries, as were nurses from Asian and Filipino backgrounds. General support was found for the notion that working conditions (for instance, support from managers and safety climate) were associated with sharps injury risk, although the associations were small. Nursing home nurses were found to have rates of injuries comparable to nurses in hospitals despite much lower rates of performing risky procedures, a pattern that is potentially explainable by the much lower reports of routine use of safety-engineered sharp devices in nursing homes. Home health nurses appeared to be at much lower risk of sharps injuries; however, their use of needles in daily practice appeared to be very low. Some evidence was found that relative inexperience and working conditions (for instance, supportive working environments) might explain at least some variation in sharps injuries in nursing homes and home health settings as well as in hospitals. Overall, this large-scale survey of direct care nurses provided confirmation of findings regarding sharps injury incidence and risk factors from earlier studies, highlighted a number of groups of nurses at high risk for sharps injuries deserving of deeper study and documented historical trends while providing a new data point for tracking this occupational health issue. (449 words)

Significant (Key) Findings

Survey data gathered in 2006-2007 from 41194 nurses working in direct care roles in hospitals, home health agencies, and nursing homes, in four US states were analyzed in relation to their reports percutaneous injuries with used sharps.

Approximately 7% and 3% of hospital nurses from California, Florida, New Jersey and Pennsylvania reported sustaining one or more injuries with used needles and used sharps other than needles in the preceding year, respectively (an overall rate of 9% of nurses reporting at least one injury of either type was calculated).

Operating room nurses were at three times higher risk of injury than their colleagues in other specialties, even after controlling for other variables in the study.

Hospital nurses' injury rates were lowest in Florida (by approximately 1/3) and were comparable across the other three states.

Nurses from Asian and Filipino backgrounds were at doubled risk of injuries even after controlling for all other variables under study.

From 80 to 90% of the hospital nurse respondents reported that safety engineered equipment were in routine use in their institutions and higher reported use of safety devices at the hospital level was generally associated with lowered injury use.

Nurses working in nursing homes were at comparable risk of injuries as compared with hospital nurses despite carrying out fewer IV starts and blood draws. Nursing home nurses were considerably less likely to report that safety engineered sharps devices were in common use than their colleagues in hospitals.

Translation of Findings

The survey results suggest that federal and state policy emphasizing environmental controls (in the form of safety-engineered devices) have been quite successful in reducing the burden of sharps injuries. The statistics presented likely show the full impact of legislative and regulatory initiatives related to safety engineered sharps that were fully implemented by the late 1990s, as well as limitations in their reach.

Operating room nurses continue to face a disproportionate sharps injury burden, as has been recognized by other observers and researchers; these results highlight a need for closer attention to specialty specific issues by occupational health and infection control personnel as well as researchers.

Safer sharps have been widely implemented in hospital settings in major U.S. states but there are some indications that uptake has been incomplete and that completeness of uptake (or staff awareness of uptake) is a predictor of injury risk. Implementation of safer sharps and differences in equipment designs being used across and within states, as well as the consequences of these differences, deserves further study.

Nurses in Florida appear to have a significantly lower rate of sharps injuries and nurses from Filipino and Asian nurses a significantly higher rate of injuries. Understanding what regulatory forces (in the

case of Florida nurses) and cultural and behavioral risk factors (in the case of both groups) may explain these robust and large differences deserves attention and could be fruitful lines of investigation from practical and broader theoretical standpoints.

Nursing home nurses are experiencing comparable injury incidence to that seen in hospitals and factors predictive of hospital nurse risk of injury appear to be both predictive of their injuries and not especially favorable (especially use of safer devices and positive working environments). Research in the nursing home sector on sharps injuries is especially important in light of the special financial and operational challenges faced by the sector and trends towards greater intensity of treatments being provided in those environments.

Outcomes/ Impact

There are multiple potential outcomes of this study in terms of the science of occupational safety and the advancement of work safety in health care, mainly in terms of direction for future program planning and research. The statistics and models presented here were based on anonymous surveys and while not immune from the biases associated with institutionally-maintained incident report and occupational injury databases, present a complementary picture to that available through other data sources. Sharps injuries, particularly in historical perspective, provide an excellent example of policy impacts on worker health, especially in health care workplaces. There are a number of important future directions for future research and institutional, state, and federal policy. Much policy and professional attention has understandably been primarily directed towards equipment and engineered device selection in health care workplaces. However, nurses and other workers in practice areas such as operating room settings and long-term care institutions may not have benefited as much as their colleagues, nor has safety device implementation necessarily been complete across even conventional hospital settings. These areas deserve greater research attention. Investigation of environmental characteristics of the workplaces and potentially subtle behavioral risk factors for sharps injuries for nurses from specific racial/ethnic groups and less experienced nurses are also identified as likely areas for future work.

Section 2. Scientific Report

Background for the Project

Every year in the United States, hundreds of healthcare workers are infected with bloodborne pathogens through occupational exposure (mostly Hepatitis B infections, with perhaps 100 Hepatitis C transmissions annually). While injury rates and occupationally-acquired infections appear to be falling and the widespread adoption of safety-engineered equipment is credited with much of this decline, diffusion of safety-engineered devices has been uneven across facilities and certainly across health care settings and some elements of risk have proven difficult to eliminate entirely in some settings and injury rates remain shockingly high.

A major strategy to reduce health care workers' risk is the use of safety-engineered devices that minimize or eliminate contact with exposed needles. Widespread adoption of newer designs for safety-engineered sharps began in the 1990s, and their use is now quite common, though not universal in the U.S. State and federal legislative action led to a series of regulations, the first of which outlawed the use of needles to connect intravenous lines with other devices in 1992. Subsequently, the landmark Needlestick Safety and Prevention Act of 2000 introduced specific record keeping requirements for all health care facilities, as well as obligations to consider adoption of safety-engineered devices and document the decision-making regarding which devices are used. However, use of safety-engineered equipment is related to cost constraints and perceived benefits and is inconsistent across and even within institutions (suggesting that it is worthwhile to examine large unselected groups of institutions (larger institutions and those perceiving equipment costs to be a lesser concern showed higher adoption) and surveying nurses across different specialties within the same facilities.

