BBIC

Biosafety and Biosecurity Training

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Neither would have been possible without the generous contributions of time, knowledge and expertise of the following:

Ruth Berkelman, Emory University
Sean Kaufman, Emory University
Lee Alderman, Emory University

Rima Khabbaz, Centers for Disease Control and Prevention
David Bressler, Centers for Disease Control and Prevention
Dwayne Lassky, Centers for Disease Control and Prevention

Stan Lemon, University of Texas Medical Branch
Jim LeDuc, University of Texas Medical Branch
Tom Ksaizek, University of Texas Medical Branch
Dee Zimmerman, University of Texas Medical Branch
Ann-Sophie Brocard, University of Texas Medical Branch
Miguel Grimaldo, University of Texas Medical Branch

Cover photo: Lee Alderman demonstrates proper stick procedure to a fully suited Professor Khalid Temsamani at Emory University. (Photo © Tim Trevan)

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Biosafety and Biosecurity International Conference
Regional Training Centre Feasibility Committee

US Training Facilities Visit
21-25 February 2010

Visit Report

Executive Summary

Members of the Regional Training Centre Feasibility Committee visited biosafety training facilities at Emory University and University of Texas Medical Branch (UTMB), and held talks with training and facility design staff from the Centers for Disease Control and Prevention (CDC).

The overriding message on training was the need to change behaviours (as opposed to raising awareness or teaching knowledge). All agreed that this required knowledge, skills, behaviours, management buy-in and cultural change at the organisation level. Thus training programmes that fail to address any part of the above adequately run the risk of failure or, worse, breeding a culture of helplessness and apathy towards biosafety and biosecurity. For CDC and UTMB, this is mitigated by institutional requirements for training certification before access to laboratories is granted to personnel.

With regards to the different Biosafety Level (BSL) requirements, it was clear that for skills and behaviours there was a quantum leap in practice between BSL2 and BSL3, whereas the transition from BSL3 to BSL4 was more of one of degree.

However, with regards to facility design, each level represented a quantum leap in terms of both complexity and cost of operation. The participants were offered an amazing opportunity to see both the laboratories and the infrastructure floors of the newly constructed BSL4 labs at UTMB. Apart from requiring its own power station to operate the facility, the utility bill for the facility is projected to be $3 million per year.

Clearly, operating mock facilities offers the cheapest option for the Regional Training Centres. However, other options include having an institutional link with an organisation with fully operational laboratories to which students can graduate after sufficient training in the mock lab, and setting aside time in an operational laboratory for the conduct of biosafety training. The downside of this is the requirement to thoroughly decontaminate the laboratory before any training session starts.

Background to the Visit

Extraordinary advances being made in biotechnology bring enormous benefits to society. But such advances also bring potential for accidents, sabotage or misuse. Natural biological risks also persist.

The Biosafety and Biosecurity International Conference (BBIC) Process is a mechanism which aims to enable the countries of the Middle East and North Africa (MENA) region to identify the biological risks to which they are exposed and mitigate them through the development of national and regional biosafety and biosecurity strategies underpinned by legislative, human and physical infrastructure.

The first BBIC was held in Abu Dhabi in November 2007. It was organised by the International Council for the Life Sciences (ICLS) and the Abu Dhabi Environment Agency (EAD) to examine biological threats in the MENA region and how to mitigate them. During the course of the conference, speakers enumerated many areas in the biosafety and biosecurity field where much work remained to be done in the region. A Core Group convened to turn this 'wish list' into a conference statement, which was adopted by acclamation during the final session of the conference and issued along with a press release.

The Core Group, sponsored by EAD, met again in Abu Dhabi in May 2008 to develop further the ideas contained in the conference statement. As a result of its deliberations, and based on a draft prepared by the ICLS in advance of the meeting, the Core Group produced a Framework Document entitled 'Developing Biosafety and Biosecurity Strategies for the MENA Region'.

