60th Annual Biological Safety Conference Poster Abstracts

INACTIVATION OF SELECT AGENTS AND TOXINS: META-ANALYSIS OF PUBLISHED LITERATURE (ID #1)

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Objectives: Examine the published literature for inactivation methods that cover the current list of Federal Select Agents and Toxins. Identify published primary data that validates a given inactivation. Assess gaps in the literature.

Method: Embase, PubMed, Web of Science, and the journal Applied Biosafety were queried using two defined criteria: one pertaining to treatment, one pertaining to a select agent or toxin with publication dates between 1900 and 2015. Selection criteria were established to screen the search results for further analysis. Screened articles were categorized by treatment method, effectiveness of a given method, and the agent or toxin treated.

Results: For 56 agents and toxins, the majority of 11,534 search results did not describe inactivation procedures specifically validating methods for the transfer of agents between biocontainment levels. However, 313 publications were identified that described at least one inactivation method.

Conclusion: The number of publications that describe inactivation methods greatly depending on the select agent or toxin. Direct primary data could not be identified that described inactivation for some select agents or toxins. Additionally, there are gaps in the literature that need to be filled.

Outcomes: Procedures for validating a given inactivation method exist in the literature and should be used to support in-house validation results. Where validated inactivation procedures do not exist, appropriate methods should be published in a peer-reviewed journal for the benefit of the research and biosafety communities.

60th Annual Biological Safety Conference Poster Abstracts

CYCLE DEVELOPMENT OF VAPORIZED HYDROGEN PEROXIDE DECONTAMINATION UNDER NEGATIVE ROOM EXHAUST CONDITIONS IN THE CONTAINMENT LEVEL 3 LABORATORY (ID #2)

Joanna Spinato, Aurel Tamburri, Public Health Ontario Laboratories, Toronto, Ontario, Canada

Objectives: To initiate a VHP decontamination cycle development process under slight room exhaust to establish cycle parameters. Decontamination technology validation prior to initial use is required by the Canadian Biosafety Standards. A 350 ft^3 decontamination room is situated on the perimeter of the containment level (CL) 3 laboratory at PHOL-Toronto. This room is equipped with a trim valve to allow some VHP to exhaust from the room while ensuring inward directional airflow and preventing leakage of VHP into adjacent space. With this design, PHOL strives to evolve beyond current procedures to establish a decontamination method that will not require the complete sealing of a room to run a rapid decontamination cycle.

Method: The cycle parameters of the VHP cycle and trim valve settings to keep the room under negative exhaust were developed. Biological indicators (BIs) and chemical indicators (CIs) were placed throughout the room to validate sterility assurance level (SAL) and to demonstrate VHP distribution, respectively. Four VHP runs were performed to develop initial cycle parameters, to revise parameters, and finally to determine final cycle parameters. The cycle development process will be complete when all cycle parameters are determined, a 6 log reduction of *G. stearothermophilus* spores is demonstrated, a final VHP concentration level of 1 ppm or less is achieved, and when the cycle is reproducible.

Results: The results of the initial cycle development process will be presented including operational parameters, trim valve settings, challenges encountered, performance of the BIs and CIs, and the cycle parameter phases required to achieve a 6 log reduction of the BI.

Conclusion: The cycle parameters developed in this investigation will require optimization at this stage of the cycle development process. Cycle parameters must be clearly defined and demonstrate effectiveness against the microorganisms involved.

Outcomes: Develop an effective VHP decontamination cycle evolving beyond current industry practices. Identify the requirements for validation of VHP decontamination under negative exhaust conditions. Conduct a VHP validation process under a slight negative exhaust condition and establish trim valve and exhaust settings to be programmed in at the push of a button.

MECHANICAL AND BIOLOGICAL PARAMETERS OF AN AGING LIQUID EFFLUENT DECONTAMINATION SYSTEM (ID #3)

Rebecca V. Anderson, Thomas Arminio, Nancy P. Hoe, National Institutes of Health, Hamilton, MT

Objectives: Current biosafety best practices for BSL-4 laboratories, described in the BMBL 5th edition, require that facilities decontaminate liquid effluents from chemical showers, laboratory sinks, floor drains, and autoclave chambers before releasing contents into sanitary sewers. The decontamination process must be biologically validated at least annually. At Rocky Mountain Laboratories, liquid waste from the BSL-4 laboratory is first chemically disinfected prior to being added to the Effluent Decontamination System (EDS) where it is heat treated. Initial process validation in 2008 consisted of direct biological challenge of each EDS tank. Annual biological validation is performed by incubating biological indicators (BIs) in an oil-filled "dry well" that extends into each tank. The goal of this work was to evaluate the mechanical parameters over time of an effluent decontamination system that has been operational for 9 years, and to biologically confirm that the current parameters are still valid.

Method: Historic temperature and pressure profiles were evaluated for changes in maximum and minimum cycle temperatures and pressures. BIs containing *Geobacillus stearothermophilus* spores and temperature probes were placed at three separate height locations in the dry well on each tank. BIs were incubated in the dry well for 20, 15, 10, 5, and 1 minute intervals during the 1-hour sterilization phase of each of 3 tank cycles. Results were read at 48 hours.

Results: Temperature and pressure parameters were stable over the period evaluated. Under the conditions tested, 10 minutes at 126°C was sufficient to kill *G. stearothermophilus* spores incubated in the drywell of each tank.

Conclusion: The mechanical parameters of the system have remained stable.

Outcomes: The current 1-hour sterilization time established 9 years ago still provides an adequate safety margin for sterilization of biological material.

60th Annual Biological Safety Conference Poster Abstracts

EFFICACY OF UV LIGHT FOR DECONTAMINATING SAFETY GLASSES (ID #4)

Amy F. Helgerson, Bethzayda Matos, Anne M. Dombroski-Brokman, Steven J. Ziegenfuss, James S. Dickson, Iowa State University, Ames, IA

Objectives: Reusable plastic safety glasses are commonly used in workplace environments to provide eye protection to users. When multiple individuals use a pair of safety glasses, there is the potential for transmission of commensal pathogenic organisms. Chemical decontamination methods are one intervention to prevent transmission between users, but require time and effort for each pair of glasses. A more convenient option is the use of UV light for decontamination of safety glasses after each use. A germicidal UV light decontamination cabinet was tested for its efficacy in routine decontamination of reusable plastic safety glasses using Staphylococcus aureus as an indicator organism.

Method: A germicidal UV light decontamination cabinet was tested for its efficacy in routine decontamination of reusable plastic safety glasses using Staphylococcus aureus as an indicator organism.

Results: A statistically significant reduction of contamination was seen ($P < 0.05$), dependent on both location of the glasses within the cabinet and location of contamination on individual glasses.