A particularly important issue in research on needlesticks is the underreporting of injuries and the biases it creates. While institutional policy, along with guidelines around coverage for disability and expenses associated with occupational injuries, usually dictates that sharps injuries be reported immediately to authorities (and often is entered into databases of various kinds), this does not happen. Earlier studies have shown that 27% to upwards of 50% of injuries are never reported to agency authorities. Major reasons for not reporting an injury include beliefs that the injury is minor or poses trivial risk for disease transmission, and perceptions that one lacks time to complete required paperwork and/or screening. There are important consequences of underreporting for the well-being of injured nurses and for the utility of institutional data for quality and safety efforts and research purposes.

A unique opportunity to evaluate trends and patterns in sharps injury epidemiology in a period of widespread, yet incomplete, adoption of safety-engineered technology in hospitals was presented by a survey of nurses concluded in the winter of 2006 in three major states (New Jersey, Pennsylvania, and California). Nurses represent the largest group of health care providers in many settings and are the largest group affected by sharps injuries. The data collection itself was funded by a large NIH grant (R01-NR04513, 2004-2009, Linda H. Aiken, PI) and companion funding from the Robert Wood Johnson Foundation (for the New Jersey survey). Shortly after the initial award for the present study began, in 2007 a survey of Florida nurses using a parallel questionnaire and similar methods conducted a survey in cooperation with a team at the University of Florida; the data were analyzed in parallel with those from the other states and results included in this report.

In terms of the number of nurses whose experiences have been captured, this project is one of the largest studies of occupational sharps injuries in nurses ever conducted and provides an important complement to data gathered using other methods and by other groups of investigators.

Specific Aims

1. To obtain reliable estimates of the incidence of injuries from needles and sharps to nurses working in three large states.
2. To determine the prevalence and investigate the relative importance of various risk factors associated with sharps injuries, including personal and practice characteristics of nurses, organizational characteristics of the institutions where they work, and the use of safety engineered sharps.
3. To compare rates of sharps injuries to hospital nurses with rates for nurses working in home health and nursing homes, and to determine how the use of safety-engineered equipment differs across settings.

Methodology

Subjects included 41,194 registered nurses (and a small number of licensed practical nurses in New Jersey) selected from the rosters of the state boards of nursing in the states of California, New Jersey, Pennsylvania and Florida and contacted at their home addresses with mail surveys. To be included in the analyses in this project, they needed to self-identify as direct care providers in hospitals, home health agencies or in nursing homes.

Nurse survey data were collected in 2006–07 from large random samples of RNs obtained from licensure lists in California (40 percent), Pennsylvania (40 percent), New Jersey (50 percent), and Florida (30 percent). Sampling nurses to obtain information about hospitals greatly diminishes response bias at the hospital level, which is the greatest potential threat to validity in studies of hospital performance involving primary data collection. It also provides data about nurses' work environments, in addition to staffing levels—a primary advantage of these data over using other administrative data sources, such as the AHA Annual Survey.

A two-stage sampling design was used. More than 98,000 nurses responded to the mailed survey in the first stage (36 percent response rate). This cannot necessarily be interpreted as the response rate of the target population of hospital staff nurses because the sample included all nurses holding active licenses even though a large proportion were not working. Nonresponders were mailed reminder postcards and duplicate surveys following a modified Dillman approach. To obtain external validity for the first sampling stage, a random sample of nonresponders (650 each in Pennsylvania and California) was drawn. Nurses in the second sample received a shortened survey, telephone reminders, and a monetary incentive to encourage their responses. The second sample's response rate was 91 percent. A few differences were noted in some nonresponders' demographic characteristics when compared with the first sample; however, there was no evidence of response bias in the measures of interest here. In Florida, after the original study was proposed and funded, in 2007, using a publicly available mailing list provided by the Board of Nursing, a sample of registered nurses (49,385) licensed and residing in the state were surveyed and a response rate of 39% was recorded.

A battery of instruments originally developed for a large scale statewide survey of Pennsylvania nurses in 1999 and refined in studies at the University of Pennsylvania over 20 years was prepared. Using a modification of Dillman's (1978) method, all sampled nurses received a mail survey with an accompanying cover letter explaining the purpose of the survey, its voluntary nature, and the strict protection of anonymity. A postcard reminder was sent out two weeks later to non-respondents to encourage their participation. A follow-up mailing was sent to all remaining non-respondents, followed by a second reminder postcard to those who had still not responded.

All nurses received a single survey constructed with skip options to enable respondents to proceed page by page, regardless of role or work setting. Nurses were also provided with information about a website on which they could complete an electronic version of the questionnaire. The questions regarding sharps injuries and safety-engineered equipment are found in the sections addressed only to nurses who work in direct patient care roles in hospitals, home health, and nursing homes. Major categories of questions included that are pertinent to the proposed study include: 1) characteristics of the nurse respondent, including general demographic information and part-time/full-time status; 2) characteristics of the respondent's work setting from the Revised Nurse Work Index (NWI-R), including their perceived autonomy, control over their practice environment, and administrative support; 3) nurse workload; 4) nurse-reported sharps injuries with needles and with sharps other than needles over the past year, and information about the use of safety-engineered equipment. The questionnaire also contained questions related to nurse outcomes other than sharps injuries, patient outcomes and adverse events, and patient readiness for discharge, but those measures were developed primarily to satisfy the aims of the patient outcomes-oriented parent study.

Variables

Injury Reports. In earlier research we tested retrospective reporting of needlestick injuries by nurses against a much more intrusive and expensive prospective method that involved requiring nurses to report injuries at the end of each shift over the period of one month. We found the rates of injuries estimated from the prospective

and retrospective data were similar and that differences between estimates could be attributed to sampling fluctuations or chance. In this study, nurses were asked whether they had been stuck with a used needle or used sharp other than a needle in the course of doing their work over the past year and were asked to indicate whether they had sustained 0, 1, 2 or 3 or more injuries.

