

EXPO-S.T.O.P.-2012: Year Two of a National Survey of Sharps Injuries and Mucocutaneous Blood Exposures Among Healthcare Workers in U.S. Hospitals

By Grimmond, T.* FASM, BAgrSc, GrDpAdEd and Good, L.^ PhD, RN, COHN-S

*Director, Grimmond and Associates, Microbiology Consultants, Hamilton, New Zealand

^ Director, Employee Occupational Services, Scripps Health, San Diego, CA

Abstract

Purpose: Blood exposure (BE) among healthcare workers (HCW,) either from percutaneous sharps injury (SI) or mucocutaneous (MC) exposure, is a serious occupational risk that healthcare facilities (HCF) strive to reduce. The Exposure Study of Occupational Practice (EXPO-S.T.O.P.) is used annually to ascertain BE incidence in the HCF of members of the Association of Occupational Health Professionals in Healthcare (AOHP.) This BE incidence survey is for the 2012 calendar year.

Design: A 15-item electronic survey was developed and distributed to AOHP members to ascertain BE incidence and denominator data in their hospitals.

Methods: 2012 data was requested on SI and MC incidence in all staff and in nurses, hospital bed size, location, and teaching status, OSHA Form 300 inclusion items and proportion of total SI occurring in surgical procedures. Several denominator metrics were also requested, including full-time equivalent staff (FTE,) nurse FTE, 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 1,000 APD were calculated and compared with relevant U.S. databases, including the original EXPO-S.T.O.P. 2011 study. Best practices from the top five lowest-exposure teaching and top five non-teaching hospitals were also sought.

Findings: Responses from 157 hospitals in 32 states were received, making the survey the largest in the United States. Of the 9,494 BE reported, 73.9% were

from SI and 26.1% from MC. Overall SI incidence rates were: 28.2/100 OB (22.5 in non-teaching and 31.4 in teaching hospitals); 2.2 /100 FTE; 3.3 per 100 nurse FTE; and 0.43 /1000 APD. Of the total SI, 43.9% occurred during surgical procedures. Overall MC incidence rates were: 10.1 /100 OB (9.8 in non-teaching and 10.5 in teaching hospitals); 0.8 /100 FTE; and 0.15 /1000 APD. Hospital size significantly impacted their incidence rates. The SI incidences in the top five teaching and non-teaching hospitals were more than 60% below their size-group average. Effective reduction strategies in these low-incidence, "sharps aware" 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

The importance of BE risk to HCW and the need to annually audit these exposures has been documented.¹ Members of AOHP are annually invited to participate in the association's Exposure Study of Occupational Practice (EXPO-S.T.O.P.) BE survey. Currently in the United States, EXPO-S.T.O.P. is the only active national BE data collection system. The University of Virginia Health System's International Healthcare Worker Safety Center's Exposure Prevention Information Network (EPINet) pioneered BE data collection and has published multi-state data since 1993,² but ceased (hopefully temporarily) in 2012. In 1995, the Centers for Disease Control and Prevention's (CDC) National Surveillance System for Healthcare Workers (NaSH) began

collecting BE numbers from HCF,³ but ceased in 2007. Since 2002, the Massachusetts (MA) Department of Public Health (MADPH) Sharps Injury Surveillance System has annually published SI data from all hospitals as required under MA legislation.⁴ In terms of national databases, there was therefore a void, and the AOHP EXPO-S.T.O.P. surveys seek to fill this.

Our first survey (EXPO-S.T.O.P.-2011,) published in 2013, involved 125 hospitals and found the incidence of BE to be higher than that reported in EPINet or MADPH databases.¹ EXPO-S.T.O.P.-2012 seeks to determine BE incidence for the 2012 calendar year, examine several new BE exposure parameters and compare these rates with other databases.

Methods

A 15-item questionnaire (Table 1) pertaining to 2012 calendar year data was developed by the investigators and reviewed by a panel of occupational health experts and a data analyst/statistician for clarity. 2012 data was requested on: SI and MC incidence in all staff and in nurses; hospital bed size; hospital location and teaching status; OSHA Form 300 inclusion items; and proportion of total SI occurring in surgical procedures. Four denominator metrics were requested: full-time equivalent staff (FTE;) nurse FTE; average daily census (ADC;) and adjusted patient days (APD) – see Table 1, Q13 for APD formula. Exposure data and denominators were also sought from facilities in non-hospital settings.

The questionnaire was distributed via e-mail to the members of AOHP using the electronic format Survey Monkey™.

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 hospital's exposure management program. AOHP provided a free AOHP Annual National Conference registration as the prize in an incentive drawing for those completing the survey by the specified deadline. Participants with contact details were contacted if their data was incomplete or contained "outlier" data.

