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Major Article

# EXPO-S.T.O.P. 2016 and 2017 blood exposure surveys: An alarming rise

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***Background:*** The annual Exposure Survey of Trends in Occupational Practice (EXPO-S.T.O.P.), conducted by the Association of Occupational Health Professionals in Healthcare, provides a U.S. national overview of sharps injuries (SIs) and mucocutaneous exposures (MCEs). This study presents the 2016 and 2017 surveys.
***Methods:*** An 18-item survey was distributed to Association of Occupational Health Professionals in Healthcare members and colleagues and requested total SIs and MCEs; SI in nurses, doctors, and surgery; staffed beds; teaching status; full-time equivalent staff (FTE), nurse FTE, and average daily census (ADC).
***Results:*** In 2016, 170 hospitals reported 10,271 exposures (72.9% SIs); in 2017, 224 hospitals reported 12,672 exposures (74.4% SIs). In 2016, SI rates were 27.0 per 100 ADC, 2.3 per 100 FTE, and 2.8 per 100 nurse FTE. Of the total SIs, 36.4% were nurses, 35.6% were doctors, and 39.0% occurred during surgery. In 2017, the respective SI rates were 27.7 per 100 ADC, 2.5 per 100 FTE, and 2.7 per 100 nurse FTE. Of the total SIs, 37.6% were nurses, 32.7% were doctors, and 39.9% occurred during surgery. In 2016, MCE rates were 11.2 per 100 ADC and 0.82 per 100 FTE, and in 2017, MCE rates were 9.6 per 100 ADC and 0.87 per 100 FTE. Teaching hospitals had higher rates than nonteaching hospitals.
***Discussion:*** EXPO-S.T.O.P. SI rates have risen year-on-year for 3 years and now match 2001-2005 levels.
***Conclusions:*** There is an urgent need for aggressive SI-reduction strategies, including leadership support, safety-engineered devices (SED) training/education, and adoption of safer, less user-dependent SED. Further research on SI mechanisms, SED effectiveness, and reduction strategies is required.


Sixty bloodborne pathogens can be acquired via blood and body fluid exposure (BBFE),[1] and such exposures are a serious occupational risk to health care workers (HCWs).[2] Surveillance, the ongoing collection, analysis, and interpretation of data on these exposures, both institutionally and nationally, is vital as it underpins prevention and commitment.[3]

Since its first 2011 survey of sharps injury (SI) and mucocutaneous exposures (MCEs),[4] the **E**xposure **S**urvey of **T**rends in **O**ccupational **P**ractice (EXPO-S.T.O.P.) has annually surveyed members of the Association of Occupational Health Professionals in Healthcare (AOHP) on their hospital's reported BBFE. The EXPO-S.T.O.P. surveys are a high-level, national overview of BBFE rates among hospitals and supplement the valuable, detailed annual surveys of the International Safety Center (EPINet)[5] and the Massachusetts Sharps Injury Surveillance System (MSISS).[6]

Disturbingly, the 2015 EXPO-S.T.O.P. survey[7] found the SI rate per 100 average daily inpatient census (ADC) to be significantly higher than that reported in the 2011 EXPO-S.T.O.P. survey.[4] Similarly, the annual EPINet SI rates per 100 ADC from 2014-2017 (24.7-33.8) were each significantly higher than that in 2001 (22.7),[5] the year the Needlestick Safety and Prevention Act (NSPA) became effective and was enforced.[8] Massachusetts surveys for 2016 and 2017 are not yet available, however, the SI rates for 2009-2015 have plateaued to around 22 per 100 ADC.[6]

Using full-time equivalent staff (FTE), a denominator more closely reflecting workload increases and thus SI exposure risk,[7] the EXPO-S.T.O.P. 2015 rate of 2.1 per 100[7] confirmed that SI incidence was rising and approaching the EPINet SI per 100 FTE rate of 2001.[9]

This study presents the results of the EXPO-S.T.O.P. 2016 and 2017 surveys, and, using several denominators, statistically compares BBFE rates and trends with those of previous EXPO-S.T.O.P., EPINet, and MSISS surveys.