Conclusion: The commercial UV light decontamination cabinet was effective in reducing contamination on plastic safety glasses.

Outcomes: The use of a UV cabinet is recommended as an effective and convenient option for decontamination of plastic safety glasses between uses.

ENHANCING THE ANTIBACTERIAL EFFICIENCY OF SILVER-CONTAINING MAGNETIC NANOCOMPOSITES THROUGH EDTA SURFACE PASSIVATION (ID #5)

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Objectives: The purpose of this study was to determine if the antibacterial properties of a magnetic silver (Ag) nanoparticle composite could be enhanced by the addition of a chelating ligand into the composite. Chelating ligands such as EDTA are known to increase the permeability of the outer membrane of gram-negative bacteria. We propose that the addition of Ag ions, known to be toxic to many bacterial strains, in the presence of EDTA will enhance the antibacterial properties of a magnetic Ag nanocomposite compared to the Ag only nanocomposites.

Method: This was explored using easy to synthesize EDTA containing magnetic silver nanocomposites for testing against gram-negative *Escherichia coli*, as well as gram-positive *Bacillus subtilis* bacteria strains. Antibacterial efficacy was determined for each composite toward each bacterium using the minimum inhibition concentration (MIC).

Results: Results showed that the addition of the chelating ligand had a dramatic impact on the antibacterial properties of the nanocomposites, resulting in a 50% decrease in Ag needed to kill bacteria when the EDTA was present.

Conclusion: The results of this study confirm the advantage of including the chelating molecule EDTA into the Ag nanocomposite structure. These advantages are particularly appealing when one considers the technological deployment of Ag ion containing nanocomposites. The development of bacterial resistance to silver represents one of the greatest threats to the success and longevity of Ag based technologies, so limiting the artificial presence and persistence of silver in targeted environments is paramount.

Outcomes: The iron oxide-EDTA-Ag system not only dramatically reduces the dosages of silver necessary to inhibit bacterial growth, but it is retrievable from liquid environments via magnetic separation. This study represents an initial proof-of-concept for the enhancement of Ag toxicity through interactions with ligands functionalized to the nanoparticle surface. Future work will include identifying a suite of ligands capable of enhancing Ag toxicity and continuing to investigate and develop the reusability of a robust composite iron oxide-EDTA-Ag nanocomposite.

60th Annual Biological Safety Conference Poster Abstracts

THE EFFECTIVENESS OF HEPA FILTERS ON DNA (ID #6)

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Dan Ghidoni, NESA, Sanford, ME
Tania Spenlinhauer, Joan Gordon, Steven Nesbitt, Maine Molecular Quality Controls, Inc., Saco, ME

Objectives: Most laboratory techniques utilize biosafety cabinets (BSCs) in order to provide contamination control of the experiments. BSCs depend on airflow and HEPA filters to remove aerosols and particulates to create a clean environment. Aerosols are created constantly by common lab practices, such as centrifugation, pipetting, and opening tubes. The main principals of HEPA filtration demonstrate that these airborne contaminants are captured and remain adhered by cohesive forces on the fibers of the filter, effectively removing them from the airstream. HEPA filters are very effective at removing various sized particles, but do not prevent gasses and vapors from penetrating through them. At some particular size of particle, HEPA filters will not be effective in their removal. It has been speculated that DNA may not be captured by HEPA filters, allowing for contamination of subsequent experiments by aerosolized DNA. Here we propose to: 1. Determine if DNA is captured by a HEPA filter. 2. Discover if DNA can be dislodged from a HEPA filter. 3. Discern whether Type A2 BSCs will prevent DNA contamination.

Method: Here we have tested this theory in multiple avenues. First, a concentrated solution of plasmid DNA was nebulized directly onto a HEPA filter and the DNA penetrated was measured. Secondly, the DNA was released inside the airflow of a Class II Type A2 BSC and the DNA that has adhered to various surfaces, upstream and downstream of the HEPA filter were measured to determine where DNA deposition occurs, and if it will penetrate through the HEPA filter or not in the context of a BSC. Lastly, we tested whether DNA once stuck to a HEPA filter can become detached through mechanical or electrical forces, allowing for a future unexpected contamination.

Results: These results quantify the capture efficiency of the HEPA filter and the class II BSC system in reducing the recirculation of airborne DNA, demonstrating HEPA filter capture of the DNA and preventing its release.

Conclusion: HEPA filters provide an excellent method for cleaning air particulates, including DNA, with a high efficiency.

Outcomes: DNA work should be conducted in a Type A2 BSC to minimize sample to sample DNA contamination, providing clean and accurate work for any lab using quantitative DNA methods.

60th Annual Biological Safety Conference Poster Abstracts

ACCOMPLISHING ABSL-2+ IN DIFFERENT FACILITIES (ID #7)

Kalpana Patel, Maureen Thompson, Yerkes National Research Primate Center, Atlanta, GA

Objectives: As Zika became a worldwide concern in 2016, research to study Zika increased tremendously. Emory University chose to conduct Zika research at BSL-2+/ABSL-2+ due to reproductive hazard concerns. At the Yerkes National Research Primate Center, research with Zika included using non-human primates (NHP) and involved all levels of personnel from facilities management to animal care. In order to work with this agent, SOPs were developed, facilities modified, and personnel were trained for these modified facilities. All personnel accessing areas conducting Zika research completed an occupational health consult to discuss any concerns with the occupational health physician. Challenges occurred as different facilities were used to accommodate the research. Procedures were modified to allow research for adult and infant NHPs to be conducted in two different facilities. An existing ABSL-3 and ABSL-2 facility were modified to ABSL-2+, which presented obstacles to address before the facilities could go live. In addition to the facility modifications, a multitude of groups were involved and varying schedules had to be adjusted so that the projects could run smoothly. The process involved conducting risk assessments for both facilities and adjusting the engineering controls, PPE, and SOPs to achieve ABSL-2+ for both facilities.