Hospitals stating that non-employed medical doctors (NEMD) were excluded from their OSHA total, yet included an SI figure for these staff, were contacted to confirm their MD figure was excluded from their OSHA figure and that it needed to be added to obtain their facility total. A small sample of these hospitals were contacted to ascertain their MC exposure incidence for NEMD, and this MC proportion was calculated and added to the OSHA Log MC figure for these hospitals in the relevant calculations.

Incidence rates for the four denominators were calculated, as well as SI and MC per 100 OB for teaching and non-teaching facilities, and these, together with the nurse, MD and OR proportions, were compared with EXPO-S.T.O.P.-2011,¹ EPINet² and MADPH 2010 survey results.⁴ To compare with MADPH results, MA licensed beds were converted to OB using American Hospital Association data relevant to Massachusetts hospitals in 2010.⁵ Survey responses were sorted by "teaching" and "non-teaching" facilities, and the five facilities with the lowest percutaneous exposure rates were identified for each category. Interviews were conducted with occupational health professionals from each of these facilities, and their BE reduction strategies identified.

WinPepi v11.26 was used to calculate Chi,² log-transformation risk ratios (RR) and 95% confidence limits (CL.) Statistical significance was set at $p \leq 0.05$.

Table 1. EXPO-S.T.O.P.-2012 Survey Questions

1. What is your healthcare setting? (Hospital or Non-hospital)
2. Number of sharps injuries from your 2012 calendar year OSHA Form 300.
3. Number of mucocutaneous blood or other potentially infectious material exposures (including bites) in 2012 calendar year.
4. Number of sharps injuries in surgical procedures (i.e. OR + Procedure Rooms + Labor & Delivery in 2012 calendar year.)
5. Number of sharps injuries reported by nurses (e.g., RN, LPN/LVN.)
6. Number of sharps injuries reported by doctors.
7. Are your NON-EMPLOYEE medical staff included in the OSHA Form 300 exposure data?
8. What is your hospital size (Number of staffed beds in hospital from which exposure data was derived?)
9. How many hospitals were included in your exposure data? Note: Separate data for each hospital is preferred.
10. Average daily inpatient census (i.e. average daily Occupied Beds) for calendar year 2012.
11. Number of Full-Time Equivalents (FTE) as reported on your 2012 calendar year OSHA Form 300A.
12. Number of NURSING full-time equivalents (FTE) in 2012 (i.e. RN, LPN/LVN.)
13. Adjusted Patient Days for 2012 (Available from your Finance Department.) Adjusted Patient Days = (Total Revenue/Inpatient Revenue) x Total Inpatient Days.
14. 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.)
15. In what state is your hospital located?

OSHA - Occupational Safety and Health Administration, Department of Labor, USA; OR - Operating Room; RN - Registered Nurse; LPN - Licensed Practical Nurse; LVN - Licensed Vocational Nurse.

RESULTS

The EXPO-S.T.O.P.-2012 data were derived from 157 hospitals in 32 states. An additional 14 sets of data from facilities in the non-hospital setting were excluded from analysis, as a meaningful common denominator could not be determined. Of the 157 hospitals, 59% were able to supply usable APD data (Q13 of Table 1.) Of the 155 hospitals answering Question 7 ("Non-employee MD,") 104 stated their NEMD exposures are excluded, and these MD SI needed to be added to their OSHA Log figure to obtain their facility's total. This was done for all relevant numerator calculations. The sampling from the 104 "MD excluded" hospitals revealed an MC exposure inci-

dence among NEMD of 24% of total BE, and this proportion was used to calculate MC exposure incidents among non-employee MD for these hospitals in all relevant numerators.

Table 2 shows an overview comparison of the EXPO-S.T.O.P. 2011 and 2012 survey results. Table 3 compares EXPO-S.T.O.P.-2012 SI incidence rates with those of EXPO-S.T.O.P.-2011, EPINet 2011 and MADPH 2012, the latest years available for these surveys at the time of publication. Table 4 compares EXPO-S.T.O.P.-2012 MC incidence rates with those of EXPO-S.T.O.P.-2011 and EPINet 2011 (MC exposure not assessed in MADPH surveys.) Sharps injury rate by

Table 2. Survey Overview: EXPO-S.T.O.P.-2011 vs. EXPO-S.T.O.P.-2012

	Total hospitals participating	Hospital size range (ADC)	Total BE exposures	Total sharps injuries	Total mucocutaneous exposures	Number U.S. states participating
2011	125	6 - 975	8,101	5,932	2,169	29
2012	157	5 - 985	9,494	7,119	2,375	32

