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 (AOHP), provides a US national overview of sharps injuries (SI) and mucocutaneous exposures (MCE). This paper presents the 2016 and 2017 surveys.
Methods: An 18-item survey was distributed to AOHP members and colleagues and requested: Total SI and MCE; SI in nurses, doctors, 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% SI); in 2017, 224 hospitals reported 12,672 exposures (74.4% SI). SI rates for 2016 were: 27.0/100 ADC; 2.3/100 FTE; 2.8/100 Nurse FTE; of total SI, 36.4% were nurses, 35.6% doctors, and 39.0% during surgery. In 2017 the respective rates were 27.7/100 ADC; 2.5 100 FTE; 2.7/100 Nurse FTE; and of total SI, 37.6% were nurses, 32.7% were doctors; and 39.9% occurred during surgery. In 2016 MCE rates were: 11.2/100 ADC and 0.82/100 FTE, and in 2017 were 9.6/100 ADC and 0.87/100 FTE. Teaching hospitals had higher rates than non-teaching.
Discussion: EXPO-S.T.O.P. SI rates have risen year-on-year for three years and now match 2001-2005 levels.
Conclusions: Aggressive SI-reduction strategies are indicated, including leadership support, SED training/education, and adoption of safer, less user-dependent SED. Continued research on exposures and reduction-strategies is required.

BACKGROUND

Sixty bloodborne pathogens can be acquired via blood and body fluid exposure (BBFE),[1] and such exposures are a serious occupational risk to healthcare workers (HCW).[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 (MCE) exposures,[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/100 ADC from 2014 – 2017 (24.7 to 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 but SI rates for 2009 to 2015 have plateaued to around 22/100 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 2.1/100[7] confirmed that SI incidence was rising and was approaching the EPINet SI/100 FTE rate of 2001.[9]

This paper 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.

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 upon request). Data on reported exposures from 2016 and 2017 calendar years were requested on: 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. Three denominator metrics were requested: Total full time equivalent staff (FTE) (Total FTE was "all staff, all roles, all sites" whether or not they have BBFE risk[9]); Nurse FTE; 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™ to insert their data or emailed data directly to the authors. An Excel spreadsheet 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 their hospital's exposure management program 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 completing the survey by a 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 Non-teaching facilities, and these, together with nurse, doctor and surgical proportions, and with the number of states contributing data, were compared with 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 EPINet and EXPO-STOP 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 was used to calculate Chi^2, log-transformation risk ratios (RR) at 95% confidence limits (CL95). Statistical significance was set at $p \leq 0.05$.[10]

RESULTS

In 2016, 37 states had participating hospitals, a slightly larger geographic spread than EXPO-S.T.O.P. 2017 with 33 states involved (Figure 1), however, with 224 hospitals participating, the 2017 survey is the largest EXPO-S.T.O.P study to date (Table 1). Non-hospital 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 to 950, and almost 50% were teaching facilities (Table 1).