Method: In order to determine if personal were able to work in the facilities, all individuals accessing the ABSL-2+ areas had to undergo an occupational health screen. This entailed a one on one visit with our occupational health physician to ensure the individual understood the reproductive risks associated with working in the facility with Zika. If individuals were planning on starting a family they may have declined to work in the facilities or may have not passed the occupational health screen. Only individuals that passed the occupational health screen were allowed into the facilities. Risk assessments for the Zika projects had different concerns since one project involved adult macaques and the other involved infants. The project with adult macaques could easily be done in the ABSL-3 facility; whereas the project with the infants needed to have access to a kitchen, thus could not be done in the ABSL-3 facility. For the ABSL-3 facility that was brought down to ABSL-2+, only one change in engineering controls that had to be made; whereas the ABSL-2 had several engineering controls made. Air curtains were installed above the entry doors in both the ABSL-3 and ABSL-2 facilities. Since the ABSL-3 facility already had controlled access, no changes were made. The ABSL-2 room had to have a control access pad installed to add access restrictions to the facility. PPE for both the facilities were the same and included designated work attire, Tyvek suits, double gloves, Kevlar, shoe/boot covers, face shield, and either face mask or N-95's or PAPRs. N-95s or PAPRs were used only when cage washes were being done in the room in case anything was aerosolized. The standard operating procedures (SOPs) for both facilities were different since the ABSL-3 facility was a stand-alone facility with an autoclave on site and the ABSL-2 was a room in an existing animal facility where other ABSL-2 work was being conducted. The ABSL-3 facility had SOPs developed that included directional work flow, signing in and out of the facility, lab work being conducted in a biosafety cabinet, disinfecting and autoclaving cages and waste and sample removal processes. For ABSL-2+ in the ABSL-2 lab additional PPE was donned in the animal hallway, the door could not be opened if any other doors were open in the hallway, all laundry was removed from the area and autoclaved before being laundered, bottles were disinfected before being washed, waste bags were sprayed with disinfectant before being removed from the room, additional PPE was removed in the room before entering the animal hallway where additional PPE could be replaced. In addition, the ABSL-2+ for the infants had SOPs for necropsies that would be handled in the ABSL-2+ that was used for the adult macaques including MRI and behavioral testing procedures performed in other facilities. In both facilities various groups had to be trained to work at the higher containment levels, including: animal care; veterinary techs; veterinarians; necropsy staff; behavioral management; clinical laboratory staff; MRI staff; lab staff; and facilities personnel. Each group had to work with the animals or in the facilities.

Results: Both animal facilities were ABSL-2+, but the practices in both were different to accomplish this. The ABSL-2+ that was done in the ABSL-3 facility had less challenges, since it was set up as an ABSL-3 and fewer changes had to be made. The ABSL-2+ in the ABSL-2 for the infants had more challenges as it was

an animal facility and the ABSL-2+ was set up in one room of the facility. The infants needed to be close to a kitchen due to the bottle feeding schedule. The infants also were going to have MRI and behavioral testing done, so they needed to have easy access to these areas. By developing SOPS, adding additional PPE, and adding some engineering controls to address some of the concerns brought up during the risk assessment the for the infant facility ABSL-2+ was accomplished.

Conclusion: Different facilities can be converted to meet ABSL-2+ practices. It is easily done when the facility is an ABSL-3, but it can also be done with an ABSL-2 by addressing the concerns brought up during the risk assessment. The concerns can be addressed by adding engineering controls, developing SOPs, adding additional PPE, and training personal. For the work in our ABSL-2+ we had an additional requirement of having occupational health screen.

Outcomes: We had two very different ABSL-2+ facilities that worked for the purposes we needed at the time.

ROLE OF THE NATIONAL MUSEUMS OF KENYA ZOOLOGICAL COLLECTIONS IN THE PROMOTION OF BIOLOGICAL SAFETY AND SECURITY AFRICA (ID #8)

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Objectives: The African continent faces great risk of potential, emerging, and re-emerging infectious diseases such as Ebola and avian influenza, among others. The National Museums of Kenya (NMK) houses a large natural history collection dating over one hundred years back which forms a wealth of knowledge, an important component in promoting biological safety and security in Africa. The collection with over 1.4 million specimens of invertebrates, birds, mammals, reptiles, amphibians and fishes is bedrock for improvement in biosafety, biosecurity, and disease surveillance in the region.

Method: Example of the use of the NMK collection in biosafety was well demonstrated after the outbreak of Ebola in Guinea in March 2014 and the quick spread to eight other countries. Biosecurity and health scientists mentioned in published articles that the outbreak was likely to have come from wild animals. In Kenya one of the responses to the Ebola threat was the establishment of a multi-sectoral National Ebola taskforce coordinated by the Ministry of Health. The taskforce approached the National Museums of Kenya to provide expertise and information.

Results: Using the bat collection and the associated data at the Zoology department at NMK, reports were given on the taxonomy, distribution and possible viral profile of bats, a primary suspect as Ebola reservoir host. Low to high risks areas of possible Ebola disease outbreak have been mapped alongside other areas in the country where bats or rodent species are potential agents of zoonotic diseases.

Conclusion: It is important to appreciate the value of natural history collections in the advancement of biological safety initiatives. They play a key role in the development of biosafety and biosecurity risk frame work for target reservoir animal species and associated zoonotic diseases.

Outcomes: The poster highlights the status of the Zoological collections at the National Museums of Kenya, gives a brief progress on some of the ongoing research initiatives, current and future research opportunities and also highlights the gaps in existing mandates and frameworks that need improvement.

60th Annual Biological Safety Conference Poster Abstracts

APHL BIOSAFETY PEER NETWORK (ID #9)

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Objectives: Strengthen biosafety and biosecurity across PHLs. Facilitate mentoring and information sharing among biosafety professionals. Develop a baseline level of competency in biosafety and biosecurity for all programs across all PHLs.

Method: Recent lapses in institutional biosafety and the 2014 Ebola outbreak have demonstrated the necessity to fill gaps and deficiencies that remain in the nation's biosafety apparatus. In 2016, the Association of Public Health Laboratories (APHL) established the Biosafety Peer Network. The free program partners state, local or territorial public health laboratories (PHLs) with each other that are funded via the Centers for Disease Control and Prevention Epidemiology and Laboratory Capacity for Infectious Diseases (ELC). The PHLs partnered were based on their current strengths in specified areas of biosafety and biosecurity. In its initial year, applications were accepted from 12 PHLs that were eventually twinned. Based on the twinning model, the PHL alternately visit the other's institution. The visiting lab spends approximately three days at the host PHL working closely with them on an agenda tailored to the needs of the visiting institution. Biosafety and biosecurity plans, occupational health programs, regulated waste management and sentinel clinical outreach are a few of the topics that are examined. Within three months, the roles are reversed, and the initial host travels to the other's facility.

Results: Analyzing the trip reports from the 6 twinned labs, we have seen PHLs improve the implementation of their perspective biosafety and biosecurity programs. Labs have initiated changes in their biosecurity plans, donning and doffing procedures, waste management protocols and sentinel laboratory outreach program to name a few. Finally, this program pools limited resources to strengthen biosafety and biosecurity nationwide as well as fostering an environment of collaboration and community among the relevant stakeholders.

Conclusion: The biosafety and biosecurity programs at several different PHLs are more harmonized due to their common source of guidance. This standardization among different organizations is beneficial in many aspects such as implementing new procedures and communication between partners.