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## METHODS

An 18-item questionnaire, 1 question less than that used in 2015,[7] was made available electronically to all AOHP members and other hospitals expressing an interest in participating (questionnaire available from corresponding author on request). Data on reported exposures, from 2016 and 2017 calendar years, were requested on the following: total SI and MCE from all staff; SI in nurses, SI in doctors; SI in surgical procedures; and hospital bed size, teaching status, and state. The 3 denominator metrics requested were: total full-time equivalent staff (FTE) (total FTE included "all staff, all roles, and all sites" whether or not they have BBFE risk ); [9] nurse FTE; and average daily overnight-patient census (ADC). Adjusted patient days was not requested in the surveys as, in previous surveys, only 40% of participants were able to easily obtain this figure.

The questionnaire was distributed via e-mail, and participating hospitals used Survey Monkey (Survey Monkey, San Mateo, CA) to insert their data or e-mailed data directly to the authors. A Microsoft Excel spreadsheet (Microsoft Corp, Redmond, WA) of the questions was also made available to enable hospital systems to conveniently supply data on individual hospitals. Accompanying the survey was an explanation of the purpose and goals of the survey and investigator contact information. Participants were given the option of providing their contact information if willing to be contacted for further information about their data and the exposure management program of their hospital, and were assured no hospital name would be revealed without their permission. To encourage participation, AOHP provided a free conference registration as the prize in a drawing for those who completed the survey by the specified deadline. Participants with contact details were contacted if their data was incomplete or contained "outlier" data. Participants with nonsensical data, who could not be contacted, had their data excluded from that calculation.

Hospital incidence rates for SI and MCE per 100 ADC, 100 FTE, and 100 nurse FTE were calculated for teaching and nonteaching facilities, and these, together with nurse, doctor, and surgical proportions, and with the number of states contributing data, were compared with the EXPO-S.T.O.P., EPINet, and MSISS surveys. The official MSISS results are reported using licensed beds as the denominator and, to compare this database with the EPINet and EXPO-S.T.O.P. results, the MSISS data were converted to rates per occupied beds (ADC) using hospital-specific occupancy data for all MSISS-licensed hospitals as published by the Massachusetts Department of Public Health.[6]

WinPepi v11.26[10] was used to calculate $X^2$, log-transformation risk ratios (RR) at 95% confidence limits. Statistical significance was set at $P \leq .05$.

## RESULTS

In 2016, 37 states had participating hospitals, a slightly larger geographic spread than EXPO-S.T.O.P. 2017, with 33 participating states involved (Fig 1). However, with 224 hospitals participating, the 2017 survey is the largest EXPO-S.T.O.P study to date (Table 1). Nonhospital facilities are excluded from this report and will be the subject of a separate paper. Hospital sizes, measured by average daily inpatient census (ADC), ranged from 1-950, and almost 50% were teaching facilities (Table 1).

SI and mucocutaneous incidence rates for 2016 and 2017 were statistically compared with those of 2011 and 2015 (Table 2). Nurse SI rates were not requested in the 2011 survey, however, rates in 2015, 2016, and 2017 are compared (Table 2). MCEs, as a percentage of BBFE, are also shown in Table 2 for the 4 study years. To assist in incidence benchmarking, Figure 2 depicts SI incidence by 5 hospital FTE sizes for 2016 and 2017. As a proportion of total SI reported, the percentage of SI among nurses, doctors, and surgical procedures is shown in Table 3. Trends in SI rates per 100 ADC, from 2000 to 2017, using EXPO-S.T.O.P., EPINet, and adapted MSISS databases, are shown in Figure 3, and in SI rates per 100 FTE for the available years of data from EPINet and EXPO-S.T.O.P. in Figure 4.

