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Exposure Study of Occupational Practice (EXPO-S.T.O.P.): An update of a national survey of sharps injuries and mucocutaneous blood exposures among healthcare workers in US hospitals

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Abstract

Purpose. Blood exposure (BE) among healthcare workers, either from percutaneous sharps injury (SI) or mucocutaneous (MC) exposure, is a serious occupational risk that healthcare facilities strive to reduce. The Exposure Study of Occupational Practice (EXPO-S.T.O.P.) surveys members of the Association of Occupational Health Professionals in Healthcare (AOHP) to ascertain BE incidence among healthcare professionals in their facilities.

Design. A 16 item electronic survey was distributed to AOHP members to ascertain BE incidence and denominator data for their hospitals.

Method. Data from 2013 and 2014 were collected in the same survey distributed in early 2015. Participants were asked to report the annual number of SI and MC exposures for all staff; the annual SIs reported separately for surgical procedures, for nurses, and for doctors. Hospital characteristics (number of staffed beds, teaching status) were also ascertained.

The denominator metrics included full time equivalent (FTE) staff, FTE nursing staff, average daily census (ADC) and adjusted patient days (APD). Incidence rates per 100 FTE, per 100 Nurse FTE, per 100 Occupied Beds (OB), and per 1000 APD were calculated and compared with relevant US databases, including the 2011 and 2012 EXPO-S.T.O.P. data. Best practices from the five lowest-exposure teaching and five non-teaching hospitals were also sought.

Results. Responses from 84 hospitals in 28 states were included in this analysis. In 2013, 7,158 BEs were reported and in 2014, 6,954 BEs were reported. In both years, 73% of BEs were SIs and 27% were MC exposures. The SI incidence rates in 2013 were: 33.0/100 OB; 2.6/100 FTE; and 0.54/1,000 APD. In 2014 the SI incidence rates were: 33.3/100 OB; 2.7/100 FTE; and 0.56/1,000 APD.

Effective reduction strategies in the low-incidence, hospitals included prevention through education, data-driven communication, immediate root cause investigation of all exposures, adoption of safer safety engineered devices, engagement of staff on all levels, and acceptance by staff that safety is their responsibility.

Introduction

Blood exposures (BE) among healthcare workers is a serious occupational risk. Tracking this exposure is important to document the extent of the problem. Awareness of the extent of the exposure, in part, led to the Needlestick Prevention Act (NSPA), enacted in 2000 and implemented the following year.¹ BE tracking showed the subsequent drop off in BEs after the implementation of the NSPA.^{2,3}

Several blood exposure data collection systems exist, with advantages and disadvantages associated with each. The Exposure Prevention Information Network (EPINet) surveillance system is currently housed within the International Safety Center. They began collecting multi-state data in 1992 and collection continues to the present.^{4,5} This voluntary data reporting system collects data from hospitals located primarily in South Carolina. The number of hospitals included in EPINet includes approximately 85 over the years, with an average of 25-30 who participate currently. Since 2002 Massachusetts Department of Public Health (MDPH) Sharps Injury Surveillance System has annually collected and published sharps injury (SI) data from all hospitals as required by law in the state of Massachusetts.⁶ This system has the advantage of more comprehensive data, but it is limited to only one state. The Center for Disease Control and Prevention's (CDC) National Surveillance System for Healthcare Workers (NaSH) collected BE data from healthcare facilities from 1995 to 2007.⁷ In terms of current, national databases there was therefore a void which the Exposure Study of Occupational Practice (EXPO-S.T.O.P) survey sought to fill.

Since 2011, members of the Association of Occupational Health Professionals in Healthcare (AOHP) have been invited to participate in the AOHP's EXPO-S.T.O.P. survey. While still a voluntary reporting survey, the EXPO-S.T.O.P. survey is more nationally representative and reaches a larger number of hospitals than other

current collection systems. The first survey in 2011 included data from 125 hospitals and the second survey in 2012 included data from 157 hospitals.^{8,9} The BE incidences in the previous EXPO-S.T.O.P. surveys were higher than the EPINet and MDPH survey rates from the same years.^{4,5,6,8,9} The most recent EXPO-S.T.O.P. survey included data from 2013 and 2014 and will allow for further comparison against EPINet and MDPH, as well as the examination of trends over time.

