Applied Biosafety
Volume 28, Number 1, 2023

DOI: 10.1089/apb.2022.0032

ORIGINAL ARTICLE

A Means of Codifying Safety Cross-Training Knowledge Expectations for Biosafety Professionals

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Abstract

Introduction: The health and safety issues encountered by biosafety professionals in the daily conduct of their work is rarely limited solely to potentially infectious pathogens. A basic understanding of the other types of hazards inherent to laboratories is necessary. As such, management of the health and safety program at an academic health institution sought to ensure crosscutting competency for its technical staff, including staff members within the biosafety program.

Methods: Using a focus group approach, a team of safety professionals from a variety of specialties developed a list of 50 basic health and safety items that any safety specialist should know, inclusive of basic but important information about biosafety that was considered imperative for staff members to understand. This list was used as the basis for a formal cross-training effort.

Results: Staff responded positively to the approach and the associated cross-training, and overall compliance with an array of health and safety expectations was experienced across the institution. Subsequently, the list of questions has been shared broadly with other organizations for their own consideration and use.

Discussion/Conclusion: The codification of the basic knowledge expectations for technical staff within a health and safety program at an academic health institution, which includes the biosafety program technical staff, was warmly received and helped establish what information was expected to be known and what issues warranted input from other specialty areas. The cross-training expectations served to expand the health and safety services provided despite resource limitations and organizational growth.

Keywords: training, biosafety professional, professional development, cross-training, continuing education

Introduction

Biological safety professionals rarely operate in an environment where the sole risks present are pathogenic agents. In most laboratory settings the risk of fire, physical hazards, chemical hazards, perhaps radiological hazards, along with other risks exist. Biosafety professionals may have some knowledge of the management of some of these risks, but the extent of that knowledge may not be codified, thus resulting in uncertainty, confusion, and possibly risks that remain unmitigated. This situation can become exacerbated when understaffing exists within either the biosafety program or the entire safety program as a whole. This condition can result in some hazards potentially being left unrecognized or unattended.

The University of Texas Health Science Center at Houston (UTHealth Houston) addressed this situation

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Presentation: The 50 questions list has been shared broadly and provided to environmental health and safety professionals during professional development presentations conducted throughout the United States and around the world.

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through the development of a finite set of clear knowledge expectations for all safety department staff (inclusive of the biosafety program staff) so that safety personnel resources could be optimized to effectively manage as many risks as possible. The codified list of knowledge expectations became colloquially known as ''the fifty (50) questions every safety professional should be able to answer'' and has become a popular tool used by many safety programs across the country and around the world.

Program Description

UTHealth Houston is a public academic health science center located in Houston's Texas Medical Center, the largest medical center in the world and eighth largest business district in the United States.[1] The university comprises ~18,000 individuals, including students, faculty, and staff, and consists of six graduate schools, the nation's largest inpatient psychiatric care facility, and >130 ambulatory care clinics located in a geographic region roughly equivalent to the size of Connecticut.[2]

Inherent to its advanced biomedical teaching, research, and service missions, UTHealth Houston conducts activities that often involve a broad spectrum of hazardous agents or conditions that may be biological, radiological, chemical, or physical in nature.[3] These risks are managed by the Office of Safety, Health, Environment, and Risk Management (SHERM). SHERM is organized into three primary units: environmental health and safety (EHS), risk management and insurance, and occupational (employee) health (OH).[4] The Biological Safety Program resides within EHS, along with the Radiation Safety, Chemical Safety, Occupational Safety & Fire Prevention, Hospital & Clinic Safety, and Environmental Protection Programs.

Given the size and scope of the university, it is imperative that SHERM ensures that all safety staff are cross-trained on at least the basic aspects of each hazard area so that, as part of routine safety surveillance activities, basic safety issues can be identified and appropriately resolved to prevent accidents, injuries, and exposures. This approach was originally derived from an effort initiated in 1995 where all UTHealth Houston radiation safety staff were cross-trained on a finite set of basic safety aspects from other domains.[5] During the subsequent 1-year period after training, 55% of the deficiencies noted as part of the required radiation safety inspections were identified as not directly related to radiation safety, demonstrating that SHERM's overall performance could be positively impacted through formalized cross-training. It was upon these data and feedback that SHERM leadership decided to embark upon the creation of the codified list of knowledge expectations.

Methods

To establish a baseline level of knowledge expectations for all SHERM staff, the office's management team was challenged with a simple question: what basic things would you want every staff member in this department to be knowledgeable about regarding your specialty area while they are completing their assigned tasks? Department leadership provided high-level administrative items and information that they expect everyone to understand to maximize their understanding of the mission of the organization and the ''customers'' they serve across the campus.