## DISCUSSION

Of the nation's 6,200 hospitals,[11] 1,122 (20%) are teaching hospitals.[12] Therefore, with EXPO-S.T.O.P.'s high bias toward teaching facilities (Table 1) and their associated higher exposure rates,[5,7] EXPO-S.T.O.P. overall exposure rates are likely to be higher than the true national incidence. Notwithstanding this bias, EXPO-S.T.O.P. SI rates per 100 FTE show a year-on-year significant increase for the past 3 years. The SI rates per 100 ADC, while leveling in 2017, show significant increases over the rate for 2011 (Table 2). However, SI reported by nurses have shown a significant trend downward since 2011,

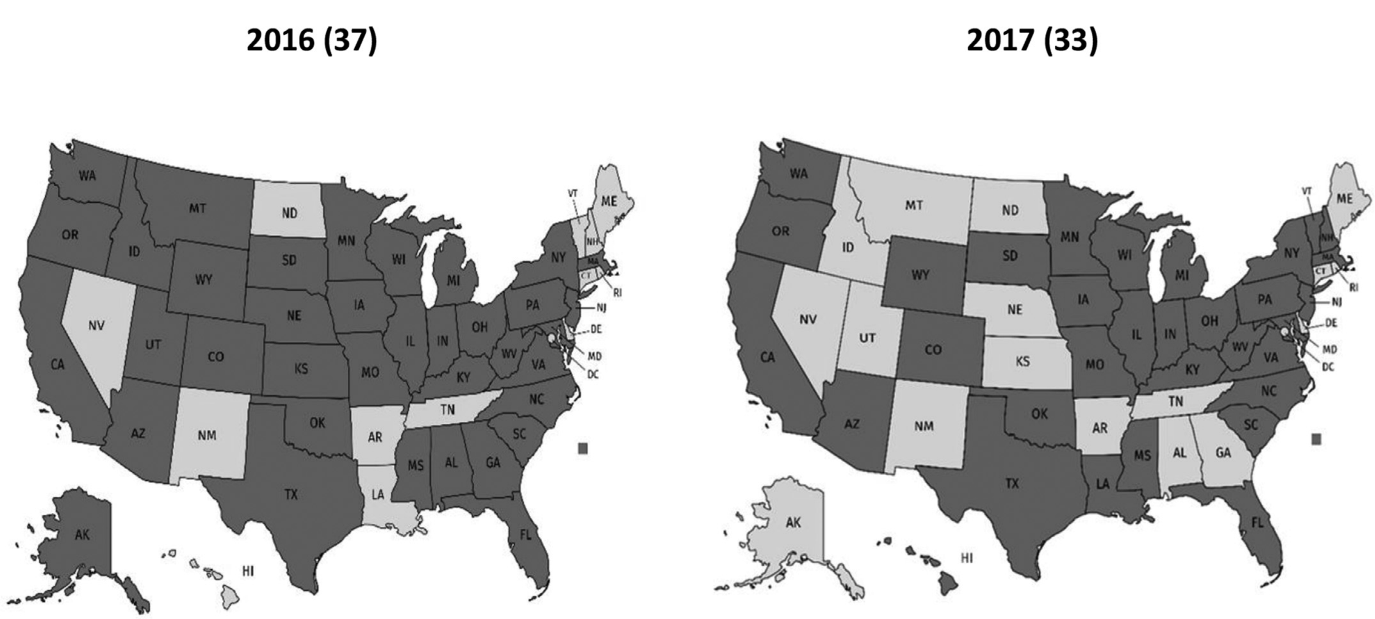


**Fig 1.** Participating states (No.) in 2016 and 2017 surveys.

**Table 1**
Overview of EXPO-S.T.O.P. surveys

| Year | Total responses* | Nonhospitals | Hospitals* | Hospital size range (ADC) | No. of U.S. states | % of Teaching hospitals |
|---|---|---|---|---|---|---|
| 2011 | 116 | 0 | 125 | 6-975 | 29 | 38.3% |
| 2012 | 125 | 14 | 157 | 5-985 | 32 | 39.8% |
| 2013 | 100 | 12 | 94 | 1-984 | 28 | 53.3% |
| 2014 | 100 | 12 | 94 | 1-984 | 28 | 53.4% |
| 2015 | 182 | 41 | 182 | 1-924 | 38 | 39.8% |
| 2016 | 159 | 11 | 170 | 1-898 | 37 | 46.5% |
| 2017 | 174 | 37 | 224 | 2-950 | 33 | 49.6% |