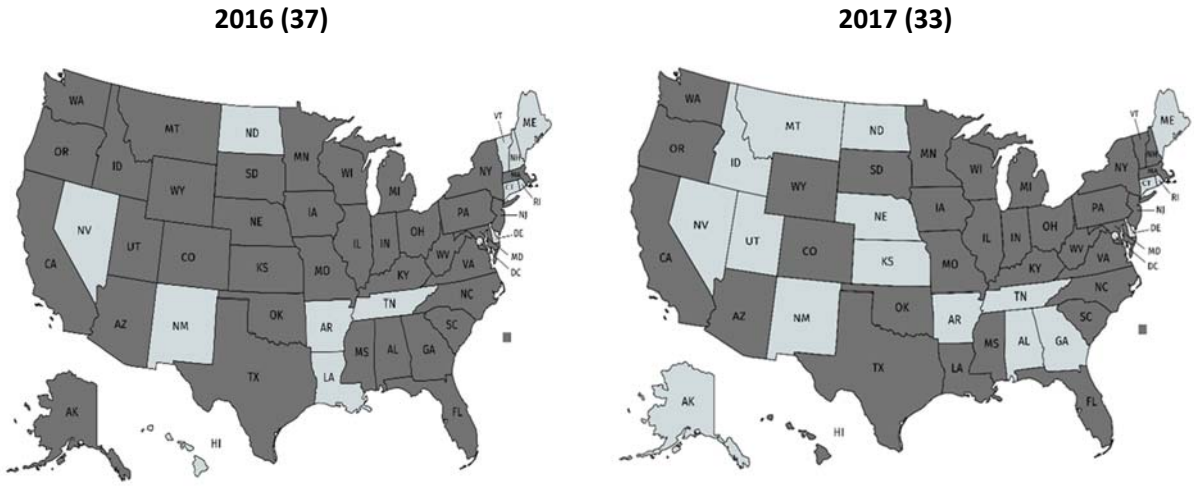

Fig 1. Participating states (No.) in 2016 and 2017 Surveys

Table 1. Overview of EXPO-S.T.O.P. Surveys

Year	Total Responses*	Non-hospitals	Hospitals *	Hospital size-range (ADC)	Number US states	% 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).

* Multiple hospitals may be submitted by responders.

Sharps injury 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 but rates in 2015, 2016 and 2017 are compared (Table 2). Mucocutaneous exposures as a percentage of BBFE is also shown in Table 2 for the four study years. To assist in incidence-benchmarking, Fig 2 depicts SI incidence by five 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 is shown in Fig 3, and in SI rates per 100 FTE for the available

years of data from EPINet and EXPO-S.T.O.P. in Fig 4.

DISCUSSION

Of the nation's 6200 hospitals,[11] 1,122 (20%) are teaching,[12] thus, with EXPO-S.T.O.P.'s high bias towards 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 three years. The SI rates per 100 ADC, whilst leveling in 2017, show significant increases over the rate for 2011 (Table 2). However, SI reported by nurses have shown a significant trend downwards since 2011, particularly in teaching hospitals (Table 2). When using ADC as denominator, MCE have not shown a linear trend since 2011, but 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 theirs. Previously we expressed our dissatisfaction with ADC as a denominator,[7] this year we expressed SI rates by five 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 due to the greater intensity of sharps use in larger hospitals and a "no-secrets atmosphere" and perhaps higher reporting rate in smaller hospitals.[7]

Incidence of mucocutaneous exposures. 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 due 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 three 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.

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

	2011	2015	2016	2017	2017 Median	2017 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**
• Non-teaching 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**
• Non-teaching 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**
• Non-teaching 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**
• Non-teaching 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**
• Non-teaching 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%**

BBFE blood and body Fluid exposure; MCE mucocutaneous exposure; SI sharps injury; ADC average daily census (overnight occupied beds); FTE full time equivalent staff.

* Significantly different from value in column to left (probability; risk ratio; 95% confidence limits)

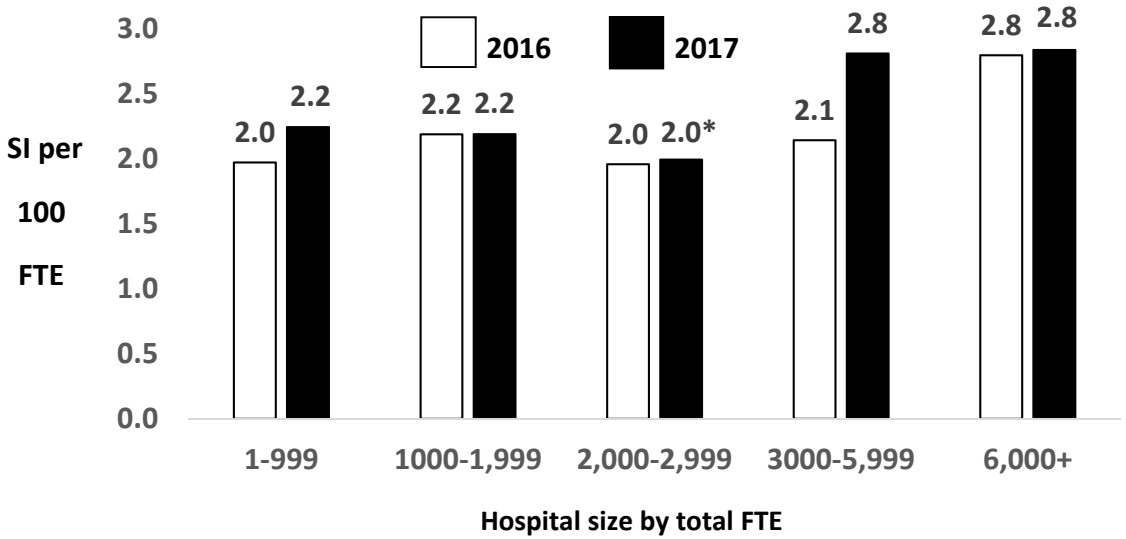

Fig 2. Sharps injury incidence by year and hospital FTE size (all hospitals)