Managers overseeing the disciplines of biosafety, radiation safety, chemical safety, employee health safety and fire safety, hospital and clinic safety, and environmental protection (inclusive of hazardous waste management) all provided their input. Their responses were collated, screened, and discussed. After deliberation, some were discarded because they were deemed too complicated for someone outside a particular specialty area to fully understand and master. Others were set aside because they were not considered prevalent issues in the existing work setting. For example, in the area of biosafety, the following four items selected as basic questions that any SHERM staff member should be able to answer:

1. What are the two main elements of a biosafety level and what is the main driver for the assignment of these levels?
2. How is a biosafety cabinet different from a chemical fume hood or a clean air bench?
3. How should a bloodborne pathogen exposure, such as a needlestick or other contaminated sharps injury, be handled?
4. What is the most common disinfectant used, including the concentration and recommended contact time, for effectively cleaning up most spills or leaks of potentially infectious agents?

The consensus opinion among the departmental leaders is that it would be reasonable to expect any staff member to know these issues regarding biosafety, and they would also know when more complex issues arise to reach out to the biosafety specialists that reside within the department for further information and/or ownership.

Some items identified during the group discussions, particularly those administrative in nature, were added and expanded because they were considered to be crucial to the overall understanding of the university and its operations. The value and importance of each item were repeatedly discussed and sometimes heatedly debated, until finally, a resultant compiled list of 50 questions was derived (Table 1). Note that although we have colloquially called this list ''the 50 questions every safety professional should be able to answer,'' over the course of time several items have been added to various topical areas that has resulted in a list that has exceeded 50 total questions. For example, additional questions specifically covering security considerations for EHS staff to consider when providing routine services have been

Table 1. This table reflects the 50 questions every environmental health and safety technical staff member should know, grouped by programmatic area, as designed by (Redacted)

No.	Question	Example answer from UTHealth Houston
General administration		
1	What are the core missions of any university?	Teaching, research and service (in our case, include clinical care service)
2	What are the three main institutional constituencies we serve and who is the most important?	Faculty, students, staff, with faculty being most important
3	What is the mission of our EHS department?	Help people go home as healthy and as safe as they arrived
4	What are the 4 main KPIs for our department?	Losses—personnel and property Compliance—external and internal Financial—expenditures and revenues Client satisfaction—external and internal
5	What are the department's strategic initiatives and desired outcomes for the current year?	Maintain high quality of service levels Particular focus on support for growing clinical enterprise
6	What is the safety committee structure for UTHealth Houston?	Safety Council, supported by three committees: Radiation Safety Committee, Chemical Safety Committee, and Institutional Biological Safety Committee
7	What is ''goodwill value'' and how do we measure it in our department?	Goodwill value is an accounting term that quantifies the value of intangibles such as service, reputation, and trust. Goodwill value is calculated by determining the difference between the market value of an organization minus the total asset value. Goodwill value is measured in our department through the provision of prompt services and the routine assessment of client satisfaction with our services.
8	What is the total budget for our EHS department (rough estimate)? What are the two biggest expenditures?	Approximately (redacted), with the largest percentages going to personnel (salaries) and hazardous waste disposal
9	What is ''indirect cost recovery''?	Indirect cost recovery is a rate negotiated between a funding agency and the university that provides for funds in addition to the funds allocated to support a research project to pay for institutional services such as building maintenance, utilities, and administrative costs.
10	What is our total campus square footage and the subset amount of lab/clinic square footage? How many buildings do we have on campus?	Approximately (redacted) gross square feet, with (redacted) laboratory square feet (about 13%) We possess (redacted) buildings, plus the Housing Apartments, and lease space in other buildings.
Biological safety		
11	What are the two main elements of a ''biosafety level,'' and what are the main drivers for the assignment of these levels?	Facility characteristics combined with microbiological laboratory practices and procedures The drivers for the assignment of a biosafety level include agent pathogenicity, route of transmission, host susceptibility, infectious dose, availability of prophylaxis, and so forth. Risk assessment will help to dictate appropriate biosafety level.
12	How is a biosafety cabinet different from a chemical fume hood or a clean air bench?	Biosafety cabinets afford both user protection and product protection, whereas chemical fume hoods only afford worker protection and clean air benches only affords product protection.
13	What is the certification frequency for a biosafety cabinet?	Initially when first installed, then annually thereafter, or when the unit is moved or otherwise serviced
14	How should an exposure to a recombinant or synthetic nucleic acid molecule be handled? Similarly, how should a bloodborne pathogen exposure, such as a contaminated needlestick be handled?	r/sDNA exposure: Initial routine first aid should be first—wash the site of injury with soap and water or flush the site of mucous membrane exposure with water or saline. Seek medical attention. Complete supervisor's first report of injury form. Consult the Biological Safety Program immediately to determine next steps for reporting to NIH Office of Science Policy, if necessary. BBP exposure: Initial routine first aid should be first—wash the site of injury with soap and water or flush the site of mucous membrane exposure with water or saline. Seek medical attention. Complete supervisor's first report of injury form AND call the needlestick hotline. Obtain source patient exposure information, if applicable.