Nurse Characteristics. Demographic characteristics of the respondents will be used for descriptive purposes and as control variables in our analyses which involve modeling likelihoods and rates of injuries. These include gender, age, race/ethnicity, and education. Questions were also asked regarding the length of time since first licensure as a nurse, the length of time they have worked in nursing, and the length of time in their current position. Respondents were asked to identify the type of setting where they practice (hospital, home health, nursing home or other setting) and hospital nurses were asked their area of specialty practice. Nurses were asked if they were employed on a casual/per-diem, part-time or full-time basis by their organizations and were also asked about the length of their employment with their current agency. An innovation in our survey is to ask specific questions of nurses working for supplemental staffing agencies or otherwise employed on a per-diem basis.
Nurse burnout was measured using the Maslach Burnout Inventory (MBI). The MBI measures three components of work-related burnout: emotional exhaustion (i.e., feelings of being emotionally overextended and exhausted by one's work); depersonalization (i.e., an unfeeling and impersonal response to clients); and lack of personal accomplishment (Maslach & Jackson, 1986). Our primary interest is in the emotional exhaustion subscale, which we think has a strong theoretical link to nurse errors and accidents, including needlesticks and sharps injuries.

Sharps-Related Risk Factors. Nurses were asked whether they started intravenous lines and performed routine venipuncture on the last shift they worked and if so, how time-consuming these two activities were (not very, somewhat, or very). Nurses were also asked whether safety containers for sharps and needle disposal were routinely used in their work setting and whether or not four different functional types of safety-engineered sharps were being used (intravenous line connectors, intravenous catheter insertions, injections and other procedures requiring needle-syringe combinations, and blood draws). These variables will be analyzed at the level of the individual nurse respondent, as well as in versions aggregated across the hospitals to address Aim 2.

Practice Environment/Organizational Climate. Nurses in all settings involved in clinical care were also asked to complete the Revised Nursing Work Index (NWI-R), which contains 49 items (a number of "test" items have also been added to these in the 2005-2006 questionnaire) and asks nurses to indicate the degree to which various organizational features are present in their practice setting. The Practice Environment Subscales from the NWI-R (Lake, 2002) were adopted by a national consensus panel of the National Quality Forum will be used in this study to characterize work environments for nurses across hospitals. These have been validated and shown in prior work to be strong predictors of nurse outcomes, including needlestick injuries. Especially important here are subscales which measure support from unit-level nurse managers and perceptions of the adequacy of staffing and other resources. Published internal consistency coefficients (Cronbach's alphas) for these subscales range from .71 to .84, well within the range of generally-accepted values. These scales were analyzed primarily by aggregating nurses' responses to the level of the employing hospital.

Safety Climate. AHRQ commissioned and distributed a safety culture survey tool that is intended for wide use in quality assurance and research efforts (Nieva & Sorra, 2003; Sorra & Nieva, 2004). Pilot work provides good evidence for factor structure and reliability and preliminary evidence of validity. Seven items were used and were rated by nurses on a 5-point scale from "strongly agree" to "strongly disagree." These included questions regarding non-punitive response to error, 2 items about hospital patient handoffs and transitions, an item dealing with communication openness, 2 questions regarding feedback and communication about error between management and staff, and an item regarding hospital management support for patient safety. Also incorporated was a question asking respondents to give their organization an overall grade (A through F) on patient safety. Aggregated hospital-level scores were computed for these items.

Nurse Workload. The questionnaire asked nurses involved in direct patient care about their most recently worked shift. Major details included the type of unit where they worked, start time and end time of the shift,

and the number of patients assigned to them, with a cleaned version of the data from the latter item aggregated to the hospital level.

Other Hospital Characteristics. Data regarding hospital structural characteristics for hospitals in Pennsylvania, New Jersey and California in terms of size (number of beds), teaching status and technology will be obtained from state health department public use data sets and from the American Hospital Association Annual Survey.

Results

Survey data gathered in 2006 from 41,194 nurses working in **direct care roles** in hospitals, home health agencies, and nursing homes, in four US states were analyzed in relation to their percutaneous injuries with used sharps. Only nurses indicating that they had a role in the delivery of patient care were included in these analyses. Subsets of these nurses

Aim 1. Injury incidence among hospital nurses across states

Table 1 indicates that overall, approximately 7% and 3% of hospital nurses reported sustaining one or more injuries with used needles and used sharps other than needles, respectively (an overall rate of 9% of at least one injury of either type was calculated across all four states). However, significant differences were identified across states and specialties within hospital nurses, a point that will be revisited in later modelling. Many fewer than 1% of the nurses reported 2, 3 or more injuries over the past year. Therefore, a variable contrasting nurses reporting 1 or more injuries with those who reported none will be the focus of the results in this report. Furthermore, while injuries with used sharps other than needles (for instance, lancets or scalpels) are potentially serious, they were considerably less common and will similarly not be the focus of the reports presented.

Table 1. Percentages of Hospital Nurses Experiencing One or More Sharps Injuries in the Preceding Year With Needles and Other Sharps (Overall and For the Six Largest Specialty Groups in the Specialty)

	% of Nurses Reporting One or More Injuries with Used Needle				% of Nurses Reporting One or More Injuries with Used Sharp Other Than a Needle			
	CA	FL	NJ	PA	CA	FL	NJ	PA
OVERALL (N=37922)	7.0	5.1	7.9	6.4	4.1	2.1	3.9	3.2
Med/Surg (N=4635)	7.7	5.2	8.1	6.2	2.8	2.0	2.5	1.7
IC Adult (N=4492)	5.9	5.8	9.3	5.1	4.6	2.7	3.6	3.5
Outpatient Settings (N=2965)	7.0	3.7	4.3	5.4	4.2	1.7	2.2	2.4
Emergency Room (N=2916)	7.7	5.3	8.7	7.5	3.6	1.7	4.3	2.7
Operating Room (N=2230)	17.3	7.3	14.2	16.4	12.9	5.4	13.1	11.0
Multiple Settings (N=2491)	7.3	5.9	10.6	6.3	3.5	2.1	4.2	3.0

Florida hospital nurses appeared to be at significantly decreased risk of both needle and other sharps injury risks; critical care nurses slightly lower than their colleagues and operating room nurses at dramatically increased risk of both types of injuries (likely because of exposure to suture needles, scalpels and other surgical instruments as well as the types of sharps encountered by other hospital nurses, as well as the special context and environment of the surgical suite).