Outcomes: The second round of this program will begin in the summer of 2017 to partner additional PHLs.

60th Annual Biological Safety Conference Poster Abstracts

BIOLOGICAL AGENTS IN MICE: PERSONAL PROTECTIVE EQUIPMENT AND HANDLING OF CAGES/BEDDING (ID #10)

Kathleen Azzam, National Institute of Environmental Health Sciences, Research Triangle Park, NC

Objectives: Identify the biological agents being used by principle investigators (PI) in rodent models for the animal facility, which is governed by the comparative medicine branch (CMB). Clarify the personal protective equipment (PPE) biosafety recommendations. Clarify the biosafety recommendations for the handling of potentially hazardous cages and bedding.

Method: Develop an intuitive chart for the NIEHS animal facility that lists all the biological agents currently being used in rodent models. Biological agents are defined as any human materials, hazardous biological agents unassociated with recombinant DNA (rDNA) and hazardous biological agents associated with rDNA. Within this chart, requirements for both PPE and the handling of potentially hazardous cages and bedding are included. The chart is used as a guide for animal facility management and the ACUC. However, this chart should not be used as a replacement for a biosafety assessment, which is always conducted on a case-by-case basis within regulatory compliance with the institutional biosafety committee (IBC).

Results: The chart lists all current biological agents in rodent models, and the biosafety recommendations associated with each biological agent in for PPE and potentially hazardous bedding. The biosafety survey of the animal facility helped CMB and the ACUC prepare for AAALAC with NIH-required first aid signage, Appendix D signage, and a clearer understanding of requirements associated with the voluntary and involuntary use of N-95 respirators. After finding a closed front gown which is both cost effective, available in the warehouse, and satisfies ASTM1670 and ASTM1671 viral and penetration resistance criteria, the biosafety specialist consulted with CMB as to what PPE was being supplied to both researchers and animal facility personnel.

Conclusion: Registration of biological agents at the NIEHS allows for biosafety assessments to be conducted on a case by case basis. An easy to follow guide was created to help investigators and staff in their facility. The chart was generated and is included on the NIEHS HSB webpage, as well as in animal facility specific standard operating procedures/waste manual.

Outcomes: The NIEHS IBC, ACUC, and CMB collaborated together in a combined effort to better understand biosafety associated with the use of biological agents in rodent models.

60th Annual Biological Safety Conference Poster Abstracts

DEVELOPMENT OF A MODULAR LABORATORY EMERGENCY RESPONSE TOOL FOR REGIONAL PUBLIC HEALTH LABORATORIES IN EGYPT (ID#11)

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Dalal Moneir El Sayed, Central Public Health Laboratories, Cairo, Egypt
Benjamin Fontes, Yale University EHS, New Haven, CT

Objectives: Central Public Health Laboratories (CPHL) has a supportive, control role on activities of 26 Regional laboratories across Egypt. Regional Public Health Laboratories are playing an important role in preventive health sector, and the Ministry of Health is considered the first line of defense against infections and emerging diseases. Albeheria Regional Lab in the Egyptian Ministry of Health initiated a comprehensive laboratory emergency response training project to raise awareness of the importance of preventing incidents, and ensuring that employees were prepared for dealing with emergencies. In parallel, the Central Public Health Labs (CPHL) requested that the emergency response information generated by this project be packaged for sharing with other regional laboratories within the Egyptian Ministry of Health.

Method: CPHL and Albeheira decided upon the development of a customizable plan that could be modified as needed by other regional labs. Our methodology focused on the creation of a Modular Laboratory Emergency Plan that contains inventory sheets to collect information on chemical and biological hazards; emergency response SOPs; a training program outline and training slides; development of a comprehensive training evaluation form on lab safety and emergency response; emergency response posters; sample emergency response drills and exercises; a CPHL incident tracking form; and a library of training photos and videos.

Results: The packaged Modular Laboratory Emergency Response Plan was piloted at the Albeheira Regional Lab with great success. The results were over 150 laboratory staff trained in laboratory safety and emergency response over five, two-day training sessions, and three different emergency response drills were conducted. Pre- and post-training evaluation forms identified a significant increase in knowledge and understanding of laboratory safety and emergency response protocols.

Conclusion: This project demonstrated the importance of training and continuous training and reinforced that emergency response is part of the backbone of a Biorisk Management Program. The results indentified that hands-on practical drills help keep employees prepared and ready for dealing with a wide range of lab emergencies, and emphasized how training and exercises can have a positive impact on the safety environment. Leadership commitment by attendance and participation in the training program help to overcome resistance through implementation of the Emergency Response Tool.

Outcomes: This project will be disseminated and implemented at the 25 Egyptian Ministries of Health Regional Labs over the next 18 months. This includes the use of the Modular Emergency Response Tool and Training Manual, incident response spreadsheet, posters, training program, exercises and drills. The modular plan can be used by in a wide array of laboratory settings to implement a comprehensive emergency response management program, and enhance staff awareness and knowledge in laboratory emergency response procedures.

HAND HYGIENE TRENDS AMONG FUTURE HEALTH CARE WORKERS WITH REFERENCE TO KAP &LT KNOWLEDGE, ATTITUDE AND PRACTICE&GT (ID #12)

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Sarmad Pirzada, Dow University of Health Sciences, Karachi, Pakistan

Objectives: To determine the knowledge and general perception regarding hand hygiene practices among medical undergraduate students in different institutes of Karachi, Pakistan. To ascertain the capability of educational institutes to improve this practice. To develop plans to reduce the gaps found in hand washing practices and to emphasize the importance of hand hygiene in daily clinic and hospital practice

Method: The cross-sectional study was conducted from July 2016 to December 2016 in three different medical schools that were classified as public, semi-private or private. Stratified random sampling was used to create the study sample. A pre-validated, piloted questionnaire was used for data collection which was analyzed using SPSS 20.0

Results: Of the 435 participants, 74% were females. Only 27.6% of the undergraduate students were found to have adequate hand hygiene knowledge. Females had better knowledge regarding hand hygiene practices (mean score of 9.50±1.866) as compared to males (9.04±1.880). Significant differences were seen in knowledge scores of various categories of medical schools p=0.05, with the highest scores occurring in public institutes. Moreover, 45.3% of the respondents claimed that it was very unlikely that the healthcare workers at their hospital perform hand hygiene in the required situation, while more than half of the medical students (56.8%) claimed that it is highly likely that they would perform appropriate hand hygiene practices when needed. Similarly, a greater number of participants (56.3%) from a private medical school reported that their faculty assigns high importance to performing optimal hand hygiene practices, as compared to public (50.4%) and semi-private (42.0%) medical colleges. The majority (70.6%) of the respondents believed that the availability of hand-sanitizers at each care point would be the most effective method for improving hand hygiene practices in their respective institutions.