(*continued*)

Table 1. (Continued)

No.	Question	Example answer from UTHealth Houston
15	What is an appropriate disinfectant used for effectively cleaning up most, but not all, spills or leaks of potentially infectious agents?	Freshly prepared 1:10 dilution of bleach, with a contact time of at least 15 min; or another EPA-registered disinfectant capable of destroying the pathogens present at the manufacturer's recommended concentration and contact time. Contact Biological Safety Program to verify or to determine suitable disinfectant, concentration, and contact time for pathogen, if needed.
*	What is the best way to address laboratory security when working with pathogenic microbiological agents?	All doors to laboratories and areas storing pathogenic agents should be closed and locked when not in use. Pathogen storage areas should be identified as biohazardous to communicate the hazard, and should be locked when unattended if necessary (e.g., incubators and freezers).
Chemical safety		
16	What is the desired fume hood flow rate? What should be done if this rate is not achieved, and what are the most common problems causing this failure?	100 lfpm is ideal, range from $\sim$60–150 lfpm is acceptable. If not within range, notify user, post unit ''out of order'', and contact (redacted) for repair. Most common problems include balancing of ventilation and fume hood mechanical malfunction (fan failure).
17	What are the critical chemical classes at UTHealth Houston that we do not want stored together?	Acids and bases Flammables and oxidizers Essentially, all chemicals should be segregated according to class.
18	What chemicals form peroxides and thus can be explosive, hence are ones we should look out for?	Old organic peroxides, especially with crystals noticeable around the cap, are a possible explosion risk and should be handled with great care. Other explosion risks can include dry picric acid.
19	Where do I access SDS information? And what are the important pieces of information on these documents?	SDS's may be located by searching for the ''SDS'' online; by searching the Chemwatch Gold software found on the UTHealth Houston website; directly through the manufacturer; and may be found in existing chemical safety binders within laboratories. Important information on the SDS includes the 24-h emergency hotline number, hazards identification, first-aid measures, accidental release measures, exposure controls, and stability and reactivity.
20	What are the accepted key indicators of indoor air quality that should be initially addressed when responding to complaints or concerns?	Temperature, relative humidity, CO_2, CO, TVOC's particulates, and perhaps viable and nonviable spores
21	What are the common causes of IAQ complaints? Also, what is the key to successfully addressing an IAQ complaint?	Malfunctioning HVAC systems, poor or absent HVAC maintenance, closed fresh air intakes, re-entrainment of contaminants (source located near intakes) or poor usage of local exhaust ventilation systems (fume hoods); temperature not appropriate for indoor space Responsiveness and empathy, monitoring and evaluation, communication, and prompt feedback
22	What important limiting factors must be understood when using an air purifying respirator?	Medical clearance and fit testing and training is required; cannot be used in IDLH conditions; oxygen concentration must be known; filter cartridge lifespan is finite.
Radiation safety		
23	What is the annual whole body dose limit? The limit for the skin and extremities? And the limit for the fetus?	5 rem/year to the whole body, 50 rem/year to the skin or extremities, and 0.5 rem/9 month gestation period for the fetus of a declared pregnant individual
23	What is the requirement for the issuance of a dosimeter? What if someone requests one and does not meet this threshold?	A person must be issued a dosimeter if they are likely to receive any dose in excess of 10% of the applicable limit. When someone requests a badge, even if unlikely to reach this limit, it is usually prudent to provide for monitoring in some capacity to objectively demonstrate to the person the actual doses being delivered.
25	What is the difference between ''radiation'' and ''radioactivity''? What is the difference between being ''radioactive'' and ''contaminated''?	Radiation is energy in motion, whereas radioactivity is the characteristic of some materials to be able to spontaneously emit radiation. Something is considered radioactive only if it can spontaneously emit radiation. Surfaces and people can become contaminated with radioactive particles—the particles exhibit the characteristic of radioactivity, whereas the surface or person is contaminated and in many cases can be decontaminated.