SI sharps injury; FTE full time equivalent staff

* 2017 Mid-size (2000-2999 FTE) hospitals significantly different from smaller hospitals (p=0.01; RR=0.90; CL95=0.84-0.98) and larger hospitals (p=0.001; RR=0.71; CL95=0.66-0.76)

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, nurse-reported SI, for the first time, fell below 40% of total SI. (Table 3). SI 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 number of reported SI.[5] This may indicate doctors are reporting more SI 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). Of note is that in EXPO-S.T.O.P. hospitals, the doctors plus nurses SI proportion shows a significant decrease between 2015 and 2017 (78% to 70%) (Table 3), indicating that support staff in EXPO-S.T.O.P. hospitals are reporting/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]

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%

SI sharps injury, NA Not available

*Doctors plus Nurses SI proportions significantly different from 2011 ($p<0.001$; RR 0.91; CL95 0.89-0.93)

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

Trends in SI. The incidence per 100 ADC in EXPO-S.T.O.P., EPINet and MSISS databases is shown in Fig 3. MSISS surveys show a steady fall from 2002 to 2009 but then the rate plateaus (2016 and 2017 results yet to be released). The results of 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/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/100 FTE rates are not available for all years, Fig 4 depicts the early EPINet FTE rates and the first and most recent 3 years of EXPO-S.T.O.P. SI/100 FTE rates. It is of concern that the 2017 EXPO-S.T.O.P. rate of 2.5 SI/100 FTE is identical to the EPINet average of 2.5 SI/100 FTE for the 2001-5 post-NSPA period. [9]

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

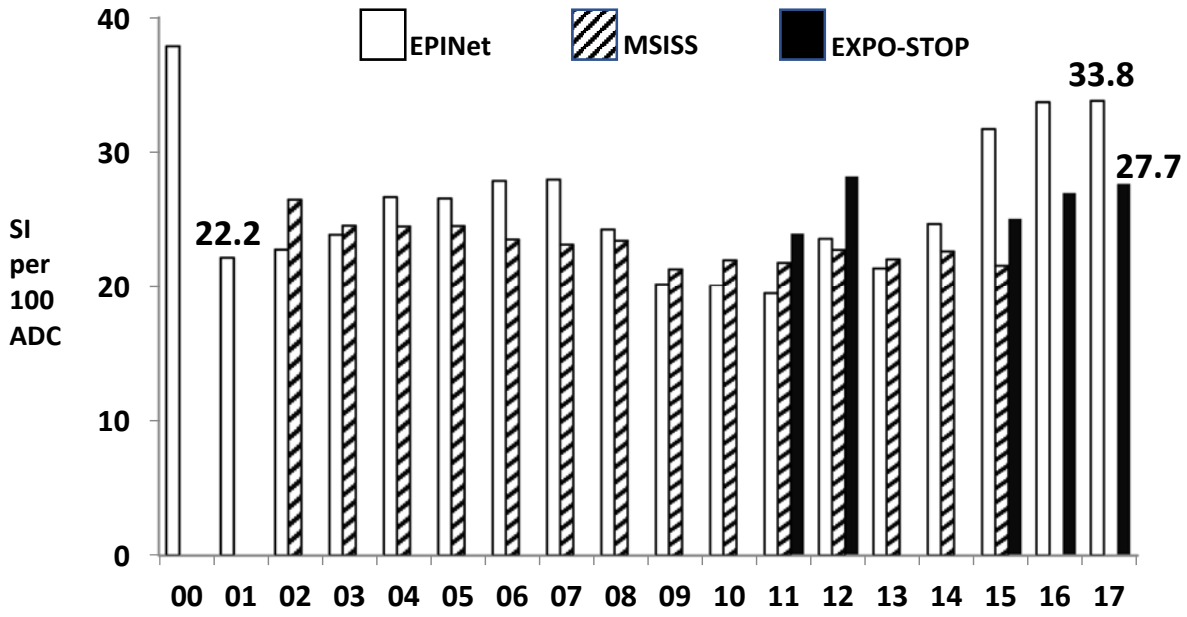

Fig 3. Sharps Injury incidence by year 2000 – 2017 comparing databases (ADC as denominator)

ADC average daily census (overnight occupied beds); SI sharps injury; EPINet Exposure Prevention Information Network; MSISS Massachusetts Sharps Injury Surveillance System; EXPO-S.T.O.P. Exposure Survey of Trends in Occupational Practice.