Conclusion: Hand hygiene knowledge of the medical students was not satisfactory. The majority of students were unaware of WHO hand hygiene guidelines and its importance in preventing infectious diseases. Changing these trends would not only require different interventions to improve general awareness but also, institutional emphasis on executing proper hand hygiene and providing accessible facilities to perform it. In addition, workshops for hand hygiene practices in medical schools at the national level would be valuable and would increase the knowledge and skills and encourage a positive attitude towards the importance of this very basic practice. Hand hygiene must be a part of the curriculum at the high school and undergraduate student level to reflect the importance of this hygienic element in day to day life activities. It is further suggested that a full-time study be conducted on a national scale to quantify the level of knowledge, practices and attitudes concerning hand hygiene in order to develop a national level program for informing and training medical school students. Increasing awareness and hand hygiene will lower the burden of nosocomial infections.

Outcomes: Recall the possible gaps in hand hygiene practice in Pakistan. Understand the shortfalls in the knowledge of target audience. Identify the differences in knowledge, attitude and practices of various medical schools in Pakistan. Highlight the disparity in the practices and the attitude of the students towards hand hygiene. Identify the possible role of faculty in advocacy for hand hygiene.

NATIONAL BIOSAFETY MONTH CAMPAIGNS AT ARIZONA STATE UNIVERSITY (ID #13)

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Objectives: Arizona State University (ASU) has led innovative campaigns for National Biosafety Month since 2014, in conjunction with the National Institutes of Health Office of Science Policy's compliance initiatives. By using a creative marketing strategy to convey the importance of high profile biosafety and biosecurity topics, ASU has successfully engaged the campus and local community to raise awareness and participate in safety and compliance activities.

Method: Campaigns have included building a culture of biosafety and biosecurity, sustainability in the lab for the cold storage of biological materials, hand washing, and needle stick awareness. Strategies for the campaigns included the creation and distribution of professionally developed, color, laminated posters featuring photographs of the ASU mascot wearing personal protective equipment (PPE) and lists actions for the observer to follow. Campaigns were advertised through email and web-based communications as well as in person meetings with stakeholders.

Results: The campaigns were well received at ASU, and materials were shared with and customized for use at other institutions. The successes from these campaigns have proven that creative and innovative marketing materials effectively communicate the importance of biosafety and biosecurity practices at academic research institutions.

Conclusion: As a result, ASU will continue to be a leader in promoting National Biosafety Month and fostering biosafety and biosecurity stewardship.

Outcomes: A major outcome was that participants adopted the practices identified in the marketing campaigns and became advocates to improve biosafety and biosecurity at ASU. Changes included researchers submitting a catalog of organisms form to the Institutional Biosafety Committee (IBC), cleaning their freezers and refrigerators, and complying with hand washing practices.

60th Annual Biological Safety Conference Poster Abstracts

PLAN, DO, CHECK, ACT AT WORK IN ANIMAL FACILITY INSPECTIONS (ID #14)

Alaina Whitton, Kalpana Rengarajan, Patricia Olinger, Emory University, Atlanta, GA

Objectives: Completing holistic animal facility inspection through utilization of the skill sets of multiple groups within the Environmental Health and Safety office (EHSO) and releasing iterations of improvement roll-outs using the Plan Do Check Act (PDCA) management system philosophy. Through this approach, programs can decrease time spent on administrative tasks and increase customer engagement.

Method: Utilize PDCA management philosophy. Allow for a period of input on inspection items from the EHSO team and the DAR Can someone indicate what DAR stands for? This needs to be indicated one time to staff (Act from previous years). Have a "kick-off" meeting with both animal resources staff and EHSO. Assignment of cross-functional EHS teams to highlight individual's strengths (Plan). Scheduling and inspection process (Do). Result reporting after both initial and follow-up inspections (Do). In the next round of inspections, lessons learned from the next period of input on inspection items (Check) will be implemented (Act). Throughout the entire process the team leader was in contact with the DAR supervisor to relay information that affected the program as a whole or was department-wide.

Results: Continuous improvement of the inspection process and the relationship with animal resources staff, resulting in few findings during an AALAC inspection in the following months.

Conclusion: By implementing PDCA methods, Biosafety/EHS groups can have higher quality interactions with their customers. Encouraging and including feedback from customers fosters camaraderie and involvement in the inspection process.

Outcomes: Successful AALAC inspection in the following weeks and increased dialogue with animal facility management.

60th Annual Biological Safety Conference Poster Abstracts

ASSESSMENT OF BIOSAFETY PRACTICES IN THREE VETERINARY CLINICS (ID #15)

Bonodong Zongnukuu Guri, Ghana Atomic Energy Commission, Accra, Ghana

Objectives: Veterinarians or animal care workers provide medical, surgical and preventive health care services to different species of animals. These workers are at risk of exposure to biological hazards such as infectious and zoonotic diseases. The objective of this study is to assess the practices of veterinary clinics personnel (veterinary professionals) towards biosafety measures in their respective clinics.

Method: There were 16 respondents in this study. Individual questionnaires were admitted to all workers at three selected veterinary clinics located in Accra; two public veterinary clinics and one private veterinary clinic. In addition, observations were made to assess the guidelines and standards for veterinary practices.

Results: The private veterinary clinic fared better than the two public veterinary clinics in the assessment of personnel regarding biosafety measures. Variables in the assessments included containment practices, guidelines and standards for veterinary practices, usage of protective clothing, and steady flow of water for hand washing and cleaning.

Conclusion: Though the absence of appropriate biosafety practices is one of the challenges facing health care workers in sub-Saharan Africa and some unsafe biosafety practices were revealed in this assessment, it is premature to conclude generally based on these results.

Outcomes: There is the need for biosafety to be placed in forefront of issues in our workplaces. Therefore, more investigation is needed on this matter.

60th Annual Biological Safety Conference Poster Abstracts

PERFORMANCE OF ACCESS CONTROLS IN DEVELOPING COUNTRIES (ID #16)

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Objectives: Laboratory biosecurity is the protection, control and accountability for valuable biological materials within laboratories, in order to prevent their unauthorized access, loss, theft, misuse, diversion or intentional release. (*Biorisk management - Laboratory biosecurity guidance, World Health Organization, 2006).* The adequate prevention of unauthorized access by persons (both outsiders and insiders) to valuable biological material relies on a combination of engineered and administrative controls.

Method: Access controls are an important tool in supporting this goal. Access controls rely on both engineered controls (walls, auto-locked doors, and electronic credentialing) and administrative controls (such as badges, guard checks, procedures). Risk-informed performance based selection of access controls should include prioritization of the valuable biological material, safety requirements, consideration of infrastructure (power, facility design), security culture, maintenance requirements, and availability of components in the country. This risk-informed process helps to ensure systems will provide adequate functionality and be sustainable.