Method

One hundred people responded to the EXPO-S.T.O.P survey. Sixteen responses were excluded from analysis since they were from non-hospital systems, leaving 84 useable responses for the 2013 and 2014 data collection. Responses came from 28 states and the median average daily census (ADC) for the hospitals was 128, with a range from 1 to 984.

A 16-item questionnaire (Table 1) was developed by the investigators and reviewed by a panel of occupational health experts and a data analyst/statistician for clarity. Very minor modifications were made from the previous year's questionnaire. Respondents were asked to report the annual number of SI and MC exposures for all staff; the annual SIs reported separately for surgical procedures, for nurses, and for doctors. Hospital characteristics (number of staffed beds, teaching status) were also ascertained. The denominator metrics included full time equivalent (FTE) staff, FTE nursing staff, average daily census (ADC) and adjusted patient days (APD) (see question 14 in Table 1 for APD formula).

The electronic questionnaire was distributed via e-mail to the members of AOHP. The email explained the purpose and goals of the survey, provided a link to complete the survey, and included investigator contact information. After the original invitation to complete the survey, three additional reminders were sent. Participants were given the option of providing their name and email address if they were

willing to be contacted to provide further information about their hospital's exposure management program. AOHP provided a drawing for a free conference registration as the incentive to complete the survey by the specified deadline. Data from 2013 and 2014 were requested at the same survey point, though respondents were instructed to report data from each year separately.

SI and BE incidence rates per 100 FTE, per 100 Nurse FTE, per 100 Occupied Beds (OB), and per

1000 APD were calculated and compared with relevant US databases, including the previous EXPO-S.T.O.P. data^{9,10}, EPINet data^{4,5}, and MDPH data.⁶ Survey responses in the EXPO-S.T.O.P. dataset were sorted by "teaching" and "non-teaching" facilities and the five facilities with the lowest blood exposure rates were identified for each category. Semi-structured interviews were conducted with occupational health professionals from each of these facilities, and their BE reduction strategies were identified.

Table 1. 2013 and 2014 EXPO-S.T.O.P. Survey Questions

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1. Are you a member of the Association of Occupational Health Professionals in Healthcare (AOHP)?
 2. What is your healthcare setting? (hospital, non-hospital, both hospital and non-hospital)
 3. Number of sharps injuries from your 2013 and 2014 calendar years OSHA Form 300
 4. Number of mucocutaneous blood or other potentially infectious material exposures (including bites) in 2013 and 2014 calendar years
 5. Number of sharps injuries in surgical procedures (OR + Procedure Rooms + Labor & Delivery) in 2013 and 2014 calendar years
 6. Number of sharps injuries reported by nurses (e.g., RN, LPN/LVN) in 2013 and 2014
 7. Number of sharps injuries reported by doctors in 2013 and 2014
 8. Are your NON-EMPLOYEE medical staff included in the OSHA Form 300 exposure data?
 9. (Hospital Only) What is your hospital size (number of staffed beds in hospital from which exposure data was derived)?
 10. (Hospital Only) How many hospitals were included in your exposure data? Note: Separate data for each hospital is preferred.
 11. (Hospital Only) Average Daily Inpatient Census (average daily occupied beds) for calendar years 2013 and 2014
 12. Number of Full Time Equivalents (FTE) as reported on your 2013 and 2014 calendar years OSHA Form 300A
 13. Number of NURSING Full Time Equivalents (FTE) in 2013 and 2014 (e.g., RN, LPN/LVN)
 14. (Hospital Only) Adjusted Patient Days for 2013 and 2014. Adjusted Patient Days = (total revenue/inpatient revenue) x total inpatient days
 15. (Hospital Only) Is your hospital a teaching hospital? (teaching = affiliated with a medical school and serving as a practical education site for medical students, interns and residents)
 16. In what state is your facility located?
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OSHA – Occupational Safety and Health Administration

OR – Operating room

RN – Registered Nurse

LPN – Licensed Practical Nurse

LVN – Licensed Vocational Nurse

Results

The requested 2013 and 2014 EXPO-S.T.O.P. information was provided by respondents from 84 hospitals in 28 states. Of the 84 hospitals 59.5% supplied usable APD data (Q14 of Table 1). Table 2 shows an overview comparison of the EXPO-S.T.O.P. survey results from 2011 to 2014.^{8,9} Some of the 2013 and 2014 characteristics are the same; since that data was collected in the same survey, it includes the same respondents. The current survey includes responses from only 84 hospitals, less than in previous years. The number of states is approximately the same, with respondents from throughout the United States. Further, the range of the average daily census (ADC) is 1 – 984, which is very similar to previous years.