ADC – Average Daily Census; BE – Blood Exposure

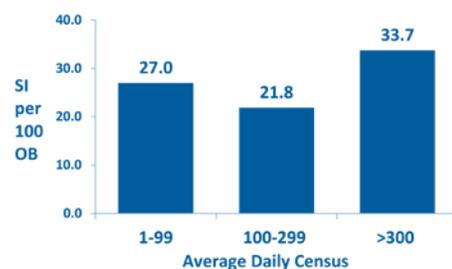
Table 3. EXPO-S.T.O.P.-2012 Sharps Injury Incidence: Comparison With EXPO-S.T.O.P.-2011 and Other Databases (significance against EXPO-S.T.O.P.-2012 results)

	EPINet 2011	MADPH 2012	EXPO-S.T.O.P.	
			2011	2012
SI/100 Occupied Beds	19.5 (p < 0.001; RR 1.4; CL 1.26-1.45)	24.0 (p < 0.001; RR 1.1; CL 1.09-1.18)	24.0 (p < 0.001; RR 1.2; CL 1.11-1.19)	28.2
Non-Teaching Hospitals	16.5 (p < 0.001; RR 1.3; CL 1.13-1.51)	Not available	17.8 (p < 0.001; RR 1.2; CL 1.14-1.30)	22.5
Teaching Hospitals	20.7 (p < 0.001; RR 1.3; CL 1.28-1.51)	Not available	27.4 (p < 0.001; RR 1.1; CL 1.07-1.15)	31.4
SI/100 FTE	2.5 (2001-2005) (p < 0.001; RR 0.9; CL 0.87-0.93)	Not available	1.9 (p < 0.001; RR 1.2; CL 1.13-1.21)	2.2
SI/100 Nurse FTE	NA	Not available	NA	3.3
SI/1000 Adjusted Patient Days	NA	Not available	0.53 (p < 0.001; RR 0.8; CL 0.77-0.86)	0.43
Nurse SI as % of Total SI	41.9% (p = 0.95; RR 1.0; CL 0.90-1.10)	37% (p = 0.002; RR 1.1; CL 1.02-1.15)	NA	41.8%
MD SI as % of Total SI	22.8% (p < 0.001; RR 1.4; CL 1.22-1.64)	37% (p = 0.20; RR 0.96; CL 0.90-1.03)	NA	35.5%
Surgical Procedure SI as % of Total SI	39.9% (p = 0.14; RR 1.07; CL 0.96-1.19)	45% (p = 0.72; RR 1.0; CL 0.93-1.05)	37.2% (p < 0.001; RR 1.1; CL 1.06-1.19)	43.9%

EPINet Exposure Prevention Information Network; FTE – Full-Time Equivalent Staff; MADPH – Massachusetts Department Public Health; MD – Medical Doctor; OB – Occupied Beds; SI – Sharps Injuries

Figure 1. Sharps Injury Incidence by Hospital Size

OB – Occupied Beds



hospital size is shown in Figure 1. The annual incidence of SI per 100 OB for EPINet, MADH and EXPO-S.T.O.P. databases is shown in Figure 2.

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. While the first survey (EXPO-S.T.O.P.-2011) was the largest BE sur-

Table 4. Comparison of EXPO-S.T.O.P.-2012 Mucocutaneous Exposure Rates With EXPO-S.T.O.P.-2011 and EPINet 2011 Rates

	EPINet 2011	EXPO-S.T.O.P.	
		2011	2012
MC/100 Occupied Beds	7.2 (p < 0.001; RR 1.4; CL 1.22-1.64)	9.0 (p < 0.001; RR 1.3; CL 1.04-1.17)	10.1
All Hospitals			
Non-Teaching Hospitals	5.8 (p < 0.001; RR 2.0; CL 1.64-2.40)	7.1 (p < 0.001; RR 1.3; CL 1.20-1.49)	9.8
Teaching Hospitals	7.8 (p < 0.001; RR 1.7; CL 1.35-2.19)	10.1 (p = 0.3; RR 1.0; CL 0.97-1.11)	10.5
MC/100 Full-Time Equivalent Staff	Not available	0.7 (p = 0.002; RR 1.1; CL 1.03-1.16)	0.8
MC/1000 Adjusted Patient Days	Not available	0.20 (p < 0.001; RR 0.77; CL 0.71-0.84)	0.15

EPINet Exposure Prevention Information Network; FTE – Full-Time Equivalent Staff; MADPH – Massachusetts Department Public Health; MD – Medical Doctor; OB – Occupied Beds; SI – Sharps Injuries