(*continued*)

Table 1. (Continued)

No.	Question	Example answer from UTHealth Houston
26	What is the predominant radiation emission type from the radionuclides used at UTHealth Houston?	Mostly beta with some gamma
27	How do you detect tritium (H-3)?	Because the beta emitted by H-3 is so weak, it must be monitored for by liquid scintillation counting rather than a portable GM survey instrument.
28	What is a ''broad license'' and why do we have one?	A broad license permits on-site management of principal investigator sublicenses to accommodate the dynamics of large research enterprises. Broad licenses are expensive (>$10,000/year in license fees alone), and necessitate to presence of vibrant radiation safety programs to support the activities, but better accommodate the needs of a research enterprise like ours.
*	What is the best way to address laboratory security when working with radioactive materials?	All radioactive material packages must be sent directly to EHS for acceptance and processing. All doors to laboratories and areas storing radioactive materials should be closed and locked when not in use.
Hazardous waste and environmental protection		
29	What are the three main hazardous waste steams we manage?	Hazardous chemical, biological, and radioactive wastes
30	What is our institution's hazardous waste generator status?	SQG for main campus VSQG for south campus
31	Where are the main bulk storage areas for possible environmental contaminants?	Diesel fuel storage: Redacted for security Liquid chlorine (sodium hypochlorite): Redacted for security Hazardous wastes: Redacted for security
32	What is the process for research or clinical staff to request hazardous waste collection and disposal?	Call the EHS Hazardous Waste line at (redacted) and leave a detailed voicemail as to your name, contact information, location, type(s) of waste to be picked up, and list any replacement containers that may be needed. EHS collects waste on M, W, F each week.
33	What are the RQs for petroleum products spilled on the land and water?	Diesel fuel and used oil RQ is 25 gal on land, or amount sufficient to cause a sheen on a waterway
34	In a satellite accumulation area, a full container of hazardous chemical waste must be removed from the laboratory within what time period?	72 h (3 days)
35	What hazardous waste can be classified as universal waste, and what are the labeling requirements for universal waste?	Batteries, pesticides, mercury containing equipment, and fluorescent lamps, and in TX paint and paint-related waste. Label container as universal waste + type, used + type, or waste + type, date.
*	What security considerations do we have for our hazardous waste storage areas?	All hazardous waste storage areas on campus should have doors closed and secured at all times unless authorized personnel are actively using the space. Report suspicious activity or signs of intrusion to (Redacted) immediately.
Fire and life safety		
36	What are the three key aspects that should be examined every time we pass by a fire panel within a building? What actions should be taken if you find an abnormal condition?	Alarm, trouble, and supervisory conditions. If an abnormal condition is found, notify OSFP of condition. If it is an alarm event you need take response actions including making the investigation announcement.
37	How do you respond to a fire alarm?	Report to fire panel and identify alarm location(s). Make the alarm notification announcement over the building loud speakers. Inform responding emergency response personnel (Facilities, Houston Fire Department, EHS) of alarm location(s). Remain at panel to give further announcements as necessary. Give the building evacuation announcement if necessary (i.e., fire). Give the all clear announcement after emergency response personnel complete alarm investigation.

(*continued*)

Table 1. (Continued)

No.	Question	Example answer from UTHealth Houston
38	What should be verified on any portable fire extinguisher, automatic external defibrillator, emergency shower, and eyewash station?	That the unit is present, it is functional and charged, not tampered with and has been inspected within the last year.
39	What is the UTHealth Houston policy on the placement of items in a corridor?	HOOP 88:Building Pathways Use—items cannot limit required egress No flammable or combustible liquids No compressed gas cylinders No liquefied gases, radioactive materials, or biohazardous agents No equipment, which by design or use, would present a significant hazard (e.g., incubators, drying ovens, and centrifuges). No waste containers or construction items
40	Which buildings are/are not equipped with a fire suppression system?	All buildings 100% covered except the following: Phase 1 Student Housing (low rise apartments)
41	What are the primary loss prevention and control techniques being used to prevent accidents and minimize the potential for accidental and financial loss?	Building safety surveys, education and awareness, and engineering controls such as lifting aids
42	Are there ACM on campus, and if so, where are these materials found?	Yes, some buildings contain ACM, most commonly in older buildings. Typical materials that are ACM include flooring, insulation, and mastic. State of Texas asbestos rules must be followed when disturbing ACM, for example, when these items are disturbed for renovation or construction activities. An abatement contract is in place, and EHS maintains a licensed asbestos inspector under the state rules.
Risk management, insurance, and emergency management		
43	From an insurance perspective, what are the major ''perils'' for our properties?	Fire, flooding, and wind
44	What is the deductible on our property insurance policy?	(Redacted)
45	How does one go about responding to and reporting an injury?	For injuries/illnesses which appear to be life threatening: 1. Contact 911 or (redacted) at (redacted) and provide the dispatcher with. 2. Remain with the injured person until Emergency Medical Services arrive on scene. 3. The supervisor must prepare a Supervisor's First Report of Injury once the emergency situation is under control. This form can be found on the (Redacted) website at the following location. For minor or work-related injuries: If the employee chooses to seek medical attention through UT Health Services, the supervisor should call UT Health Services at (redacted). An injured employee may request to see his/her Health Care Provider. An employee utilizing his/her personal physician should refer the physician to RMI for Workers' Compensation verification and billing instructions.
46	What is a workers compensation ''experience modifier'' and what is UTHealth Houston's current EM?	An experience modifier is a means of adjusting or comparing an organization's WC insurance premium based or good or poor performance. Experience is compared with industry average norms (1), so organizations with low numbers of losses will have an EM <1, whereas those with relatively high numbers of losses with have an EM >1. The FY21 WCI EM for UTHealth Houston is 0.07.
47	What is the most common injury reported by Employees? Residents? Students? and what are the top three departments experiencing the highest frequency of workplace incidents and injuries?	Employees: assaults, slips/trips/falls, needlesticks Medical residents and students: needlesticks, cuts and other bloodborne pathogen exposures Nursing, animal care, and facilities