Table 3 presents SI incidence rates from the 2011 to 2014 EXPO-S.T.O.P. survey results.^{8,9}

Incidence rates are presented separately for all FTE, nurse FTE, and adjusted patient days (APD). Additionally, incidence rates are presented per 100 occupied beds (OB) and are separated for teaching and non-teaching hospitals. There is an increase in SI incidence each year from 2011 to 2013, with 2014 results similar to 2013.

Teaching hospitals have higher SI incidence rates than non-teaching hospitals. Higher SI rates also occurred in larger hospitals, and the “high, low, higher” pattern seen in 2011 and 2012 with the three hospital sizes, was repeated in 2013 and 2014 - see Figure 1. Over the years, nurses have consistently reported a higher proportion of total SI than physicians. Additionally, approximately 40% of SIs have occurred during surgical procedures. See Table 4 for annual percentages.

Table 2. Survey overview: EXPO-S.T.O.P 2011 – 2014

	Hospitals Participating	States Participating	ADC Range	Blood Exposures	Sharps Injuries	Mucocutaneous Exposures
2011	125	29	6 - 975	8,101	5,932	2,169
2012	157	32	5 - 985	9,494	7,119	2,375
2013	84	28	1 - 984	7,158	5,222	1,936
2014	84	28	1 - 984	6,954	5,072	1,882

Table 3. EXPO-S.T.O.P. 2011 – 2014 sharps injury incidence rates

	2011	2012	2013	2014
SI/100 Occupied Beds	24.0	28.2	33.0	33.3
Non-teaching hospitals	17.8	22.5	23.9	24.0
Teaching hospitals	27.4	31.4	35.3	35.5
SI/100 FTE	1.9	2.2	2.6	2.7
SI/100 Nurse FTE	N/A	3.3	2.9	3.1
SI/1,000 Adjusted patient days	0.53	0.43	0.54	0.56

Table 4. EXPO-S.T.O.P. 2011 – 2014 percentage of sharps injury, by profession and procedure

	2011	2012	2013	2014
Nurse SI as % of total SI	N/A	41.8%	40.2%	44.4%
MD SI as % of total SI	N/A	35.5%	31.0%	32.7%
Surgical procedure SI as % of total SI	37.2%	43.9%	40.7%	43.0%