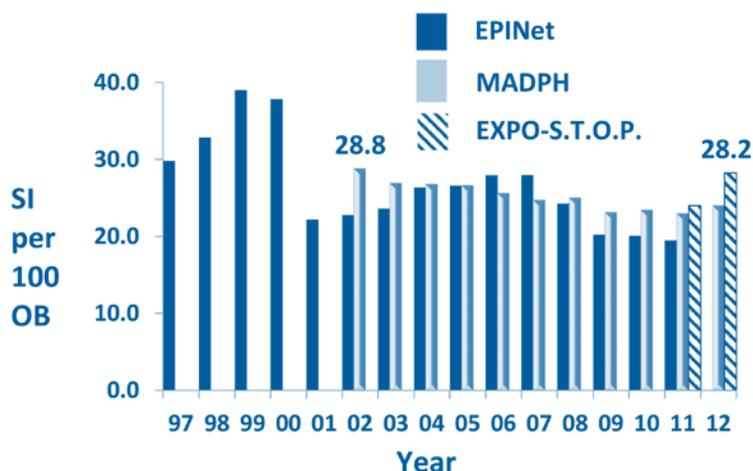
vey conducted in the United States, this second survey (EXPO-S.T.O.P.-2012) is even more comprehensive, reporting on data from 157 hospitals in 32 states (Table 1.) The EXPO-S.T.O.P. surveys are conducted as a broad overview of exposure incidence and not as a detailed database of exposure mechanisms. The survey tool was constructed to promote maximum response by asking minimal but valuable questions to enable 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 survey's SI incidence rate of 28.2 per 100 OB is significantly higher than MADPH 2012,⁴ EPINet 2011² and EXPO-S.T.O.P.-2011¹ and, disturbingly, is the highest incidence reported among the three databases since 2002 (Figure 2.) Possible explanations for the higher rate may be: EXPO-S.T.O.P. hospitals reported more of their SI; EPINet hospitals reflect a regional-specific low incidence due to their early adoption of safety engineered devices;⁶ that Massachusetts hospitals may also reflect

Figure 2. Comparison of EXPO-S.T.O.P. Exposure Rates with EPINet and Massachusetts Rates

OB – Occupied Beds



a low state-specific incidence due to their SI reporting laws and/or a state-wide “sharps awareness;” that of the EXPO-S.T.O.P.-2012 hospitals, 39.8% were teaching hospitals; and/or EXPO-S.T.O.P. hospitals reflect a true national incidence.

The high incidence may also be due to the fact that 67% of EXPO-S.T.O.P.-2012 hospitals stated they do not include NEMD in their OSHA Log totals, but supplied NEMD SI data, and this was included in the total SI numerator. The authors believe that, to obtain a true picture of a facility’s SI incidence, employee and non-employee exposures need to be collected and totaled. Databases and surveys from hospitals not collecting/supplying non-employee exposure data will always show incidence rates below the true incidence for the facility. In the United States, OSHA’s Needlestick Prevention Act⁷ requires only employee exposures be logged, and the issue of facility total is a difficult one to solve without active questionnaire surveys of employee and non-employee exposures. The authors, being aware of the issue, asked whether non-employee exposures were included (and those supplied were included in numerator;) however, this approach may still produce a conservative incidence rate, as it is dependent on non-employees voluntarily reporting their exposures to the

facility. The numerator issue is muddled a little further by some hospitals including NEMD exposures in their OSHA Log, although this is not required under the Act.⁷ Exposure surveys need to include “non-employee” exposure questions to elicit clarity and accuracy in the resultant data.

Of the hospitals participating in EXPO-S.T.O.P.-2012, 39.8% were teaching hospitals. The increased SI rate per 100 OB in teaching hospitals over non-teaching hospitals mirrors that of EXPO-S.T.O.P.-2011 and EPINet surveys and is indicative of procedure intensity and trainee “learning curve,” together with SI incidence in research (non-bed) departments in teaching hospitals.

In terms of clinical work groups, of the total SI, 41.8% were reported by nurses and 35.5% by doctors (in hospitals where employee and non-employee exposures were captured and reported).

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 throughput. The issue has been highlighted by Chen et al,⁸ 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. Their arguments are valid; however, we used FTE as it better reflects hospital workloads (i.e. outpatients and day-surgery) than occupied beds. The 2012 incidence of 2.2 per 100 FTE is significantly lower (Table 3) than the 2.5 per 100 FTE found in EPINet hospitals for 2001 to 2005,⁶ but was significantly higher than the 1.9 per 100 FTE of EXPO-S.T.O.P.-2011 (Table 3.) The reason for this variation is not apparent to the authors.