(*continued*)

Table 1. (Continued)

No.	Question	Example answer from UTHealth Houston
48	How many tort claims and/or premises liability claims were reported in the last year?	None
49	What is the institution's TIV (building and contents)	FY21 (redacted)—Buildings and contents (redacted)—Business income
50	How are emergency communications disseminated on our campus?	The UTHealth Houston ALERT emergency communication system is used to quickly disseminate emergency information to all university constituents. SHERM is responsible for all security-related messaging and EHS/Public Affairs for all severe weather-related emergency communications. Text messages are sent out to provide up-to-date information, and the UTHealth Houston website is updated frequently to provide more detailed information. Emails from Public Affairs are also frequently used to provide more information.
Security		
*	What are the most common security risks that we encounter in the field that we can assist with correcting?	Theft is our most common security risk, so EHS can be mindful of unsecured operations and help remind the community about this risk. Monitoring for proper badging and suspicious persons can also be useful.
*	What is the campus policy about wearing identification badges while on campus?	HOOP policy #148 requires all members of the university community to wear a UTHealth Houston identification badge while on campus. Visitors should check in with the respective security desk within the building they are visiting.
*	What is an insider threat and how can EHS serve to help identify potential insider threat risks?	Insider threats are people who have legitimate access to the UTHealth Houston network, facilities, or data and intentionally misuse that access to negatively impact the organization or an individual for a specific reason or cause. If EHS is doing its job correctly, we should know our people and our spaces better than most, so we can look for anomalies and report them if something does not look right. ''See something, say something''.
*	What are the expectations for safety and security when conducting field research, especially in urban areas where safety and security may be a concern?	Each research project involving field research should develop a field safety plan. EHS and UT Police have collaboratively developed a document entitled ''Community Based Research Safety and Security Guidance Document,'' which can be distributed to the research team and includes a field safety plan template for completion.
*	Can building fire alarm panels be used information in the event of an emergency other than a fire?	Yes. Although fire alarm panels are typically used for fire emergencies, the fire alarm panel intercom system can be used to communicate important information throughout a building during an emergency such as a severe weather event, active shooter, or other emergency situation.

The questions and answers provided in this table for UTHealth Houston are intended to serve as an example for other organizations to consider and adopt for their own staff cross-training purposes. Note the additional security-related questions (indicated by *) that have been added as a best practice for the EHS personnel to consider when performing routine services.

ACM, asbestos containing materials; BBP, bloodborne pathogens; EHS, environmental health and safety; EM, experience modifier; EPA, US Environmental Protection Agency; GM, Geiger Muller; HOOP, Handbook of Operating Procedures; HVAC, heating, ventilation and air conditioning; IAQ, indoor air quality; IDLH, immediately dangerous to life or health; KPIs, key performance indicators; OSFP, Occupational Safety and Fire Prevention; RMI, risk management and insurance; RQs, reportable quantities; SDS, safety data sheet; SHERM, Safety, Health, Environment, and Risk Management; SQG, small quantity generator; TIV, total insured value; TVOC, total volatile organic chemicals; TX, Texas; UT, The University of Texas; VSQG, very small quantity generator; WC, workers' compensation; WCI EM, workers' compensation insurance experience modifier.

importantly included. Interestingly, each of the questions fell into categories that mimicked the organization of the SHERM department technical programs, and were therefore grouped accordingly by programmatic heading.