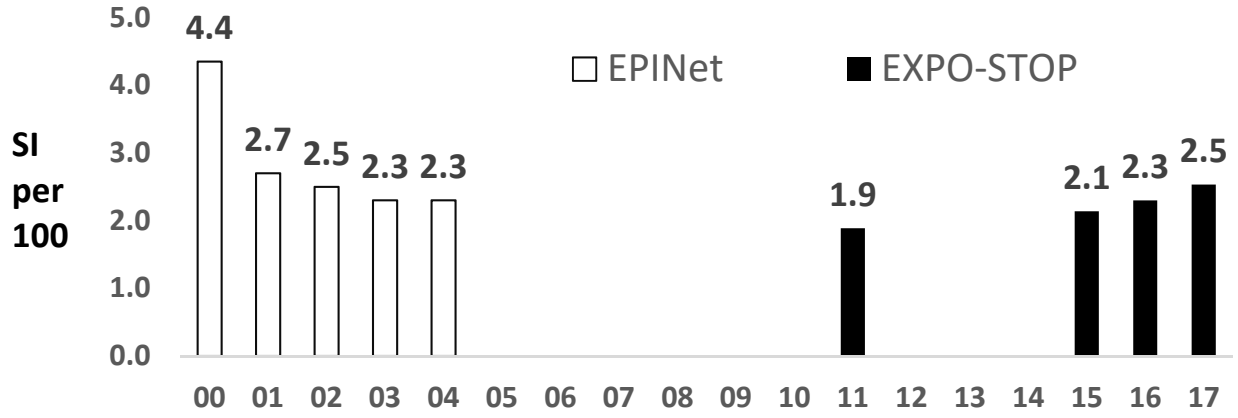

Fig 4. SI incidence trends 2000 – 2017 (FTE as denominator)

SI sharps injuries; FTE full time equivalent staff; EPINet Exposure Information Network; EXPO-S.T.O.P. Exposure Survey of Trends in Occupational Practice.

The reason for the current high SI incidence is likely multi-factorial. 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 were during SED activation.[5] When high proportions of SI are related to SED-activation it indicates: sub-optimal staff training (in correctly activating safety mechanism); sub-optimal staff education (in emphasizing importance of always activating SED mechanism immediately post-procedure), and/or use of sub-optimal SED (employer not selecting the safest possible, clinically-suitable SED, preferably with auto or semi-auto safety mechanism).[2, 16-18] The above 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 post-exposure 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]

Sharps Injuries increase when HCW are rushed, stressed, or fatigued.[19-22] In the 2017/18 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 HCW do not activate SED or do not activate the mechanism mindfully. Of note also, is that the high proportion and high rate of sharps injuries 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 US, hospitals have one of the highest rates of staff-injury of all industries – in 2017, at 5.7/100 FTE, hospital injury-rates are almost double that of construction (3.1) and manufacturing (3.5).[25,26] Many times we hear healthcare staff say, "sharps injuries 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 healthcare? 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 HCW needs aggressive and relentless intervention. The OSHA 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 sub-optimal 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 US healthcare nationally.

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.

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 6200 hospitals in the US 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 due to time or participant risk-reduction strategies. The survey is limited to results from hospitals only – more than half of HCW work outside hospitals and, with potentially less access to SED, may have higher exposure rates than hospitals. The data used for MSISS comparisons is not official MSISS results - they are a denominator-conversion using MA hospital-specific occupancy rates. In combining EPINet, MSISS and EXPO-STOP databases, the ratio of acute to non-acute hospitals may not be comparable in each database. Although the authors cross-triangulate all denominator-answers and

confirm 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 non-employee medical staff in their exposure recordings. Hospital 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 (e.g. clinics, ambulatory surgery centers, home healthcare) 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.

Acknowledgements

The authors wish to thank the Board of The Association of Occupational Health Professionals for the grant of $3,000 towards the cost of this research project. We also wish to heartily thank all the participants who contributed their hospital's exposure data.

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