*ADC*, average daily census (overnight occupied beds); *EXPO-S.T.O.P.*, Exposure Survey of Trends in Occupational Practice.
*Multiple hospitals may be submitted by responders.

**Table 2**
Sharps injury and mucocutaneous exposure incidence by year using multiple denominators (with statistical comparison)

| | | | | | 2017 | |
|---|---|---|---|---|---|---|
| | 2011 | 2015 | 2016 | 2017 | Median | Range |
| SI/100 ADC (All hospitals) | 24.0 | 25.2* (0.001; 1.06; 1.02-1.09) | 27.0* (<0.001; 1.07; 1.03-1.10) | 27.7 | 21.3 | 0-160 |
| • Nonteaching hospitals | 17.8 | 17.5 | 17.5 | 16.5 | 17.1 | 1.1-160 |
| • Teaching hospitals | 27.4 | 30.4* (<0.001; 1.11; 1.07-1.15) | 33.3* (<0.001; 1.07; 1.03-1.10) | 32.4 | 25.5 | 0-125 |
| SI/100 FTE (All hospitals) | 1.9 | 2.1* (<0.001; 1.13; 1.09-1.17) | 2.3* (<0.001; 1.08; 1.04-1.11) | 2.5* (<0.001;1.10;1.07-1.14) | 2.0 | 0-7.7 |
| • Nonteaching hospitals | 1.3 | 1.7* (<0.001; 1.31; 1.20-1.43) | 2.0* (<0.001; 1.13; 1.06-1.21) | 2.0 | 1.9 | 0.2-5.2 |
| • Teaching hospitals | 2.0 | 2.4* (<0.001; 1.19; 1.15-1.23) | 2.5 | 2.7* (<0.001; 1.11; 1.07-1.15) | 2.3 | 0-7.7 |
| Nurse SI/100 Nurse FTE (All hospitals) | N/Av | 3.2 | 2.8* (<0.001; 0.89; 0.83-0.94) | 2.7 | 2.6 | 0-13.3 |
| • Nonteaching hospitals | N/Av | 2.7 | 3.1* (0.008; 1.16; 1.04-1.29) | 2.7* (0.006; 0.85; 0.75-0.95) | 2.5 | 0-8.9 |
| • Teaching hospitals | N/Av | 3.4 | 2.7* (<0.001; 0.77; 0.72-0.83) | 2.7 | 3.0 | 0-13.3 |
| MCE/100 ADC (All hospitals) | 9.0 | 10.5* (<0.001; 1.17; 1.11-1.23) | 11.2* (0.03; 1.06; 1.01-1.12) | 9.6* (<0.001; 0.86; 0.82-0.90) | 7.3 | 0-33.1 |
| • Nonteaching hospitals | 7.1 | 8.6* (<0.001; 1.20; 1.09-1.34) | 6.5* (<0.001; 0.76; 0.68-0.84) | 6.0 | 4.2 | 0-27.7 |
| • Teaching hospitals | 10.1 | 11.7* (<0.001; 1.16; 1.08-1.24) | 13.9* (<0.001; 1.19; 1.12-1.27) | 10.9* (<0.001; 0.79; 0.74-0.83) | 9.1 | 0-33.1 |
| MCE/100 FTE (All hospitals) | 0.69 | 0.86* (<0.001; 1.24; 1.17-1.32) | 0.82 | 0.87* (0.02; 1.07; 1.01-1.13) | 0.68 | 0-3.0 |
| • Nonteaching hospitals | 0.59 | 0.85* (<0.001; 1.44; 1.26-1.65) | 0.58* (<0.001; 0.69; 0.61-0.76) | 0.72* (<0.001; 1.23; 1.10-1.38) | 0.58 | 0-3.0 |
| • Teaching hospitals | 0.71 | 0.86* (<0.001; 1.22; 1.14-1.30) | 0.92 | 0.93 | 0.83 | 0-3.0 |
| MCE as % of total BBFE | 26.8% | 28.6%* (0.009; 1.10; 1.02-1.17) | 26.2%* (<0.001; 0.92; 0.87-0.96) | 25.6% | 22.2% | 0-66.7% |