Results: For example, the lack of reliable power in many developing countries negate the usefulness of electronic access controls however, mechanical cipher locks and additional practices and procedures can be used to reach acceptable performance. Access controls are one component of a physical protection system. The physical protection system performance should incorporate detection, delay, and response elements against a defined threat. Access controls support physical protection by providing assurance regarding who has access and when, in effect granting access to individuals to bypass the physical security system.

Conclusion: The access control system supports elements of laboratory biosecurity such as material control and accountability and background checks, to achieve the performance objectives to protect, control and account for valuable biological materials. For example, robust material control and accountability, background checks, granting access based on trustworthiness, material and personnel tracking all work to address the insider threat.

Outcomes: Overall performance success is reliant on security culture around robust administrative controls combined with suitable engineered controls. Increases in cyber threats warrant more solutions to support information security.

60th Annual Biological Safety Conference Poster Abstracts

IMPLEMENTATION OF A BIOLOGICAL INVENTORY SYSTEM IN THE EGYPT CENTRAL PUBLIC HEALTH LABORATORY (ID #17)

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Objectives: The Central Public Health Laboratories (CPHL) located in Cairo, is Egypt's leading governmental institute responsible for conducting laboratory tests. Using the latest internationally scientific methods, the testing is performed a by highly qualified and well trained team. This team's primary role is to be the 1st line of defense for Egypt against epidemic and infectious diseases. The team ensures the protection of citizens' health, as well as supervising and monitoring all intermediate labs in all governorates. This conference poster will present results from a project conducted under the Sandia National Laboratory "Twinning" Program. The purpose of the project is the implementation of a biological inventory system to enhance biosafety and biosecurity in the CPHL.

Method: We worked on nine objectives. We started with the approval of the project by the Head of the CPHL. A pre-assessment of the existing inventory in 10 microbiology labs was performed: (PCR (microbiology and virology), EQAS lab, serology (virology and bacteriology lab), TB lab , tissue culture lab, pulse net lab, bacteriology lab and food microbiology lab). We created the biological inventory forms and SOPs. Pathogen safety data sheet (PSDS) notebooks were created for all infectious materials in each lab. The inventory was conducted. SOP training was provided to laboratory staff. The re-assessment and evaluation of the biological inventory system took place in the laboratories after implementation in CPHL.

Results: After the completion of the project we found that there was a 90% improvement in the biological agent inventory documentation in the CPHL laboratories.

Conclusion: The inventory system was successfully implemented and the next step of this project will be to disseminate and implement the inventory system in CPHL-affiliated labs.

Outcomes: This project will be a model for the implementation of biological inventory systems in Egypt. The results will be used to increase the awareness of biorisk management, especially in biosecurity, for laboratories in Egypt.

BIORISK MANAGEMENT PRACTICES AND TRAINING NEEDS IN EAST AFRICA (ID #18)

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Giulio M. Mancini, University of Bradford, Bradford, United Kingdom
Timothy Wakabi, One Health Central and Eastern Africa, Kampala, Uganda

Objectives: A survey was designed to query former biorisk management (BRM) trainees in the East Africa region about their practices post-training and their perceived future training needs. The survey was conducted to obtain a baseline of BRM practices that can serve as a benchmark for performance monitoring, to identify priorities for future BRM training, and to gauge local BRM trainers' abilities to deliver effective training.

Method: Those invited to complete the survey electronically were from Kenya, Uganda, Ethiopia, Tanzania, Rwanda and Cameroon. The participants had been trained in the past five years by members of the Sandia National Laboratory International Biological and Chemical Threat Reduction group (SNL/IBCTR) in principles of biorisk management on behalf of the Defense Threat Reduction Agency/Cooperative Biological Engagement Program (DTRA/CBEP). Those surveyed are members of ministries overseeing laboratories in their countries that provide management and leadership of bioscience institutes, university professors and lecturers, biosafety and biosecurity officers, veterinarians and laboratorians. Surveys were completed by BRM trainers and trainees (n = 157).

Results: The survey revealed that less than 50% of the respondents could identify evidence of a BRM system in their institute. Although a majority of respondents are practicing the desired biosafety and biosecurity behaviors, no single behavior was reported to be practiced by more than 75% of those surveyed. Coaching and mentoring by BRM experts was identified as being of highest benefit to enable success as BRM practitioners. Local trainers (n = 37) reached 1538 trainees in the previous year and reported that trainings positively correlated with desired BRM behavior. The majority of trainers (82%) and trainees (80%) belong to a professional society where BRM training and common practices could be anchored for sustainability.

Conclusion: Regular administration of a BRM practices and training needs survey would allow for monitoring of performance, adjustment of engagement strategies, and provision of data for end state goals.

Outcomes: In summary, the Biorisk Management Practices and Training Needs Survey provided a snapshot of the current status of BRM practices and perceived needs from respondents in Kenya, Uganda, Ethiopia, Tanzania, Rwanda and Cameroon.

BIORISK ASSESSMENT OF DIAGNOSTIC, HEALTH AND ACADEMIC LABORATORIES IN ZAMBOANGA CITY, PHILIPPINES (ID #19)

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Objectives: The study was conducted to assess the relative biorisks of diagnostic laboratories in academic and health institutions in Zamboanga City, Philippines. The study determined the biosafety and biosecurity risks and identified mechanisms to mitigate these risks.

Method: The study utilized a descriptive method employing qualitative and quantitative research generated from the International BioRisk Assessment Model (BioRAM). A Multi-Criteria Decision Analysis (MCDA) quantified the various aspects of biorisks with key informant interviews, focused group-discussions and facility on-site visits.

Results: The Diagnostic Laboratories in Academic and Health Institutions in Zamboanga City show moderate (1.0) likelihood of infection and exposures, via an infectious route of the biological agent, with a low (0.74) consequence of disease to the risk population. In terms of potential adversaries, the facility is moderate (1.6) resulting in a moderate consequence (1.7). The hospital and government diagnostic institutions show low likelihood and low consequences for biosafety risks.

Conclusion: The hospital and government diagnostic institutions show low likelihood and low consequences for biosafety risk in relation to a moderate likelihood and consequences for academic laboratories. This implies that the low Biosafety risks in hospitals and government laboratories has to do with strict adherence to Biosafety protocols for biological agents. Regarding biosecurity, the animal laboratories, academic, hospital and government laboratories show moderate likelihood with moderate consequences. For the identified mitigation risks, the research documented 14 pathogens.

Outcomes: Mitigation measures are summarized into biosafety and biosecurity, to wit: (1).