Chen et al⁸ found “patient days” to be the most valid denominator of the four they examined. However, “patient days” excludes outpatients, and in EXPO-S.T.O.P.-2012 we once again asked members for their APD figure (includes all inpatients and outpatients,) and 59% were able to supply this data. We believe this to be a valid measure of total hospital workload. The incidence of 0.43 SI per 1,000 APD was significantly lower than the 0.53 of EXPO-S.T.O.P.-2011. As no other U.S. or international database has used this denominator, as with EXPO-S.T.O.P.-2011, the calculation is included for future reference purposes.

For the 2012 survey, we included for the first time, “exposures per 100 nurse FTE,” as we believe “staff-group” denominators are tightly targeted to a specific clinical group, easily understood and procured, and often used in overseas databases (unfortunately, not in any other national U.S. databases.) The EXPO-S.T.O.P.-2012 incidence of SI among nurses was 3.3 per 100 FTE which means, for every 1,000 nurses, 33 will sustain an SI annually. This rate is almost identical to the 3.4 per 100 nurse FTE reported in Canada.⁹

When EXPO-S.T.O.P.-2012 hospitals were stratified into three ADC sizes (Figure 1,) the “high-low-higher” SI incidence per 100 OB mirrors that found in MA hospitals⁴ and EXPO-S.T.O.P.-2011, and the authors believe it is due to the higher procedure intensity (with con-

comitant 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 SED. Investigative studies are warranted to clarify the reasons behind this consistent finding.

Mucocutaneous exposure incidence

The survey's MC incidence rate of 10.1 per 100 OB is significantly higher than that of EPINet 2011 and EXPO-S.T.O.P.-2011, so too the MC incidence among non-teaching hospitals (Table 4.) Among teaching hospitals, the EXPO-S.T.O.P.-2012 rate of 10.5 was significantly higher than EPINet 2011 but not that of EXPO-S.T.O.P.-2011 (Table 4.) Using FTE as a denominator, the 2012 incidence of 0.8 was significantly higher than the 0.7 of 2011, but when APD was compared, the 2012 result (0.15 MC per 1,000 APD) was significantly less than 2011. Of total exposures, 25.0% were MC, similar to the 26.8% of EXPO-S.T.O.P.-2011.

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. Several themes emerged from these low-exposure hospitals.

Education:

- Require new clinicians to demonstrate competency with all new devices.
- Discuss exposure prevention individually and in orientation in a personalized way.
- Build 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.

Communication:

- Make initiatives data-driven, and report using metrics aligned with your 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.
- Implement awareness campaigns to reach front-line staff.

Investigation:

- "Drill Down." Conduct a thorough, systematic root cause analysis—avoid assuming causation.
- The manager and the injured employee must be actively involved in the follow-up investigation.

Engagement:

- 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—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.

Notable quotes from some of the hospitals recognized for their low exposure injuries that reflect the high priority which they place on this area of worker safety include: "Everyone is 100% accountable, 100% of the time"... "When it comes to awareness of exposure risks, don't stay under the radar"... and ... "The only acceptable number of exposures is ZERO."

Strengths and Limitations

Strengths of the survey were in the number of hospitals participating (157,) geographic dispersion (32 states,) hos-

pitals represented (includes all eight of CDC hospital sizes,) contemporary data (2012,) most survey questions were from annual data required by OSHA law, and incidence rates were expressed using four denominators. Further strengths were the inclusion of successful reduction strategies and having the opportunity to conduct a second administration of EXPO-S.T.O.P., validating both the instrument and the methodology. Limitations were in: the reliance on voluntary reporting of exposure incidents and voluntary survey participation with its inherent selection bias; the potential for misinterpretation of definitions; reliance on secondary data from departments in hospitals other than the participants; participating hospitals may not be representative of hospitals nationally; and that non-employee exposures may not have been fully captured in two-thirds of the hospitals participating.

CONCLUSIONS

The significant fall in SI following NSPA enactment is incontrovertible;⁶ however, it is disturbing that the 2012 EXPO-S.T.O.P. incidence of 28.2 per 100 OB is higher than the 22.2 rate found among the 58 EPINet hospitals in 2001.² The significant increase in SI since 2001 (Figure 2) is of major concern. 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. As stated above by one of the participant hospitals, "The only acceptable number of exposures is ZERO."

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Terry Grimmond, FASM, BAgr, GrDpAd-ED is Director, Grimmond and Associates, Microbiology Consultants, Hamilton New Zealand. Linda Good, PhD, RN, COHN-S is Director, Employee Occupational Services, Scripps Health, San Diego, CA. Both are long-time members of AOHP.