*ADC*, average daily census (overnight occupied beds); *BBFE*, blood and body fluid exposure; *FTE*, full-time equivalent staff; *MCE*, mucocutaneous exposure; N/Av, not available; *SI* sharps injury.
*Significantly different from value in column to left (probability; risk ratio; 95% confidence limits).

particularly in teaching hospitals (Table 2). When using ADC as the denominator, MCE have not shown a linear trend since 2011, however, using the "MCE per 100 FTE" shows a significant increase over the 2011 rate in all hospital categories.

*SI incidence by hospital size*

Ideally, benchmarking should occur against hospitals of similar size, services, patient mix, and teaching status, but many EXPO-S.T.O.P. participants express a desire to benchmark their rates against rates of similar-sized hospitals to their own. Previously, we expressed our dissatisfaction with ADC as a denominator.[7] Therefore, this year we expressed SI rates by 5 hospital FTE sizes (Fig 2) and, as in previous surveys,[7] the effect of size is not linear. In 2017, the rates in mid-size hospitals (2,000-2,999 FTE) were significantly different from smaller and larger hospitals (in 2016, a significant difference was found only between mid-size and larger hospitals). We suggest the "high-low-higher" trend is likely owing to the greater intensity of sharps use in larger hospitals and a "no-secrets atmosphere" and perhaps higher reporting rate in smaller hospitals.[7]

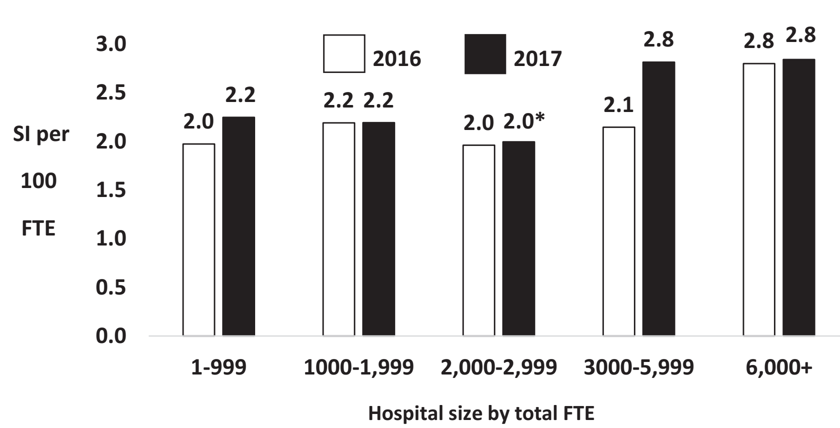


**Fig 2.** Sharps injury incidence by year and hospital FTE size (all hospitals). *FTE*, full-time equivalent staff; *SI*, sharps injury. *2017 mid-size (2000-2999 FTE) hospitals significantly different from smaller hospitals ($P = .01$; RR = 0.90; CL95 = 0.84-0.98) and larger hospitals ($P = .001$; RR = 0.71; CL95 = 0.66-0.76).