Biosafety Mitigation Measures: The need for the availability of safety equipment: Class 1 or II biosafety cabinets, wearing PPE (*N95 masks, latex gloves, nitrile gloves, disposable gowns, eye/face, and respiratory protection)*, an autoclave, biohazard signs, waste disposal management and pathogen driven facility upgrade; (2). Facility upgrade: biometric lab, with CCTV, double lock doors, power-lock doors, perimeter fence, and personnel background checks.

DEVELOPMENT OF A BIOSAFETY TRAINING PROGRAM WITH INSTRUCTOR GUIDE FOR THE NATIONAL INSTITUTE OF HYGIENE RABAT, MOROCCO (ID #20)

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Objectives: This Sandia MENA IV Twinning Project focused on the creation of an initial Biosafety training program for any new laboratory staff, including employees and students prior to working in a laboratory. The training encompasses core biosafety principles, including hazard identification and risk, good laboratory practices, personal protective equipment, use of laboratory equipment (including the biosafety cabinet, centrifuge, and autoclave), and emergency response procedures.

Method: A training guide was developed to accompany the curriculum and includes speaker's notes, short training videos on key topics as indicated above, and exercises for the trainer to emphasize essential elements of Biosafety.

Results: This project has been piloted at the National Institute of Hygiene (INH) where modifications were made following the lessons learned from the initial training launch. The length of the training has been increased to 6 hours to allow sufficient time to adequately cover all of the core topics required for new laboratory staff. The updated training materials and training guide will be distributed for use at all regional and provincial public health laboratories.

Conclusion: This project was selected to provide standardized and consistent introduction to biosafety training for new laboratory workers within the National Institute of Hygiene and throughout regional and provincial laboratories within Morocco. Currently, new laboratory employees do not have access to an introduction to biosafety training, and many are exposed to potentially infectious materials as well as known biohazards.

Outcomes: INH plans on scheduling a one day train-the-trainer event to share the tool and educate the 12 Regional Biosafety Coordinators on its use. The 12 Regional Coordinators will be responsible for implementation of the training program in each of their regions. The training and guidance information will also be shared with health schools and teaching hospitals in Morocco to reach students prior to their transition to the laboratory environment.

60th Annual Biological Safety Conference Poster Abstracts

USING A MOBILE TRAINING KIT TO PROMOTE BIOSAFETY, BIOSECURITY, AND EGBSA (ID #21)

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Objectives: The Egyptian Biological Safety Association (EGBSA) is the leading formal body in Egypt educating scientists and the public on biological and chemical risks, as well as providing awareness of current biosafety and biosecurity regulations. Our project created tools to allow EGBSA leaders to share knowledge and practical examples of biosafety and biosecurity to prevent laboratory-acquired infections. Topics covered in our training materials include definition and terminology of biosafety and biosecurity, development of standard operating procedures, disinfection and waste disposal, working safely in biosafety cabinets and lab practices (hand washing and cleaning biological spills). Throughout our 6-month Twinning project we had the opportunity to provide four presentations at three locations in Egypt. Our goal was that proper training would increase confidence in biosafety and biosecurity knowledge as well as improve confidence in handwashing and spill clean-up practices.

Method: These materials were used to train 162 researchers. We provided pre and post questionnaire to determine confidence on knowledge and practices presented.

Results: Our results showed that out of 162 participants, 41% participants answered in a pre-training questionnaire they were not confident in their knowledge in biosafety and biosecurity, but after the workshop, 88% were confident on knowledge in biosafety and biosecurity. Confidence in handwashing techniques improved from 78 to 86% and from 50 to 78% in cleaning up a spill of biological materials.

Conclusion: EGBSA has created a template with biosafety training materials and biosecurity practical examples that may be used by other professional organizations.

Outcomes: Non-governmental associations can play an effective and proactive role concerning safety and security issues. Our next steps will focus on creating more training material, a monthly newsletter with tips for participants, and sharing materials with other biosafety organizations.

PATHWAY TO CAPACITY BUILDING FOR BIORISK MANAGEMENT IN NIGERIA (ID #22)

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Objectives: Growing a culture of laboratory biosafety and biosecurity requires capacity building and implementation of biorisk management. The Nigeria Biosafety Association (NiBSA) has been very instrumental to these needs in Nigeria. The NiBSA started as an online forum in August 2010 and was formally inaugurated at the maiden meeting held November 24, 2010 in Abuja, Nigeria. The objective of this work is to trace the pathway followed for Biorisk Management (BRM) implementation in Nigeria from the formation, scope and operation mode of NiBSA to the gains of partnership in shaping the organization and enhancing BRM in the country.

Method: There was an online platform established for people interested in professionalization and raising awareness for Biosafety and Biosecurity followed by the inaugural meeting of the association in November 2010. Partnerships were then formed with partners that strengthened the capacity of local leadership. Trainings in BRM were conducted at three levels namely awareness creation for NiBSA Members, Training of Trainers and training of University Professors based on the Global Biorisk Management Curriculum (GBRMC) Library. Members trained in Biorisk Management return to their respective facilities and implement the BRM skills learnt.

Results: There is increased awareness for Biosafety and Biosecurity among healthcare professionals through the training programs of NiBSA in all the six geopolitical zones. Also, membership has increased from 12 that attended the inaugural meeting to more than 250. Members of NiBSA now train professionals in BRM. BRM components have been introduced into the curriculum of universities and diagnostic and research facilities.

Conclusion: Through strategic partnership there is increased awareness of biosafety/biosecurity in Nigeria, and the increased human capital implementing BRM in health facilities.

Outcomes: The NiBSA has developed training skills and are holding workshops involving healthcare and veterinary workers.

BIOPRISM: A LABORATORY BIOSAFETY TRAINING INITIATIVE BY PAKISTAN BIOLOGICAL SAFETY ASSOCIATION (ID #23)

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Objectives: The Pakistan Biological Safety Association (PBSA) has been committed to imparting Biosafety related training throughout the country in collaboration with the Fogarty International Centre (FIC), National Institute of Health (NIH), USA and Behavioral-Based Improvement Solutions (BBIS), USA.

Method: During one such event in 2016, PBSA conducted a practical mock laboratory "Wet" workshop, with the aim of providing mentoring on Biosafety issues and to have a team of facilitators trained to develop curriculum for a future laboratory biosafety training initiative entitled "BioPrism". The BioPrism concept is based on the phenomenon that a ray of light (mentor) when passes through a Prism (PBSA) reveals 7 colors (Facilitators). The aim was to implement conceptual biosafety changes and extend this process in future. The 5-day BioPrism workshop emphasized diversified information and practical sessions including but not limited to: four primary controls of biosafety and biosecurity, containment levels, risk group classification, packaging and shipment of biological materials, waste management, emergency response, donning and doffing personnel protective equipment (PPE) and proper use of biosafety cabinets. Training without PowerPoint Presentations was a novelty of the workshop. Participants for the first BioPrism (n=41) workshop were selected from all over the country through stringent criteria based on their working experience in biomedical and clinical labs with minimum BSL-2 standards.