Once assembled, the management team then undertook the task of crafting cogent answers to each of the questions—in essence, the 50 things that the staff were expected to know. Those answers were then peer reviewed by the department leadership team. The 50 questions list was then provided to the entire SHERM staff, and for the next several weeks, 1 h training sessions were conducted, explaining each of the 50 questions, the associated answer (including its importance to our organization), and the rationale for their inclusion in the list. In many instances, the rationale for inclusion was the frequency with which the item was encountered in day-to-day operations or during the safety surveillance program.

For example, objects placed in an exit corridor creating obstructions, materials stacked too high in the laboratory impeding fire sprinkler operations or electrical panels, and chemicals without appropriate secondary containment or labeling were commonly identified issues during routine safety surveillance. The expectation was then set that each staff member should be able to answer any of the 50 questions if asked by department management. It was made clear that the staff could carry the list of the questions

with the answers specific to UTHealth Houston with them at all times if they so choose. As long as they could address the question and managed the issue, or understood the appropriate resource or party to address the identified issue, the overall intent of the exercise was achieved.

Interestingly, during the staff training sessions an unexpected aspect emerged. Multiple staff mentioned that they felt more comfortable in addressing a safety issue outside of their primary domain once they were armed with this clear list of what they were expected to understand, as well as what was deemed beyond their scope and thus warranted the involvement of a specialist within the particular area. This notion of codification of the expected knowledge emerged as being reassuring and confidence building to the staff.

Independent Assessment

While the SHERM staff has embarked on the use of the 50 questions in their daily activities, a unique opportunity presented itself to test the approach with a set of safety professionals from outside of UTHealth Houston. In 1993, SHERM first developed a novel week-long course originally entitled the ''EHS Academy,'' which has been successfully provided at least annually since its first offering. The course has now hosted more than a 1000 participants from around the world to teach them about how universities work and how to successfully implement a safety program within the unique work environment colleges and universities represent.

In 2005, the EHS Academy course consisted of 16 participants. With their permission, we conducted a simple assessment. We provided each attendee with the 50 questions list (without the answers) and asked two basic questions: (1) could you answer this question for your institution? and (2) do you think it would be useful to you to know this information? The results of the simple inquiries are shown in Figure 1a–c.

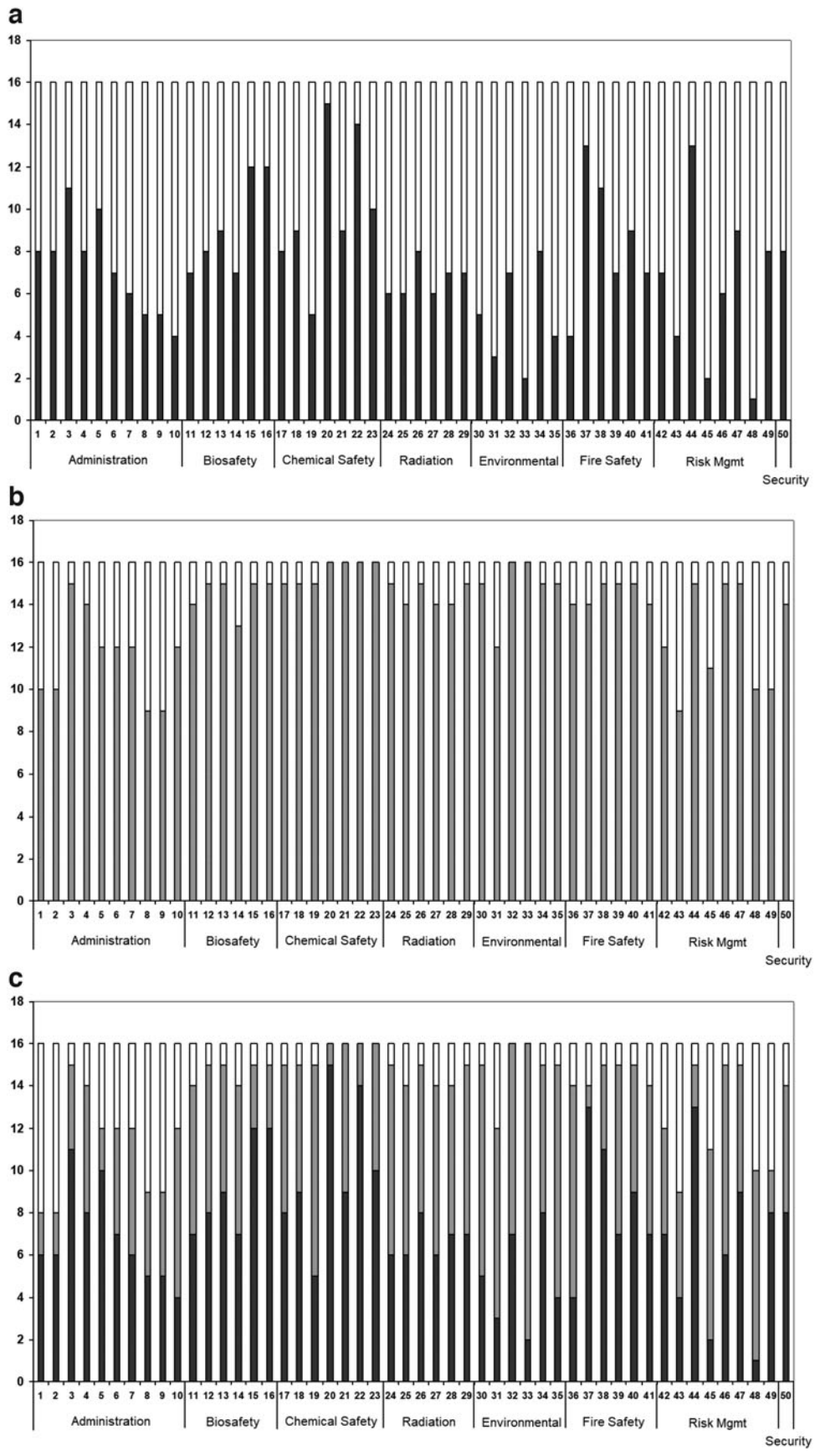
Figure 1a provides, in a quick glance, the items the participants felt they could honestly answer for their respective institutions. For example, question 20 addresses access to chemical Safety Data Sheets. Question 22 addresses the most common causes of indoor air quality complaints, and question 37 addresses the basic steps involved with how to respond to a fire alarm. Conversely, the figure also reflects questions the participants felt they could not answer, such has question 10, which is the size of their institutional measured by total net assignable square footage and their assigned research square footage; question 33 regarding reportable quantities (RQs) of petroleum products that might be spilled; and question 48 that addresses the number of tort liability or premises liability claims experienced over the previous year.