Figure 1. Sharps injury rates by hospital size

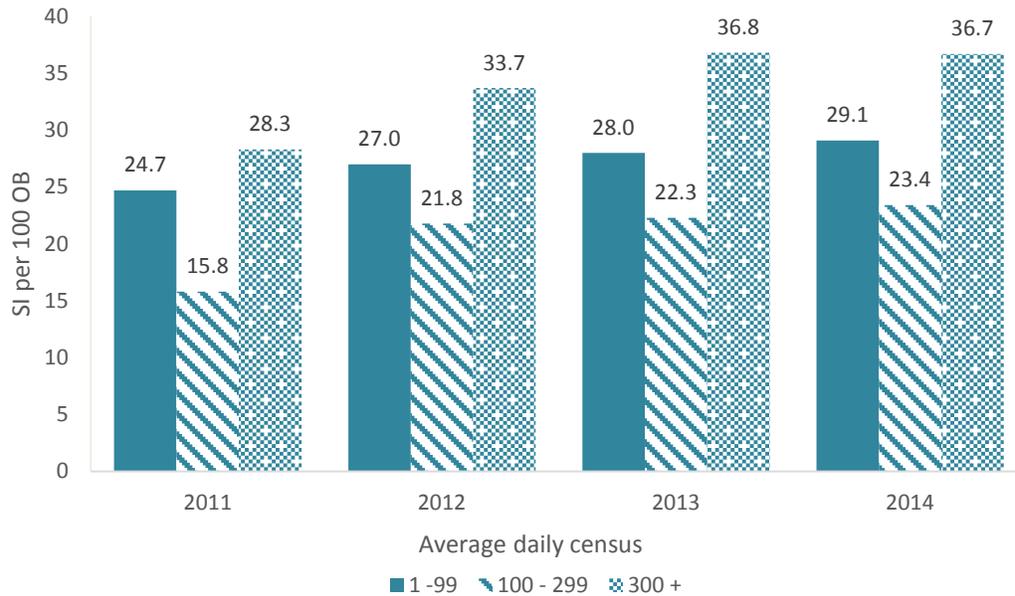
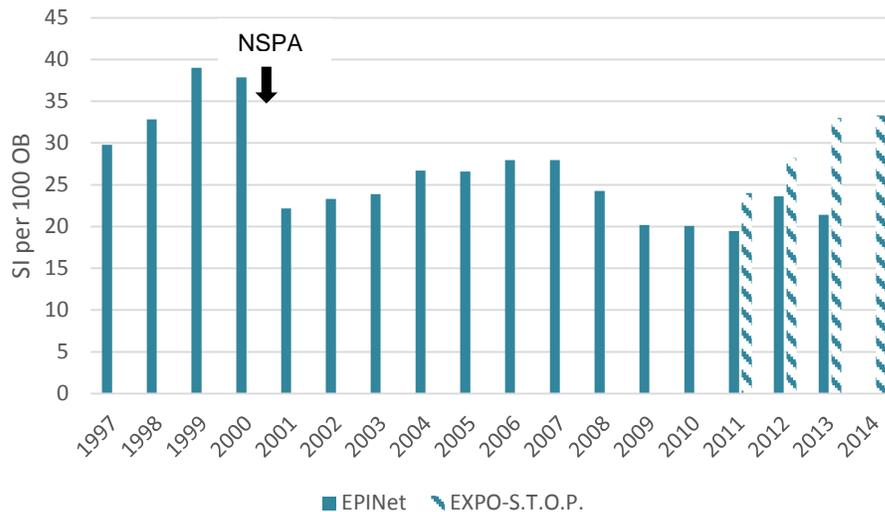


Figure 2. US sharps injury trends, 1997-2014



We examined the SI incidence rates over time, examining EXPO-S.T.O.P. data (2011 – 2014) and EPINet data (1997 – 2013), using SI rate per 100 OB.^{4,8,9} These time points were chosen to provide a historical context. The Needlestick Safety and Prevention Act was signed into law in 2000. This required employers to “identify, evaluate, and implement safer medical devices.”¹ Additional reporting requirements

were also put into place at this time. The data presented in Figure 2 shows a clear dip in the 2001 EPINet data. In the years in which data overlaps (2011 – 2013), EXPO-S.T.O.P. rates are higher than EPINet rates in all cases. There is an upward trend in both data sets.

Mucocutaneous (MC) exposure rates were also standardized and 2011 to 2014 EXPO-S.T.O.P. data are presented in Table 5.^{8,9} We see the same upward trend from 2011 to 2013, with

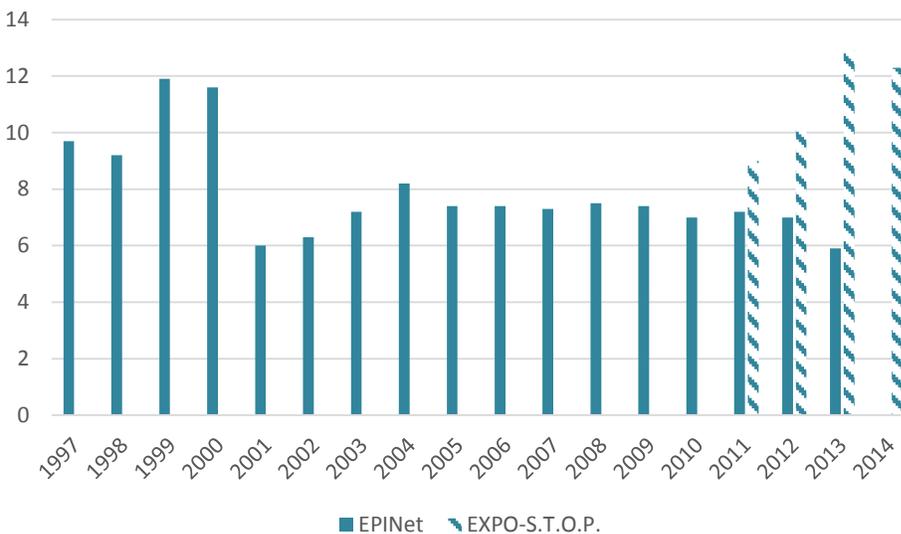
slightly lower rates in 2014. Once again, teaching hospitals have higher MC exposure rates than non-teaching hospitals. We compared the EXPO-S.T.O.P. MC rates to the

available EPINet data.⁵ Again, we find that the EXPO-S.T.O.P. rates are higher in all cases than the EPINet data from the corresponding time period.