**Table 3**
Sharps injuries: proportions among nurses, doctors, and surgery staff

| | 2011 | 2015 | 2016 | 2017 |
|---|---|---|---|---|
| Nurse SI as % of total SI | NA | 45.6% | 36.4% | 37.6%* |
| Doctor SI as % of total SI | NA | 32.3% | 35.6% | 32.7%* |
| Surgery SI as % of total SI | 37.2% | 38.3% | 39.0% | 39.9% |

NA, not available; *SI*, sharps injury.
*Doctors plus nurses SI proportions significantly different from 2011 ($P < .001$; RR 0.91; CL95, 0.89-0.93).

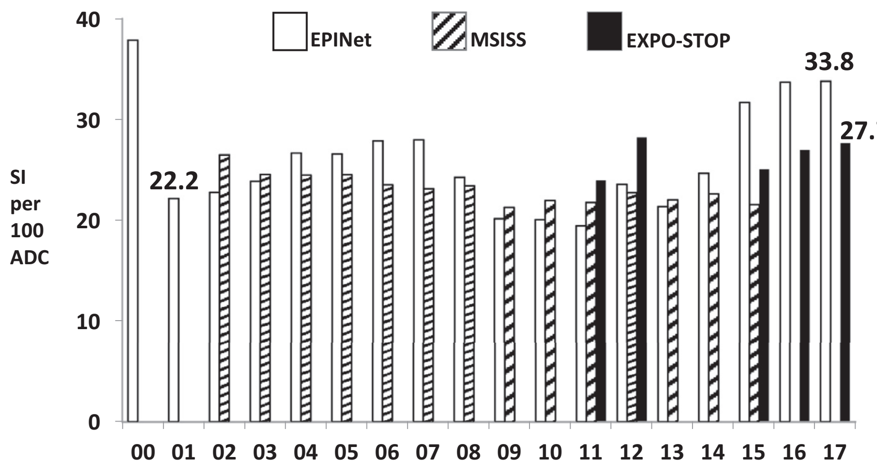


**Fig 3.** Sharps injury incidence by year 2000-2017, comparing databases (ADC as denominator). *ADC*, average daily census (overnight occupied beds); *EPINet*, Exposure Prevention Information Network; *EXPO-S.T.O.P.*, Exposure Survey of Trends in Occupational Practice; *MSISS*, Massachusetts Sharps Injury Surveillance System; *SI*, sharps injury.

*Incidence of MCEs*

As a proportion of total potential blood and body fluid exposures (BBFE), Table 2 shows MCE in 2016 and 2017 accounted for 26% of potential BBFE, with little change in 7 EXPO-S.T.O.P. surveys.[4,7,13,14] The median MCE proportion of 22.2% for 2017 is likely owing to 30 smaller hospitals reporting zero MCE exposures. Using ADC as the denominator, MCE incidence shows no linear trend from 2011 to 2017, however the all-hospital and teaching-hospital MCE rates in 2017 were significantly higher than in 2011. In 2017, using FTE as denominator, the 3 MCE indices were significantly higher than those in 2011. This increase in MCE exposures may indicate staff are conducting more MCE-prone exposures and/or are using PPE less frequently or less effectively.

*Proportions of staff work groups reporting SI*

In previous EXPO-S.T.O.P. surveys,[4,7,13,14] of total SI, nurses reported a higher proportion than doctors; however, in 2016 and 2017, for the first time nurse-reported SI fell below 40% of total SI (Table 3). SIs reported by doctors have steadily increased since 2011 but have been consistently less than that reported by nurses (including the 2016 and 2017 surveys). In contrast, EPINet 2016 and 2017 surveys show doctors exceeded nurses in the number of reported SI.[5] This may indicate that doctors are reporting more SIs and, given the majority of OR SI are sustained by doctors,[15] is supported by the steadily rising proportion of SI reported during surgical procedures in EXPO-S.T.O.P. hospitals (Table 3). Additionally, in EXPO-S.T.O.P. hospitals, the doctors plus nurses SI proportion shows a significant decrease between 2015 and 2017 (78%-70%) (Table 3), indicating that support staff in EXPO-S.T.O.P. hospitals are reporting and/or sustaining an increasing proportion of SI. However, this trend contrasts with EPINet surveys, which show doctors and nurses represent a consistent two-thirds of SI for the past 7 years.[5]