The questions that reflected low scores on the ability to answer were included for specific reasons. Knowledge of the institution's net assignable square footage is crucial as it has been shown to be the predominant statistically significant predictor of safety program staff and resourcing.[6] The question about RQs is important because if a spill or leak occurs and is not promptly reported to the appropriate authority significant compliance issues can arise. In addition, knowledge of the number of tort or premises liability claims is important because that information captures injuries or exposures to individuals outside the normal purview of students, faculty, and staff. Such data are important to understand the status of the entire population at risk for the institution, which is sound epidemiological practice.

Figure 1b reflects the responses to the question ''do you feel you would benefit from knowing the answer to this question for your institution?'' The results were dramatically different, and when overlaid as shown in Figure 1c, the self-identified knowledge gap becomes readily apparent.

The findings from this simple exercise were significant. It made apparent to us how impactful the 50 questions approach to cross-training could be and how important the codification of the knowledge expectations was for the staff from various specialty areas that support safety programs. Subsequent assessments have been performed in other EHS Academy courses with very similar results, reaffirming our observations so much that the 50 questions have become a core element for the EHS Academy course, where at the end of each section participants answer the associated 50 questions for their respective institutions.

Figure 1. **(a)** This figure provides, in a quick glance, the items the participants of the EHS Academy ($n = 16$) training course felt they could honestly answer, when asked, for their respective institutions before any additional education on the topical areas. **(b)** This figure reflects the responses from the EHS Academy participants ($n = 16$) to the question "do you feel you would benefit from knowing the answer to this question for your institution?" **(c)** This figure reflects an overlay of the responses from the EHS Academy participants ($n = 16$) to the questions "are you able to honestly answer this question for your institution?" **(a)** and "do you feel you would benefit from knowing the answer to this question for your institution?" **(b)**. Blue = able to answer and yellow = beneficial to know. Following the overlay of the answers to these two questions, what remains visible in yellow for each answer helps to elucidate the knowledge gap that exists among this group. If performed internally within your own program, this knowledge gap identification can help provide direction for additional cross-training efforts and approaches for technical staff. EHS, environmental health and safety.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Administration
Biosafety
Chemical Safety
Radiation
Environmental
Fire Safety
Risk Mgmt
Security

Feedback for course participants has been consistently positive. Another completely unexpected outcome was the diversification of safety staff from one discipline to another, both within our own organization and others. Some staff became intrigued by the area that they had been previously not familiar with, and pursued further training and education in that field and actually changed disciplines. This cross-pollination has proved to be quite beneficial as it provides a broader understanding of an array of considerations with limited human resources.