Due to the broad-based sampling approach in the parent surveys, it was possible to examine injury rates in a number of specialized types of hospitals and licensure levels of nurses. As indicated in **Table 2**, practical nurses were surveyed in New Jersey, those employed in hospitals were 52% less likely than NJ hospital RNs

to report one or more needle injuries; NJ hospital LPNs also apparently engaged in fewer procedures in their daily practice likely to pose risk. Advanced practice nurses in hospitals were 23% more likely to report one or more injuries than non-APN RNs, but were somewhat less likely to report both major types of tasks exposing hospital nurses to sharps. Nurses working in state or municipally run hospitals were at 19% increased risk of reporting at least one needle injury relative to nurses in other types of hospitals despite comparable rates of risky procedures. Finally, nurses in children's hospitals showed a 45% decreased likelihood of reporting injuries despite comparable rates of performing routine blood draws and slightly lower rates of IV starts (differences in rates of injuries between other types of hospitals, for instance rehabilitation or convalescence hospitals and psychiatric hospitals, in relation to general hospitals were not statistically significant). The rest of the discussion with respect to analyses for Aims 1 and 2 deals with registered nurses in general medical-surgical hospitals that serve adults as their primary clientele.

Table 2. A Comparison of Sharps Injuries and Risky Procedures for Special Types of Nurses/Hospitals

	% reporting one or more sharps injuries with a used needle in past year	% reporting IV start on previous shift	% reporting routine phlebotomy on previous shift
Practical nurses			
LPNs in New Jersey (432)	3.9	42	28
RNs in New Jersey (8490)	7.9	66	47
Advanced practice nurses (Nurse practitioners, nurse midwives, clinical nurse specialists, nurse anesthetists)			
APNs in the 4 states	8.0	39	21
Non-APNs in the states	6.6	64	43
State and municipal hospitals			
State and municipal hospitals in the 4 states	7.7	61	47
Private (for profit and not for profit) and federal hospitals in the 4 states	6.5	64	42
Children's hospitals			
Specialized children's hospitals in the 4 states	3.8	45	44
Adult general hospitals and other types of specialized hospitals in the 4 states	6.7	64	42

Aim 2. Prevalence of risk factors, protective equipment and organizational factors influencing sharps injury risk and the associations of these variables with reported sharps injuries

Two major risk factors for sharps injuries that can differ from worker to worker and setting to setting are the frequency of procedures where sharps must be handled as well as the types of specially engineered equipment that is in use in the facility that reduces the risk of worker injury with an exposed sharp.

As well as responding to questions about their work on the prior shift, survey respondents were asked whether different special equipment types were "in routine use" in their work settings. Their responses may have reflected staff familiarity with equipment types and terminology as well as the impact of various equipment types in and of themselves. Across the four states, some interesting differences were noted, including the lower rates of injuries in Florida nurses despite higher procedure rates (see **Table 3**). Because use of safety containers for disposing of used sharps is mandated by regulations, the 2-3% of nurses reporting that these containers were not in routine use likely represents survey "noise". Use of safety engineered equipment was generally comparable across states with a notably higher rate of the use of safety engineered systems for drawing blood samples in Florida.

Table 3. Invasive Procedures and Safety Equipment Reported by Hospital Nurses in Direct Care Roles By State (N=37922)

	CA N=12571	FL N=7544	NJ N=8490	PA N=9317
% of nurses reporting on the previous shift				
IV insertions	63	71	66	55
Routine phlebotomy	39	49	47	38
% of nurses reporting routine use on their units				
Safety containers for sharps disposal	97	98	97	97
Safety engineered systems for drawing blood	79	94	80	81
Needleless systems for IV line access/connections	91	82	89	92
Safety engineered needle-syringe combinations	83	79	82	84
Safety engineered systems for IV line starts	82	83	79	81

The frequency of handling sharps to initiate intravenous therapy or for routine blood draws (phlebotomy) varied by specialty was most common in emergency departments and least common on psychiatric units (**Table 4**). Nurse specialty is clearly an important variable to consider in analyzing risks and trends for individual nurses.

Table 4. Composition of the Hospital Nurse Sample and Involvement in Procedures Exposing Them to Sharps Risk by Specialty (N=33190)

	N (%)	% IV insertion on last shift	% phlebotomy on last shift
Outpatient Settings	2965 (8.9)	64	33
Float Pool	608 (1.8)	64	41
Medical\Surgical	4635 (14.0)	73	30
Pediatric	874 (2.6)	58	40
Intensive Care Unit—Adult	4492 (13.5)	70	64
Intensive Care Unit—Pediatric	380 (1.1)	53	65
Intensive Care Unit—Neonatal	1500 (4.5)	70	68
Intermediate Care	1031 (3.1)	76	43
Telemetry	2018 (6.1)	82	33
Oncology	703 (2.1)	64	45
Emergency Room	2916 (8.8)	95	84
Transitional Care	365 (1.1)	42	25
Behavioral\Psychiatric	1222 (3.7)	6	12
Nursery\Postpartum	1380 (4.2)	36	36
Labor\Delivery	1919 (5.8)	86	58
Operating Room	2230 (6.7)	25	9
Recovery Room	1250 (3.8)	56	45
Long Term Care	221 (.7)	46	24
Multiple Areas	2481 (7.5)	72	43

A variety of questions and tools from the questionnaire were analyzed as possible predictors of needlestick injuries. First, an exploratory approach examining bivariate associations was pursued, followed by a multivariate approach examining individual and organizational characteristics jointly. Results exploring the associations of demographics and job characteristics with injuries are displayed in **Table 5**.

Table 5. Bivariate Relationships Between Demographic Variables and Job Characteristics, with Hospital Nurses' Risks of Incurring at Least 1 Needlestick in Prior Year, Adjusted for Clustering at the Hospital Level (N=31,973 to 33,064, depending on variable, with 860 hospitals)

	Odds Ratio (95% Confidence Intervals)	P
Demographics		
Age (/10 year intervals)	.96 (.93, 1.00)	.03
Male	1.26 (1.07, 1,48)	.005
Education/experience		
BSN educated	1.33 (1.21, 1.46)	<.001
Educated in Philippines	2.37 (2.10, 2.67)	<.001
Educated outside US and Philippines	1.58 (1.32, 1.90)	<.001
Less than 5 years of experience in nursing	1.23 (1.10, 1.37)	<.001
Race/ethnicity		
Filipina/Filipino	2.17 (1.91, 2,45)	<.001
Asian	2.02 (1.69, 2.42)	<.001
Specialty		
Operating room	2.98 (2.42, 3.68)	<.001
Employment status		
Part-time	.78 (.69, .87)	<.001
Per diem	.52 (.43, .63)	<.001
Started an IV on last shift	1.25 (1.13, 1.39)	<.001
Performed routine phlebotomy on last shift	1.16 (1.05, 1.27)	.002

Notes: Calculated from logistic regression models with Huber-White sandwich parameter estimates

The odds ratios in **Table 5** suggest that younger nurses, males, those with baccalaureate degrees, those educated outside the US (especially those educated in the Philippines), nurses of Filipino and Asian descent, operating room nurses, full-time employees and those whose work required performance of IV start and routine phlebotomy on their last shift worked were more likely to sustain at least one injury with a used sharp in the preceding year. Nurses in a number of specialties showed slightly higher or lower likelihoods of injury than the reference category of outpatient clinic nurses but the strength of the associations was not particularly large, with the exception of the nearly three-fold increase in risk of at least needle injury among operating room nurses.