Nurse SI per 100 FTE (Table 2) is an excellent index of SI reduction-strategy effectiveness, as it examines SI incidence in a specific sharps-user cohort. It is pleasing to note the significant reduction in nurse SI rate in the last 3 surveys (Table 3), and this may indicate

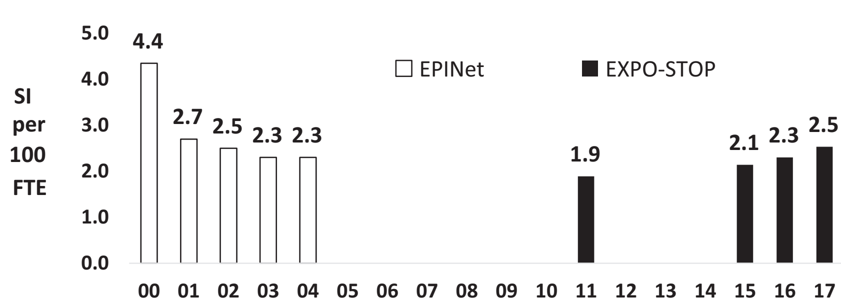


**Fig 4.** SI incidence trends 2000-2017 (FTE as denominator). *EPINet*, Exposure Information Network; *EXPO-S.T.O.P.*, Exposure Survey of Trends in Occupational Practice; *FTE*, full-time equivalent staff; *SI*, sharps injuries.

more frequent and/or more correct use of safety-engineered devices (SEDs) in non-OR clinical units.[16]

*Trends in SI*

Figure 3 shows the incidence per 100 ADC in EXPO-S.T.O.P., EPINet, and MSISS databases. MSISS surveys show a steady fall from 2002-2009, but then the rate plateaus (the 2016 and 2017 results have yet to be released). The results of the EPINet and EXPO-S.T.O.P. surveys mirror each other and show a significant SI rise since the low rates of 2009-2011 (Fig 3). In both EPINet and EXPO-S.T.O.P. surveys, the rates of SI per 100 ADC, for the past 6 years[4,5,7,13,14] have been significantly higher than the EPINet rate in 2001.[5]

Because of the anomaly of day patients not being accounted for in ADC, we believe FTE to be a more accurate workload indicator,[7] and, although SI per 100 FTE rates are not available for all years, Figure 4 depicts the early EPINet FTE rates and the first and most-recent 3 years of the EXPO-S.T.O.P. SI per 100 FTE rates. It is of concern that the 2017 EXPO-S.T.O.P. rate of 2.5 SI per 100 FTE is identical to the EPINet average of 2.5 SI per 100 FTE for the 2001-2005 post-NSPA period.[9]

Regardless of which database or denominator used, all show that the significant SI decrease in the post-NSPA period has not been sustained.

The reason for the current high SI incidence is likely multifactorial. EPINet data from 2014-2017 shows 20% of SED SI occur after activation,[5] indicating the activated mechanism failed to protect handlers. Furthermore, EPINet 2016 and 2017 surveys show 30% of SED SI occurred during SED activation.[5] When high proportions of SI are related to SED activation, it indicates suboptimal staff training (in correctly activating safety mechanism), suboptimal staff education (in emphasizing importance of always activating SED mechanism immediately postprocedure), and/or use of suboptimal SED (employer not selecting the safest possible, clinically suitable SED, preferably with an auto or a semiauto safety mechanism).[2,16-18] The following are employer responsibilities required under the OSHA BBP Standard, which states, along with hepatitis B vaccination, supply of personal protective equipment, implementation of universal precautions, record keeping and hazard communication, that employers must:

- Establish a written exposure control plan.
- Update the plan annually to reflect changes in tasks, procedures and positions and changes in technology, and document that they have considered and begun using appropriate, commercially available effective safer medical devices, and have also documented that they have solicited frontline worker input in device selection.
- Identify and use engineering controls to isolate or remove the BBP hazard.
- Identify and ensure the use of work practice controls to reduce the possibility of exposure by changing the way a task is performed.
- Make available postexposure evaluation and follow-up.
- Provide information and training to workers on initial assignment, at least annually thereafter, and when new or modified tasks or procedures affect a worker's occupational exposure.[8]

SIs increase when HCWs are rushed, stressed, or fatigued.[19-22] In the 2017/2018 American Nurses Association survey, more than 50% of nurses stated increased workloads caused them to skip breaks, work late, or work while ill,[23] and this pressure causes them to take shortcuts.[20] We believe this pressure is one reason why HCWs do not activate SED or do not activate the mechanism mindfully. Of note also, is that the high proportion and high rate of SIs during surgical procedures remains a challenge for all hospitals particularly the issues of low adoption of proven safety strategies and safety devices.[24]

In the United States, hospitals have one of the highest rates of staff injury of all industries. In 2017, at 5.7 per 100 FTE, hospital injury rates are almost double that of construction (3.1) and manufacturing (3.5).[25,26] Frequently, we hear health care staff say, "SIs are part of the job,"[2] which is effectively stating, "I come to work expecting to get injured." If no other industry tolerates such a safety culture, why does health care? If industry foyers have large signs stating how many days since last lost day, why don't hospital foyers?

The current risk of SI to HCWs needs aggressive and relentless intervention. The OSHA BBP Standard is clear: employers must eliminate or minimize occupational exposures.[8] Workloads, incorrect SED activation, low use of SED, SED dependent on manual activation, and suboptimal SED training are barriers to overcome,[16] yet in the face of such barriers, determined managers have shown that it is possible to bring about significant reductions in exposure incidence.[27,28] This determination to eliminate or minimize SI risk must pervade U.S. health care nationally.

## STUDY LIMITATIONS

The survey is voluntary and as such may exhibit participant bias. At approximately 200 hospitals, the survey samples only a small percent of the 6,200 hospitals in the United States and may not be representative of national exposure rates. Survey results are biased towards teaching hospitals and overall results may not be representative of hospitals nationally. The same hospitals do not participate each year and variation in results may not be owing to time or participant risk-reduction strategies. The survey is limited to results from hospitals only; more than one-half of HCWs work outside hospitals and, with potentially less access to SED, may have higher exposure rates than hospitals. The data used for MSISS comparisons are not official MSISS results; they are a denominator-conversion using MA hospital-specific occupancy rates. In combining EPINet, MSISS, and EXPO-S.T.O.P. databases, the ratio of acute to non-acute hospitals may not be comparable in each database. Although our study cross-triangulated all denominator answers and confirmed outliers with participants, the survey relies on participants correctly and similarly interpreting the questions. In some states, hospitals are precluded by state law from employing medical staff, and in these hospitals medical staff exposures are not required by the OSHA Standard to be recorded. Notwithstanding state laws, hospitals vary widely as to whether they include employee and nonemployee medical staff in their exposure recordings. Hospitals are asked to include results for "all staff, all roles, all sites for the hospital, and its satellites." However, hospitals vary widely as to whether their satellite services (eg, clinics, ambulatory surgery centers, and home health care) come under their hospital license, or are set up as separate business entities, and as such their numerator and denominator answers may or may not include satellite services.

## CONCLUSIONS

The significant rise in SI incidence, with the 2016 and 2017 EXPO-S.T.O.P. surveys and recent EPINet surveys, indicates that current strategies have not been successful in minimizing national SI rates. Relentless and aggressive intervention is needed, particularly increased staff training and education and the adoption of safer SED, with less user-dependent safety mechanisms. Leadership support at the highest level is essential for the success of these strategies. Continued publication of SI databases is required as well as research on SI mechanisms, SED effectiveness, effective training, and other strategies proven to reduce exposure incidence

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