Table 5. EXPO-S.T.O.P. 2011 – 2014 mucocutaneous (MC) blood exposure rates

	2011	2012	2013	2014
MC/100 Occupied Beds	9.0	10.1	12.9	12.3
Non-teaching hospitals	7.1	9.8	10.8	10.5
Teaching hospitals	10.1	10.5	13.5	12.8
MC/100 FTE	0.7	0.8	0.9	1.0
MC/1,000 Adjusted patient days	0.20	0.15	0.22	0.21

Figure 3. US mucocutaneous (MC) blood exposures trends, 1997-2014



Discussion

National databases are valuable as benchmarking tools for individual hospitals, for determining national incidence rates, and for informed discussion on national issues such as prevention guidelines, resource allocation and legislation. Large, geographically widespread databases are particularly valuable for these purposes. The EXPO-S.T.O.P. surveys were conducted as a broad overview of exposure incidence and not as a detailed database of exposure mechanisms. The survey tool was constructed to promote maximum response by asking minimal but valuable questions to calculate a national BE incidence rate using four

different denominators (Occupied Beds, Nurse FTE, FTE, Adjusted Patient Days), the latter two being measures of combined inpatient and outpatient workloads, a truer denominator of the extent of sharps usage in a facility.

The SI incidence rate of 33.0 and 33.3 (2013 and 2014, respectively) per 100 OB is higher than EPINet 2013,² and EXPO-S.T.O.P. 2011 and 2012 rates.^{8,9} It is the highest incidence reported among the databases since the NSPA was put into place in 2001 (Fig 2). EXPO-S.T.O.P. SI rates increased each year over the four years data has been collected, though the 2014 EXPO-S.T.O.P. results are similar to 2013. This might be

an artifact of collecting 2013 and 2014 data at the same time and thus having the same respondents report for both years.

Possible explanations for the higher rate may be that EXPO-S.T.O.P. hospitals reported more of their SIs or that EPINet hospitals reflect a regional-specific low incidence. Additionally, 33.3% of the EXPO-S.T.O.P. respondents indicated that non-employee medical staff are included in the OSHA Form 300 data they provide, possibly contributing to the higher incidence rates in the EXPO-S.T.O.P. data. While, MDPH rates are also lower than both EXPO-S.T.O.P. and EPINet rates, it is difficult to make direct comparisons due to the different denominators used in the MDPH data (licensed beds versus occupied beds).

Of the hospitals participating in EXPO-S.T.O.P., 53.2% were teaching hospitals, a higher percentage than previous years. The increased SI rate per 100 OB in teaching hospitals over non-teaching hospitals mirrors that of previous surveys.^{4,5,6,8,9} This is indicative of procedure intensity and trainee “learning curve” together with SI incidence in research (non-bed) departments in teaching hospitals. Additionally, teaching hospitals tend to be larger, as measured by ADC, and larger hospitals have been shown to have higher SI rates (Figure 1). Since the ADC for non-teaching hospitals was 68 and the ADC for teaching hospitals was 342, what we are seeing could be due more to teaching status than size. Based on this, we can also see that the largest hospitals are driving the increase in SI incidence rates.