Overall, with perhaps the exception of the findings regarding higher rates of injuries in Filipino and Asian nurses, the results made some sense. Lower rates of injuries among part-time and per diem nurses were expected on the basis of their having less time at work; however, no data regarding worked hours were available for any time interval, which renders interpretation of this finding challenging.

These findings do not account for the potential associations of personal or job characteristics with each other (e.g. males, non-White nurses, or nurses holding a bachelor's or higher degrees in nursing worked in different

specialties that place them at greater risk) or possible links between hospital structural or organizational characteristics with personal ones that may negate or reverse the associations seen. Estimates adjusted for these other characteristics are needed.

In terms of organizational characteristics including the proportion of staff nurses reporting routine use of various types of safety-engineered devices (**Table 6**), a number of expected associations were identified in examining bivariate associations, including higher rates of sharps injuries among nurses working in high-technology hospitals (hospitals with open heart surgery and/or major organ transplant facilities), larger hospitals, and major teaching institutions (i.e. those with more investments in graduate medical education). These trends can likely be explained by the higher intensity of care and intervention presumably provided to patients in those institutions.

Nurses working in hospitals where the highest proportions of respondents reported routine use of specially engineered sharps for drawing blood and IV line starts or special needle-syringe assemblies showed approximately 25-30% lower injury rates, which is consistent with earlier survey-based work and in agreement with findings from the literature and anecdotal experiences from many facilities worldwide regarding the effectiveness in reducing injury risk.

A large number of organizational variables at the hospital level were screened as possible predictors of sharps injuries, including the Practice Environment Scales of the Nursing Work Index (a measure of 5-dimensions of the working environment influencing the practice of professional nurses), a number of items from the AHRQ-developed safety culture survey, and staffing ratios, as well as nurses ratings of their experience at work, including their self-ratings of burnout, impressions of quality, and self-reported extent of rationing specific types of care for lack of time. No association of staffing levels with risk of injury was identified, nor were the majority of the organizational measures examined associated with sharps injuries. Generally, nurses working in facilities with lower quality hospital work environments and facilities more clinical quality challenges showed higher sharps injury risk.

Again, these results do not take into account possible confounding factors at the individual or organizational level. Many of the effects were of relatively small magnitude and variables were clearly intercorrelated. A variety of modelling strategies were attempted with results of the type shown in **Table 7**, where fully controlled models incorporating nurse demographic variables, job characteristics and organizational characteristics.

Table 6. Bivariate Relationships Between Hospital Characteristics and Organizational Factors and Risk of Incurring at Least 1 Needlestick in Prior Year, Adjusted for Clustering at the Hospital Level (N=32,700 to 33,064, depending on variable, with 842 to 860 hospitals)

	Odds Ratio (95% Confidence Intervals)	P
High-tech hospital	1.15 (1.03, 1.27)	.01
Teaching hospital (vs. non teaching hospital)		
Minor	1.10 (1.00, 1.23)	.06
Major	1.39 (1.19, 1.62)	<.001
Large hospital (250+ bed)	1.30 (1.06, 1.60)	.01
Greatest proportion of workers reporting use of safety engineered equipment		
For blood draws	.77 (.64, .92)	.002
Needle-syringe assemblies	.75 (.63, .91)	.003
For IV line starts	.67 (.56, .80)	<.001
Aggregate organizational variables at hospital level		
Worst (vs. best) global rating of work environment	1.33 (1.12, 1.57)	.001
Best (vs. worst) relations with managers (NWI-PES: Nurse Manager Ability, Leadership and Support)	.77 (.65, .91)	.02
Hospital with smallest proportion of nurses reported that mistakes were held against them (AHRQ Safety Culture Survey)	.65 (.55, .76)	<.001
Hospital with highest grade/rating for safety by nurses surveyed	1.23 (1.05, 1.45)	.01
Highest MBI burnout (emotional exhaustion) ratings of staff	1.34 (1.14, 1.58)	<.001
Lowest rating of quality of care at the unit level	1.25 (1.06, 1.46)	.007
Highest proportion of nurses reporting omitting pain management for lack of time/staffing	1.39 (1.16, 1.65)	<.001

Notes: Calculated from logistic regression models using Huber-White sandwich parameter estimates.

Table 7. Relationships Between Nurse Characteristics, Hospital Characteristics and Organizational Factors and Risk of Incurring at Least 1 Needlestick in Prior Year, Adjusted for Clustering at the Hospital Level: Simplified Final Model (Estimates Fully Adjusted for Background Variables including State; 836 hospitals, N=28029)

	Odds Ratios (95% Confidence Intervals)	P
Less than 5 years of experience in nursing	1.30 (1.15, 1.47)	<.001
Per diem	.60 (.49, .75)	<.001
Filipina/Filipino	1.79 (1.55, 2.05)	<.001
Asian	1.75 (1.42, 2.14)	<.001
Operating room nurse	3.53 (2.84, 4.39)	<.001
Started an IV on last shift	1.29 (1.13, 1.48)	<.001
Performed routine phlebotomy on last shift	1.21 (1.08, 1.36)	.001
Major teaching hospital	1.20 (1.04, 1.38)	.01
Hospital where highest proportion of nurses stated specially engineered devices were used for IV starts	.70 (.58, .84)	<.001
Hospital where the smallest proportion of nurses reported that mistakes were held against them	.69 (.58, .82)	<.001
Employed in Florida	.65 (.56, .76)	<.001

Notes: Calculated from logistic regression models with Huber-White sandwich parameter estimates, built using stepwise regression approaches

Results here suggest that relative inexperience as well as Filipino or Asian ethnicity were linked with higher injury rates as was working at a high technology hospital. Not surprisingly performing IV starts was a risk factor, given that IV line initiation is a major way that nurses come into contact with sharps. Nurses working in operating rooms were at even higher risk for injuries than those in other specialties when background variables and other risk factors were taken into account Nurses in per diem positions (who presumably spend less time at work and at risk), as well as those where safety devices were in widespread use (here for IV starts, but likely for a variety of tools). A variable capturing the safety climate in the institution around punitive responses to error was also predictive of sharps injuries but is clearly a stand in for a host of organizational conditions and management structures. Finally, nurses in Florida showed consistently lower injury rates even after many different background characteristics were taken into consideration.