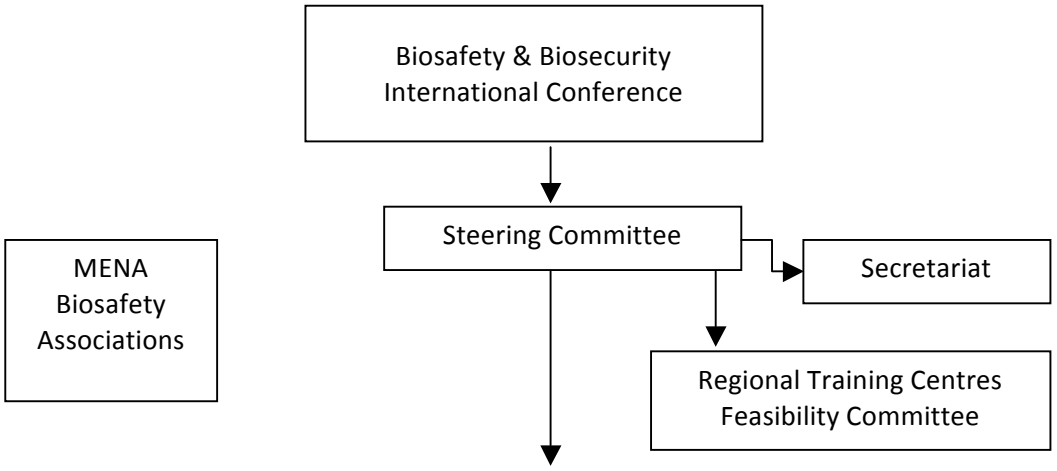
The second Biosafety and Biosecurity International Conference was held in Casablanca in April 2009. Four breakout groups examined the Framework Document in detail and made suggested amendments. The conference adopted the Framework Document, with the breakout groups' amendments, by acclamation as the roadmap for developing biosafety and biosecurity strategies in the Middle East and North Africa.

The Conference also issued the Casablanca Declaration plotting the way forward. This included, inter alia, recommendations to:

- hold biennial Conferences
- establish working groups to work on the technical issues to design and implement national strategies
- establish a Steering Committee to govern and manage the process

- establish a committee to assess the feasibility of building one or more biosafety and biosecurity training centres for the region. The UAE, Jordan and Morocco voiced interest in hosting such centres
- create national and regional biosafety associations.

As a result, the BBIC Process is now an independent process with its own decision-making structures:



Working Groups*			
I	II	III	IV
Human Capital Development	Institutional, Physical & Legal Infrastructure	National & Regional Prevention & Preparedness	Policy-Making
*Working Groups I & II may hold joint sessions, as may III & IV			

The first meetings of the Steering Committee and the Regional Training Centres Feasibility Committee were held in Jordan in July 2009. At the meeting, regional participants heard from the WHO, the UN and US experts on the Western experience of teaching biosafety and biosecurity to life sciences professionals and the implications for training centre design. There was a long, free-ranging and fruitful debate about the demand for training in the region, the type of persons who could afford to fly to another country for this training, the need for politically influential champions, and the problems with maintaining funding.

The sense of the meeting was that the Royal Scientific Society in Jordan would proceed with a commercial, dual-use facility which would offer biosafety and biosecurity courses in the same laboratory facilities as the Society would use to offer laboratory testing services for air, water and soil. Separately, Morocco would look to host a regional training centre with some sort of international standing to teach the range of biosafety and biosecurity courses, primarily to laboratory directors, and trainers of the trainers. It was tentatively agreed that this should be a mock

laboratory, to ensure its availability for training and to guard against 'mission creep'[1], as well as to reduce construction, maintenance and operation costs, and that there should be a formal link with the Institut Pasteur so that students could apply their mock laboratory training in a real lab. In the UAE, EAD agreed to wait until after both the Jordanian and Moroccan centres were operational to assess whether there was a need for a third training centre either in terms of demand volume or a specific niche of training that remained uncovered.

The meeting decided that it would be useful for members of the Regional Training Centre Feasibility Committee to visit existing biosafety and biosecurity training facilities in the United States to get a better first hand appreciation of the pros and cons of various facility design features and the types of curricula and target audiences which were the most in demand and successful.

The aim of the visit was to provide the regional participants with information and a sense of what is required to build a successful training centre, in order to assist them in their efforts to assess the feasibility of establishing Regional Training Centres and, if the decision is to proceed with training centres, the best design of both the facility and the curricula. An additional aim of the visit was to facilitate the development of a network of relevant experts and of potential partnerships for follow-on support and implementation activities.