Denominators. As stated above, using occupied beds as an exposure incidence denominator does not allow meaningful comparison with hospitals that have a different case mix, non-bed research facilities, non-clinical teaching staff, a large day-surgery capability, or a large outpatient population. The issue has been highlighted by Chen et al.¹⁰ who compared the validity of four denominators (OB, Staffed beds, FTE and “Patient Days”) and found occupied

beds to be a “sub-optimal” denominator. They also found FTE to be a poor denominator because of its varying application and definition. The SI rate by FTE was calculated, as it better reflects hospital workloads (i.e. outpatients and day-surgery) than occupied beds. The 2013 and 2014 incidence of 2.6 and 2.7 per 100 FTE is higher than the 2.2 per 100 FTE reported in the 2012 EXPO-S.T.O.P. and the 1.9 reported in 2011 data).^{8,9} These SI rates per 100 FTE are comparable to MDPH data for 2011 and 2012, though the EXPO-S.T.O.P. rates per 100 FTE are higher than MDPH for 2013, 2.6 compared to 2.0 (2013 MDPH data provided by A. Laramie, personal communication, November 6, 2015).

Chen et al.¹⁰ found “patient days” to be the most valid denominator of the four they examined. However, “patient days” excludes outpatients and in the EXPO-S.T.O.P. 2013 and 2014 survey we once again asked members for their Adjusted Patient Days (includes all inpatients and outpatients) and 59.5% were able to supply this data. We believe this to be a valid measure of total hospital workload. The incidence of 0.54 and 0.56 SI per 1000 APD (2013 and 2014, respectively) was higher than the 0.43 of EXPO-S.T.O.P. 2012 and in line with the 2011 rate of 0.53 SI/1000 APD. The percentage of respondents who supplied APD was consistent with previous years, but as it is less than 100%, it may mean the results from this are less generalizable.

Beginning in 2012, the EXPO-S.T.O.P. survey asked for nurse FTE, allowing us to calculate the SI incidence rates among nurses. These denominators are tightly targeted to a specific clinical group, easily understood and procured, and often used in non-US databases. The EXPO-S.T.O.P. 2013 and 2014 incidence of SI among nurses was 2.9 and 3.1 per 100 Nurse FTE which means, for every 1,000 nurses, approximately 30 will sustain an SI annually. This was a slight decrease over the 2012 EXPO-S.T.O.P. SI incidence for nurses which was 3.3 per 100 FTE.

When hospitals were stratified into three ADC sizes (Fig 1), the ‘high-low-higher’ SI incidence per 100 OB is consistent across years and mirrors that found in MA hospitals.⁶ This is possibly due to the higher procedure intensity (with concomitant higher use of sharps) in larger hospitals. The rate in hospitals <100 ADC may reflect better reporting, the necessity of a smaller staff to function as “generalists” filling multiple roles, and/or less use of safety-engineered devices. More research is warranted to clarify the reasons behind this consistent finding.

Mucocutaneous Exposure Incidence. The 2013 and 2014 EXPO-S.T.O.P. MC incidence rate of 12.9 and 12.3 per 100 OB is higher than that of EPINet 2013 (5.9) and EXPO-S.T.O.P. 2012 (10.1) and 2011 (9.0).^{5,8,9} Among teaching hospitals, the 2013 and 2014 rates of 13.5 and 12.8 were higher than EPINet 2013 and EXPO-S.T.O.P. 2012 and 2011 (Table 5). Using FTE as a denominator, the 2013 and 2014 incidence rates of 0.9 and 1.0 were higher than the 0.8 of 2012, but when APD was compared, the 2013 and 2014 results (0.22 and 0.21 MC per 1000 APD) were significantly higher than 2012, but in line with 2011. Of total exposures, 27% were MC exposures, similar to previous years.

Best practices Identified. Results from the EXPO-S.T.O.P. survey revealed that exposure rates varied among institutions. Among respondents, those with the lowest rates among teaching and non-teaching hospitals were identified. Occupational health professionals from many of the top “Sharps Safe” hospitals were interviewed to determine what “Best Practices” they have used to achieve their low rates (combined SI and MC rates of those interviewed ranged from 11-28 per 100). Several themes emerged from these low-exposure hospitals, which are presented in Table 6. Additionally, three innovative ideas are highlighted here.

- **Safety Advocates:** An example from one of this years “exposure safe” hospitals is the

use of “Safety Advocates”— front-line staff that partner with Employee Health, department directors and the CEO. This group meets on a regular basis at “Safety Advocate Breakfasts” where they are all briefed on current injury rates and together identify “Top 3 Problems” in each area, targeted for focused intervention. In addition, they are actively involved in the development and review of any new safety marketing materials. This empowerment of direct care providers has resulted in injury reduction and a culture of safety throughout the facility.