Aim 3. Sharps Injuries, and Risk Factors in Direct Care Nurses in Home Health Agencies and Nursing Homes

The use of mailing lists from licensure bodies allowed easy sampling of nurses from two of the other major practice settings for registered nurses beyond hospitals: home health agencies and nursing homes.

Table 8. Rates of Injuries among Direct Care Nurses Working in Hospitals, Home Health Agencies and Nursing Homes in 4 Major States, 2006-2007, N=39,931

	CA (N=12282)	NJ (N=8986)	PA (N=10225)	FL (N=8438)
1+ injuries in preceding year with a used needle (%'s)				
Hospital (N=35,474)	6.9	7.7	6.5	5.1
Home health care (N=2,720)	6.3	4.3	4.0	4.4
Nursing home (N=1,737)	12.1	8.0	7.1	6.1
1+ injuries in preceding year with a used sharp other than a needle (%'s)				
Hospital	4.0	3.8	3.3	2.1
Home health care	2.6	3.2	1.8	2.5
Nursing home	4.2	2.4	3.2	2.3

Table 9. Reports of Risky Procedures and Routine Use of Safety Engineered Devices by Practice Setting Across All 4 States

	Hospital N=35474	Home health care N=2720	Nursing home N=1737
Procedures on the last shift worked			
IV start	64.4	1.3	18.0
Phlebotomy	43.2	1.8	9.3
Safety devices			
Sharps disposal device	97	84	94
Safety engineered equipment for drawing blood	84	62	46
Needleless IV line access/connections systems	90	57	71
Safety-engineered needle-syringe combinations	83	56	71
Safety engineered systems for IV line starts	83	41	51

The rates of reported injuries were fairly comparable between hospitals and nursing homes—perhaps even slightly higher in nursing homes, and considerably lower in home health care on the whole (**Table 8**). While an high rate of injuries were noted in California home health and nursing home nurses, statistically speaking, the rates of nurses reporting either at least one needlestick or other type of sharps injury in the preceding year were not different across states, perhaps because of the smaller numbers of nurses involved.

Comparisons across settings in terms of risky procedures and use of safety devices revealed interesting patterns. Venipuncture for blood draws or for IV line starts was very uncommon among home health nurses (perhaps because of the use of specialized teams to accomplish this in many settings), and it was reported by a much smaller fraction of the nursing home nurses than nurses working in hospitals. Home health nurses were less likely to report routine use of safety-engineered equipment of various kinds, including 16% who reported that safety disposal containers for sharps were not in routine use. Significantly lower proportions of the nursing home nurses reported routine use of safety engineered devices.

Comparisons across sectors in the major groups of variables examined in hospital nurses under Aim 2 are displayed in **Tables 10** and **11.**

Table 10. Comparisons of Demographic and Professional Characteristics of Hospital, Home Health and Nursing Home Nurses by Setting

	Hospital N=35474	Home health care N=2720	Nursing home N=1737
Demographics			
Male (%)	7.4	4.0	5.8
Age (mean, SD)	43.8 (13.4)	48.5 (14.6)	47.9 (16.5)
Experience			
Percent with less than 5 years of experience	19.2	11.4	18.4
Percent self-classified as advanced beginners/competent (vs. Proficient or expert)	16.4	13.9	28.1
Race			
White	77.0	90.6	76.0
Filipino	9.9	2.3	11.9
Asian	4.0	.8	4.3
Pacific Islander	.1	--	--
Black/African-American	4.4	3.2	5.1
American Indian	.2	.2	.2
Mixed	1.5	1.1	.5
Other	2.9	1.8	1.9
Latino	4.7	4.7	2.3
Country where educated as RN			
United States	86.5	94.4	81.8
Philippines	8.4	1.6	11.7
Other	5.1	4.0	6.5
Nature of current position			
Full-time	69.9	55.8	62.2
Part-time	20.6	25.4	22.6
Per diem	9.4	18.8	15.2

Table 10 suggests that home health care nurses in this sample were older and more experienced and were more likely to be working part time or on a per diem basis than nurses in the other settings. Home health nurses were also more likely to be White/Caucasian and to have been educated in the United States. In contrast, the demographics and job characteristics of nursing home nurses resembled hospital nurses in many respects. **Table 11** shows that home health working conditions were generally rated by nurses as more favorable than those in hospitals or nursing homes.

Table 11. Comparisons of Work Environment Characteristics of Hospital, Home Health and Nursing Home Nurses by Setting

	Hospital N=35474	Home health care N=2720	Nursing home N=1737
Work environment			
Mean global assessment—quality of work environment (1-4, lower is better)	2.3	2.0	2.4
Mean NWI—Nurse-physician relations (1-4, higher	2.9	3.0	3.0

is better)			
Mean NWI—Nurse manager support (1-4, higher is better)	2.6	3.1	2.6
Mean NWI—Staffing and resources (1-4, higher is better)	2.5	2.9	2.4
Mean NWI—Nursing in institution (1-4, higher is better)	2.6	2.6	2.4
Mean NWI—Foundations for quality (1-4, higher is better)	3.0	3.1	2.8
Mean rating, "Confidence in management to resolve problems" (1-4, lower is better)	2.4	1.9	2.3
Experience at work			
Mean, overall job satisfaction (1-4, lower is better)	2.1	1.8	2.2
MBI--High emotional exhaustion (% scoring in high risk range)	33.6	25.7	37.2
MBI--High depersonalization (%)	20.2	8.4	21.3
MBI--Low personal accomplishment (%)	20.9	11.4	23.6
Perception of quality of care and safety			
Mean rating quality of care delivered (1-4, lower is better)	1.8	1.6	2.1
Mean patient safety grade (1-5, lower is better)	2.1	2.0	2.4
Mean rating, "Mistakes are held against staff." (1-5, higher is better)	2.9	3.3	2.7
Mean rating, "Patient safety is a top management priority." (1-5, lower is better)	2.2	1.9	2.1

A set of bivariate logistic regression models was fitted to determine whether nurse characteristics and organizational conditions found to predict sharps injury risk were similar to those found in Aim 2 for hospital nurses (see **Tables 12** through **14**). Associations with P values lower than .20 are displayed. Because the identity of the employing facility or organization was not consistently available across sectors outside hospitals and/or across states, no aggregate variables characterizing nurses' impressions of their employers are used in the analyses displayed in the totals: these are associations of individual nurses' self-reported injuries with other factors they report. Also, on a similar note, these estimates are not adjusted for clustering of respondents within employing agencies and significance levels should be interpreted with caution.