Discussion

The overall intent of the 50 questions endeavor was to enhance the protection of the safety, health, and well-being our institution while supporting its key missions of teaching, research, and service. The obvious question from many is ''has it worked?'' The data collected over the years show improvements in several key areas that we believe can be attributed in part to the effort.

To gauge the overall performance of the health and safety at UTHealth Houston, SHERM has identified four key performance indicators (KPIs). These include, in rank order:

- losses (in the form of number of individuals of any type reporting injuries or illness, and amount of property damage),
- compliance (the results of inspections by external agencies and the items detected during internal routine safety surveillance activities),
- costs (in the form of SHERM departmental budget and any associated cost avoidance or revenue generation), and
- measured client satisfaction (both from the clients served and the SHERM departmental staff).

Through various professional interactions, these four KPIs have been widely shared and accepted by university colleagues across the globe to provide some indication of the overall performance of their respective safety programs. The UTHealth Houston SHERM annual report is constructed around these four KPIs. The current and previous year's reports are available on the SHERM website.[4] UTHealth Houston's biosafety program's operations (and other programs) are captured within these KPIs through the number of any injuries or illnesses experienced in the laboratory setting, laboratory damage, compliance inspections, program costs, and measured client satisfaction.

UTHealth Houston's reported injury and illness rates are very low compared with national data for both the university (North American Industrial Classification System [NAICS] code 6113) and hospital work settings (NAICS code 622). These rates, which reflect employee data only, are regularly tracked and reported to the UTHealth Houston Safety Council. Additional information about the types of injury or exposure events reported and the subsequent interventions by SHERM are also presented. As part of this reporting, the setting in which the incident occurred is included, such as a laboratory, so that focused and appropriate interventions can be applied.

SHERM's regulatory compliance record has been exemplary, especially given the number and variety of inspections that are conducted annually by various regulatory agencies. The aggressive routine surveillance efforts carried out by the SHERM staff, armed with the knowledge of the 50 questions, has shown steady improvement in overall laboratory safety compliance.[7,8] SHERM's financial standing has been solid as the costs to support operations have been closely tied to the size of the institution (net assignable square footage) and its complexity (net assignable research square footage).

In addition to the injury and illness outcomes, compliance findings, and financial standing, SHERM conducts an annual client satisfaction survey directed to a specifically targeted audience. For example, one year a client satisfaction survey was directed to those individuals involved with the use of radiation sources. Another year a survey targeted those with exposure to potentially infectious agents. SHERM has also surveyed the major service units that support the university, such as police, facilities management, animal care, and auxiliary services. The results of the surveys are also shared with the Safety Council and have been consistently positive, suggesting that these populations feel their concerns are considered and addressed. The results of these surveys represent a tangible indication of SHERM's institutional ''goodwill value.''[9]

The student body also has an opportunity to provide feedback during a triennial ''student perception survey,'' conducted for the purposes of institutional accreditation and which includes consideration of the safety services provided. Again, the feedback garnered from this effort is shared with the Safety Council and has been consistently positive, suggesting that SHERM is attentive to the needs of the student body, and any issues are communicated and tracked to resolution.

Finally, the 50 questions continue to shape the weekly continuing education curriculum for the SHERM department. Each week, the entire department gathers to conduct a continuing education session that focuses on ensuring the 50 questions are routinely reviewed and refreshed for technical staff's awareness and knowledge. These sessions challenge technical staff who are content experts to remain sharp by requiring them to provide a technical presentation on the specific topics in their area of responsibility, and of course it allows for ongoing staff cross-training.

Taken together, SHERM's KPIs suggest that the 50 questions approach has been a contributor to the overall

strong status of the health and well-being at UTHealth Houston. The initiative continues to evolve and it is likely the list will continue to be modified and possibly further expanded in length to include additional or different questions in the future. Others who wish to adopt this approach are encouraged to modify the question list to fit their institution's respective needs. In the future, a comparison of various 50 questions lists developed by different organizations could be not only intriguing but very beneficial for the entire profession.

Acknowledgments

The 50 questions list has been created and refined by numerous members of the UTHealth Houston Office of Safety, Health, Environment, and Risk Management (SHERM) staff, both past and present, over the course of time. Their input and suggestions, along with input from those outside of UTHealth Houston who have adopted the approach, have made this a valuable tool and their efforts are all truly appreciated.

Authors' Contributions

All authors contributed equally to the creation, writing, and revision of this article.

Authors' Disclosure Statement

No competing financial interests exist.

Funding Information

No funding was received for this article.

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