Results: The mean pretest result of 40% increased to 99.5% in final test after five days. The daily quizzes and BioPrism evaluation record revealed significant differences among the knowledge acquired, demonstration of skills and satisfaction ($p \leq 0.01$) of various participants. The overall understanding of biosafety, four primary controls of biosafety and the behavioral changes in effectiveness of these primary controls, in limiting laboratory acquired infections (LAI's) was improved tremendously among all the participants ($\geq$ 99 %).

Conclusion: Keeping in view the outcome of this initiative, BioPrism can be considered as a right step towards extensive biosafety journey in Pakistan.

Outcomes: The successful theme of BioPrism can be utilized as a model for other regions as well. The paper further discusses the methodology and challenges faced during this success story.

BIOSAFETY AND BIOSECURITY CAPACITY BUILDING IN UGANDA (ID #24)

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Objectives: The Dutch National Institute of Public Health and the Environment (RIVM) has supported biosafety and biosecurity capacity building in Uganda within the context of the Global Partnership since 2014. For the training part of the project, a collaboration was initiated with the Uganda National Animal Disease and Diagnostics Epidemiology Center (NADDEC), which is the key veterinarian institute working with highly infectious pathogens. The aim of the training activities of this project was to enhance general biosafety and biosecurity awareness, safe and secure handling of samples and the development and implementation of SOPs, all integrated as train the trainer modules. From these training activities, we extracted recommendations for successfully conducting Biosafety and Biosecurity projects in Uganda.

Method: Training materials were customized for implementation, and made freely available electronically to the NADDEC for subsequent training activities in the country. SOP development was done in conjunction with existing NADDEC procedures.

Results: Over the course of two training sessions, 45 participants from the NADDEC, their subsidiary regional and district laboratories, as well as students from Makarere University and Veterinarian Inspectors were trained both in lectures and in laboratory practice. SOP development was exercised and implemented in the biorisk procedures. Additionally, NADDEC personnel have conducted five up-country training sessions for regional and district laboratory workers from July 2015 until May 2016.

Conclusion: The RIVM has successfully conducted Biosafety and Biosecurity trainings in Uganda, which resulted in the implementation of an institutional handbook of SOPs and supported subsequent trainings conducted by NADDEC.

Outcomes: Although the training activities were initiated prior to the development of the Global Health Security Agenda (GHSA) Roadmap in 2015, we found that aligning activities with existing Biosafety and Biosecurity initiatives such as the GHSA, but also the Uganda Ministry of Health, and affiliated ministries, resulted in higher compliance of participants, and improved embedding in national networks. Also, it is crucial to acknowledge local biologicals risks, since off the shelf trainings may be of little practical use.

DEVELOPMENT OF A BIORISK MANAGEMENT TRAINING CURRICULUM IN LIBYA (ID #25)

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Objectives: Biorisk management (BRM) is a management system approach which seeks to integrate concepts traditionally associated with laboratory biosafety and biosecurity to help biological facilities effectively evaluate and minimize biological risks. This project was aimed at the development of a BRM training curriculum to allow the development of a comprehensive training program for undergraduate students in BRM at the Department of Medical Laboratory Technology, Faculty of Medical Technology at the University of Tripoli.

Method: A survey tool was developed to evaluate the need in this population of Libyan medical laboratory technologists. A training curriculum with a focus on biosafety and biosecurity elements for an undergraduate student population was developed. Finally, an implementation plan for training at least 2 skilled teaching staff members to support the course roll-out was developed.

Results: The training curriculum was successfully implemented at the University of Tripoli.

Conclusion: This project played an important role in the implementation of BRM in laboratories of health facilities, universities and research centers in Libya.

Outcomes: This was the first opportunity for the implementation of a training program in biorisk management in Libya, and the development of this curriculum will provide a foundation for implementation of BRM across the country.

60th Annual Biological Safety Conference Poster Abstracts

EVALUATION OF NINE POSITIVE-PRESSURE SUITS FOR USE IN THE BIOSAFETY LEVEL 4 LABORATORY (ID #26)

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With the increasing number of BSL-4 laboratories entering the planning or operational phases worldwide, the availability of positive pressure suits that provide the highest level of worker protection without hindering performance is of utmost importance. The present study describes a comprehensive analysis of nine positive-pressure suits from five different manufacturers, focusing on both mechanical properties of suit materials as well as user comfort through objective readings and subjective feedback.

Objectives: The goal of the present study was to critically evaluate a panel of positive pressure suits, including models widely used in various BSL-4 facilities as well new to market models, for use in the BSL-4 laboratory and large animal cubicle.

Method: *Material Testing.* Following a 5-day exposure to 5% Microchem-Plus, the resistance of nine suit materials to puncture, abrasion, and flex-cracking was tested in accordance with international standards to determine potential detrimental effects of the chemical shower on suit performance. *Suit testing.* In a mock-BSL-4 training laboratory, positive pressure suits were assessed through data collected from a group of experienced volunteers (n=5 per suit) after completing a set of predefined tasks. CO2 accumulation and decibel levels in the visor area were measured using a wireless CO2 monitor and externally calibrated microphone, respectively, while responses to a 20-question survey were scored and averaged for each suit tested.

Results: *Material Testing.* Exposure to 5% Microchem caused little change in mechanical properties of most suit materials with respect to flex-cracking and abrasion resistance. Nearly all suit materials (7/9) showed a small decrease in resistance to puncture following treatment, though they all outperformed even the untreated material from the most highly utilized BSL-4 suit by a factor of two. *Suit testing.* Accounting for multiple factors affecting user comfort, ranging from donning and doffing to gloving mechanisms and overall suit construction, comparison of survey responses by study volunteers showed a clear preference for two of the suit models tested.

Conclusion: The basis for selection of positive-pressure suits in a given institution is multifactorial; however the results presented will aid laboratories in the planning phases and those considering broadening the types of suits available to staff. Highlighting a number of features associated with enhanced user comfort as well as overall performance, the results presented indicate suit designs that appear better suited than others to both the BSL-4 laboratory and large animal cubicle settings.

Outcomes: The results from this research project have been shared with the BSL4ZNet partners, which include high profile laboratories on four continents as well as two new BSL-4 large animal facilities in pre-operational phases. While not a direct objective, the authors hope that suit manufacturers may incorporate results obtained into design of new suit models geared specifically for the BSL-4 laboratory or large animal cubicle.