Table 12. Bivariate Associations Between Demographic Variables and Job Characteristics with Risk of Reporting at Least 1 Injury With A Used Needle in the Preceding Year, By Employment Setting

	Hospital N=35474	Home health care N=2720	Nursing home N=1737
Demographics			
Male	1.2 (1.0, 1.4)	--	--
Age	--	--	--
Experience			
Less than 5 y clinical experience	1.2 (1.1, 1.4)	1.5 (.9, 2.4)	1.3 (.8, 2.0)
Advanced beginners/competent (vs. Proficient or expert)	1.7 (1.5, 1.7)	1.9 (1.2, 3.2)	1.5 (1.0, 2.3)
Race/ethnicity (White/Caucasian			

reference category)			
Filipino	2.0 (1.8, 2.3)	2.5 (1.1, 6.0)	2.0 (1.2, 3.2)
Asian	2.0 (1.6, 2.3)	--	2.6 (1.3, 5.1)
Black	--	--	1.9 (0.9, 3.8)
Other	--	--	--
Latino	--	2.3 (1.2, 4.3)	--
Country of education (US reference category)			
Philippines	2.3 (2.0, 2.6)	--	1.9 (1.2, 3.1)
Other non-US	1.6 (1.4, 1.9)	2.5 (1.3, 4.8)	2.2 (1.2, 4.0)
Employment status (Full-time reference category)			
Part-time	.8 (.7, .9)	--	--
Per diem	.6 (.5, .7)	--	--

Table 13. Bivariate Associations (Expressed as Odds Ratios with 95% Confidence Intervals Computed from Logistic Regression Models) Between Risky Procedures, Safety Engineered Devices and Environmental Conditions with Risk of Reporting at Least 1 Injury With A Used Needle in the Preceding Year, By Employment Setting

	Hospital N=35474	Home health care N=2720	Nursing home N=1737
Risky procedures			
IV start on last shift	1.2 (1.1, 1.3)	--	1.3 (.9, 2.0)
Phlebotomy on last shift	1.2 (1.1, 1.3)	--	--
Safety-engineered devices			
For blood draws	.79 (.71, .88)	1.6 (1.1, 2.4)	.69 (.46, .99)
For accessing IV lines	--	--	--
Needle-syringe assemblies	.72 (.65, .79)	--	--
For IV line starts	.76 (.68, .84)	1.4 (1.0, 2.0)	.76 (.53, 1.08)
Work environment			
Overall assessment (1-4, lower is better)	1.2 (1.1, 1.3)	1.2 (1.0, 1.5)	1.2 (.9, 1.5)
NWI—Nurse-physician relations	.81 (.76, .86)	.80 (.71, 1.03)	.80 (.62, 1.02)
NWI—Nurse manager support	.81 (.77, .85)	.80 (.64, .99)	.83 (.67, 1.03)
NWI—Staffing and resources	.79 (.75, .83)	.70 (.55, .88)	.85 (.68, 1.06)
NWI—Nursing in institution	.78 (.73, .83)	--	.83 (.64, 1.09)
NWI—Foundations for quality	.73 (.68, .78)	.69 (.52, .93)	.80 (.61, 1.06)
Experience of job			
MBI--High emotional exhaustion	1.6 (1.4, 1.7)	1.8 (1.3, 2.7)	1.3 (.9, 1.9)

Table 14. Bivariate Associations (Expressed as Odds Ratios with 95% Confidence Intervals Computed from Logistic Regression Models) Between Safety and Quality Conditions and Risk of Reporting at Least 1 Injury With A Used Needle in the Preceding Year, By Employment Setting

	Hospital N=35474	Home health care N=2720	Nursing home N=1737
Quality and safety			
Quality of care delivered (1-4, higher is better)	1.3 (1.2, 1.3)	1.6 (1.2, 2.1)	1.4 (1.1, 1.8)
Patient safety grade (reference condition: A)			
B	1.2 (1.1, 1.4)	--	--
C	1.7 (1.5, 1.9)	1.7 (1.0, 2.8)	1.7 (.9, 3.3)
D/F	2.0 (1.7, 2.4)	3.4 (1.4, 8.1)	2.7 (1.3, 5.9)
Mistakes are held against staff (1-5, higher is better)	.84 (.81, .87)	.79 (.67, .92)	--
Patient safety is a top management priority (1-5, lower is better)	1.09 (1.05, 1.13)	1.17 (.98, 1.40)	1.20 (1.03, 1.41)

In nearly all cases, the associations of nurse reports of various types of conditions in their workplaces with their reports of needle injuries showed parallel associations across all three settings. Various demographic factors, work environment characteristics and ratings of quality and safety issues were associated in similar ways in hospital, home health, and nursing home nurses. Multivariate models were not developed because of the large (10- to 15-fold) differences in the sample sizes between the settings and other limitations in the data here, but the pattern of results suggests that similar underlying trends may be at work in accounting for variations in rates of injuries across all three settings.

Discussion

Findings here of 7 to 10% of hospital nurses experiencing one or more injuries with used sharps depending on jurisdiction and whether or not injuries with sharps other than needles are counted confirm a trend noted by a number of researchers and commentators that sharps injuries in hospital personnel showed a precipitous decline through the 1990s (in our own work from 55-66% in 1991 to 9-12% in 1998 and 1999) but leveled off during the first decade of the millennium. Injuries have remained notably high in operating rooms, an area of practice where engineering solutions are rendered quite complicated by the contexts and culture of surgery and appear to be related to both the handling of needles (including, one assumes, suture needles) and sharps other than needles (such as scalpels and other surgical instruments). Relative to the risks they appear to face, operating room workers, including nurses, appear to be understudied and engineering solutions to reduce injury risk underdeveloped.