- **Safety Scripting & Flagging:** Another effective exposure-reducing strategy identified was scripting. The Occupational Health nurse shared details of an incident in which a phlebotomist sustained a needlestick when a startled patient jumped during the puncture. This led them to develop scripting as part of their standard work. Now the phlebotomist explains the blood draw steps to the patient and asks, “*Are you able to hold still for your safety and mine?*” As an additional safety step, a flag is placed outside the room to identify to co-workers that a blood draw is taking place to prevent an inadvertent startle and possible injury.
- **Requiring a Waiver:** One hospital noted percutaneous injuries related to the use of unauthorized non-safety-engineered devices. This led them to require a “*Waiver for Use of Non-Safety Products*” from any staff member or provider requesting to use a non-safety product. Their Sharps Committee reviews requests and approves (or disapproves) this item, depending on necessity and whether there is a clinically acceptable safety alternative available. Not only does this practice help eliminate unsafe devices from coming into the facility, but also helps with standardization which has both safety and economic benefits.

Table 6. Bloodborne pathogen exposure-reducing “Best Practices” compiled from 2011 – 2014 EXPO-S.T.O.P. surveys

<p>Education:</p> <ul style="list-style-type: none"> • Require new clinicians to demonstrate competency with all new devices • Discuss exposure prevention individually and in orientation in a personalized way • Building a bloodborne pathogen exposure event into simulation lab training scenarios • Use vendor support and clinical educators to “stretch” resources and provide all-shift coverage • Provide mandatory initial and on-going education using a variety of methods, including on-line modules and face-to-face interaction with Employee Health and/or Workers Compensation Nurse Case Manager • Require a review process and waiver for requests for non-safety-engineered devices <p>Communication:</p> <ul style="list-style-type: none"> • Make initiatives data-driven and report using metrics aligned with the organization’s goals and reporting style • Be transparent with findings and get them “on-the record” by reporting through established committees that reach decision-makers • Encourage reporting (including “near misses”) by making it convenient and efficient, such as a call-in or on-line reporting system. • Awareness campaigns to reach front-line staff • Use safety scripting to prepare patients for procedures that are high risk for employee exposure such as blood draws • Use flagging outside of patient rooms to alert co-workers that a high risk procedure is in progress—to avoid an inadvertent startle and possible injury <p>Investigation:</p> <ul style="list-style-type: none"> • “Drill Down” – Conduct a thorough, systematic root cause analysis to avoid assuming causation • Actively involve the manager and the injured employee in the follow up investigation <p>Engagement:</p> <ul style="list-style-type: none"> • Hold both the healthcare worker and management responsible for their part in the “Safety Formula” and when they do it well, praise them • Partner with stakeholders using safety forums for discussion, for example: “If you arrived to work today and it was a safer environment, what would it look like?” • Include perceptions of workplace safety in employee opinion evaluation. • Use front-line staff “Safety Advocates” partnered with Occupational Health and Administration in injury reduction initiatives
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Strengths and Limitations

Though lower than previous years, the number of hospitals (84) participating in the EXPO-S.T.O.P survey is a strength. Additionally, the survey achieved good geographic dispersion (28 states), hospitals of all sizes were represented (includes all 8 of CDC hospital sizes). Most survey questions were from annual data

required by OSHA law, and incidence rates were calculated using four denominators. An additional strength is that the EXPO-S.T.O.P. survey has now collected data from four years, allowing for trends in the data to emerge. Limitations included the reliance on voluntary reporting of exposure incidents and voluntary survey participation with its inherent selection

bias. An additional limitation to this administration of the survey is that data was requested for two years at once. While the data was reported it separately, the similarity of 2013 and 2014 data is likely due to the same respondents completing both years, as there is not variance in the hospitals participating. There is potential for misinterpretation of definitions, though this is a possibility for most data collection systems. Finally, participating hospitals may not be representative of hospitals nationally.

Conclusions

The significant fall in SI following NSPA enactment is incontrovertible.³ However it is

disturbing that the 2013 and 2014 EXPO-S.T.O.P. SI incidence of 33.0 and 33.3 per 100 OB are once again increases over the previous years. Simple compliance with OSHA NSPA law alone cannot eliminate SI at the rate we expected; instead aggressive research into how and why SI are still occurring is essential in every institution.

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