Very similar risks of injuries were found across the three original states where nurses were surveyed; Florida nurses showed lower rates of injuries with both needles and other sharps across settings, specialties and in multivariate models, suggesting that a “real” difference in actual injuries or in self-reports was observed here with or without other explanatory factors at work beyond those controlled for here. Especially if some triangulation of this difference can be found in another data source, examining what is special about Florida health care settings, including regulatory climate or culture of practice, could be interesting from a policy analysis or occupational health viewpoint. Likewise, the significantly lower rates of injuries among nurses in children’s hospitals is intriguing and merits exploration. Low rates of sharps injuries among practical nurses working in hospital settings in New Jersey are perhaps readily explained by lower rates of performing potential risky procedures like IV insertions and blood draws; however, as the current nursing shortage deepens and practical nurses are encouraged to function within a wider scope of practice their injury rates should be tracked.

The use of safety engineered equipment to reduce risk of injuries is now very common, as would be expected given the operation of strong federal and state laws and regulations. There was some variation in nurses' reports of what types of equipment were in common use and higher proportions of nurses acknowledging routine use of various types of equipment was associated with lowered risk of needlestick injury. Whether these statistics reflect nurse knowledge and understanding of equipment design and education efforts at the facility level, or reflect differential use of devices across various institutions is not clear but these findings suggest that staff knowledge of and attitudes towards safety engineered sharps as well as the specific designs in use across facilities both merit investigation in the current regulatory environment.

Experience in nursing appeared in two of our earlier studies as a predictor of sharps injuries in U.S. hospital nurses; the trend continued here. The "cut point" for increased risk appears to be at 5 years—and is presumably associated with working conditions and approaches to procedures that are characteristic of those who have been in practice a shorter time. Particularly where injury rates are high, it is probably beneficial to invest in the initial orientation and ongoing monitoring of practices of nurses new to practice to ensure that they understand risks and ways of lowering them.

Nurses of Filipino and Asian descent appeared at approximately doubled risk of needlestick injuries relative to their peers of other racial/ethnic backgrounds. The reasons are not clear, but a large number of potential explanations has been ruled out through the multivariate analyses conducted here. High rates of occupational health problems among Filipino nurses have been described by at least one group (de Castro AB et al. AAOHN J. 2009; 57(4):149-57) and this study represents an independent confirmation of this trend. Potential explanations include both characteristics of the agencies in which Filipino and Asian nurses are more likely to work that may increase risk or may somehow relate to behavioral risk factors related to sharps injuries. This is also another potential direction for future investigation.

A general trend towards more favorable independent and aggregate ratings of workplace environments related to management support, safety issues and quality of care being associated with lower sharps injury risk from earlier studies was confirmed. In 3 earlier analyses based on data sets collected from 1991 through 1999 by the PI, as sharps injury rates fell, associations between staffing and organizational variables with sharps injuries became more challenging to identify and were of smaller magnitude. This was the case here. A number of associations of aggregated organizational properties with needle injuries were seen, of the smaller magnitudes generally found in the later (i.e. more recent) studies in this literature, that describe patterns and trends in the era since legislated implementation of safety engineered devices in health care settings. Whether it is a matter of decreased organizational influences as environmental (engineering) controls have been introduced around sharps injuries, and decreased statistical power to identify trends or both is not clear. While general "work environment quality" variables are predictive of needlesticks, the specific causal mechanisms are unclear and it appears unlikely that sharps injuries are highly sensitive to staffing and work environment factors in the modern era.

High rates of sharps injuries that paralleled those seen in hospital nurses were seen among nursing home nurses, along with much lower rates of reported routine use of safety-engineered devices; very low rates of injuries and risky procedures were reported by nurses in home health settings. Sharps injury incidence and sharps safety, including use of safety engineered devices in nursing homes deserves further study, keeping in mind that the intensity of medical treatment being provided in long-term care facilities appears to be increasing as the result of health system forces. The possibility that nursing home nurses' injuries may be attributable to other types of sharps than needles for intravenous line starts or blood draws, for instance, needles for injecting medications, such as insulin, and lances for taking blood samples for glucose readings should be explored. Furthermore, it is clear environmental contexts, such as poor work environments, and behavioral risk factors in handling sharps deserve attention in future research on sharps injuries among staff in nursing homes.

Limitations of this study include response biases in the samples because of the voluntary nature of the surveys and the modest return rates; it is unfortunately unclear in what ways the samples and response patterns may have been biased. Furthermore, the measures used, with the exception of hospital structural characteristics, were all derived from nurse surveys and thus subject to response and reporting biases inherent to self-report questionnaires.

In summary, in this study, despite potential limitations, considerable corroboration of earlier findings regarding sharps injuries was found in a large, high-quality survey dataset involving random selection of nurse respondents depicting conditions in four large states from distinct regions of the U.S. A likely reduced role of general work environment factors as predictors of sharps injuries in future work is recommended, as is investigation of differential use of specific types of safety-engineered sharps both within and across health care settings. A number of practice areas and risk groups for future investigation and potential intervention have been highlighted, both in terms of lower-risk (nurses in children's hospitals and from the state of Florida) and high-risk groups of nurses (including operating room nurses, less experienced nurses, nurses from Filipino and Asian backgrounds, and nursing home nurses). The data provide a new set of data points in tracking this occupational health problem over time and suggest directions for intervention and future research that may ultimately yield important improvements in safety for nurses and other health care workers.

Publications

Three manuscripts roughly corresponding to the 3 grant aims are currently in development include: 1) a policy-oriented paper describing trends in sharps injury incidence in relation to regulatory environment changes since the early 1990s and the role of advocacy and legislation in influencing workplace health issues in nursing (likely venue, Policy, Politics and Nursing Practice); 2) a paper describing the results of the modeling described in Aim 2 (likely venue, American Journal of Infection Control); and 3) an article describing the trends observed in non-hospital settings (nursing homes and home health agencies). They are expected to be submitted for review within the next months and will, of course, acknowledge the support of this study from CDC/NIOSH.