Lee Alderman, Dr Hayek, Professor Temsamani, Professor Hassar and Dr Hmoud listen to Sean Kaufman present on Emory University Biosafety Training courses. (Photo © Tim Trevan)

[1] i.e. to guard against a 'wet' training laboratory being taken over for 'higher value' non-training purposes, resulting in training activities being squeezed out.

Logistics

The visit was funded by the Nuclear Threat Initiative (NTI), with in-kind contributions from the ICLS. The visit was scheduled for 22-26 February 2010, with the intent to visit the training laboratories at the CDC, Emory University and UTMB. Invitations were issued to participants from EAD, the Royal Scientific Society of Jordan (RSS) and Morocco.

Unfortunately, the participants from EAD (Drs Bashir and Hussein) were unable to obtain US visas in time for the visit. This also meant that the visit to the CDC laboratory had to be called off, as security clearances required full visa details for the entire party 6 weeks in advance. Given that efforts were being made until the last minute to secure a visa for Dr Bashir, this meant that that deadline was missed. Consequently, the participants met CDC experts at the Emory Conference Center Hotel, rather than in the CDC laboratory.

The itinerary for the visit is found at Appendix I.

The participants congregated at the Emory Conference Center Hotel on Sunday February 21 2010:

Professor Mohammed Hassar, Director, Institut Pasteur Morocco
Professor Khalid Temsamani, President, Moroccan Biosafety Association
Dr Bassam Hayek, RSS
Dr Nisreen Alhmoud, RSS
Tim Trevan, ICLS

The ICLS and the participants would like to thank NTI for its funding of this visit, and the visited facilities and experts for their generous hospitality and sharing of their wisdom.

Biosafety poster at Emory University. (Photo © Tim Trevan)

Meetings

Emory University

The participants met at 0800 hours on Monday February 22, 2010 with Sean Kaufman and Lee Alderman from Emory University's Center for Public Health Preparedness and Research. The programme for the day is attached at Appendix 2, comprising a combination of classroom lectures, classroom exercises and laboratory exercises.

In the ***first session***, Mssrs Kaufman and Alderman discussed the lessons that, over the years, the Emory programme has learned about Behavioural-Based Biosafety Training. These included:

1. The importance of having a measurable goal for training;
2. The quality of the trainers. In this regard, it was noted that experts are not necessarily the best trainers. The purpose of training is to change behaviours, not just to impart knowledge, and for that changed behaviour to be lasting. This requires an effective training team, merging good subject matter experts with good trainers (i.e. with people who understand the science of teaching), and adjusting the training to the needs, context and culture of the end users;
3. Adjusting the programme to who is being trained. Training is not a one-size fits all. Experience shows that most classes comprise:
    a. Novices, who want to know why;
    b. Users, who want to know how; and
    c. Experts, who want to know when and where;
4. The need to push students hard and to place them in stressful situations in order to create environments in which they can learn skills. Students need to learn what they do not know, and that is uncomfortable for them. Long days with tough exams are a principal means of pushing students to their limits. This has the added advantage of making the students proud of completing the course, thereby helping both to sear the lessons into their consciousness and to encourage them to become ambassadors for what they have learnt. The harder the training, the more having the certificate means – it means something to the students because they know that they had to earn it. At Emory, the average course is 40 hours, conducted over the period of one week, with the days running from 0730-1830 hours each day. The days are split into three presentations and examinations. But, to iterate, this means that the students leave proud of what they have earned, which means the lessons they have learned last longer;
5. Measuring the impact of training. One fact is that students rate their own lab's performance worse after their training than before. For the training to succeed for them in their home environment, the training also has to prepare students for going back to their own labs post-training. This raises at least two issues:

    a. Students should not be trained into accepted helplessness, i.e. they should not leave the training course knowing that practice in their work laboratory is bad but feeling that they cannot change anything, because this will breed helpless acceptance of bad practice and will kill the energy to change and improve;
    b. Students need to know how to handle their laboratory's bureaucracy vis-à-vis how to change the laboratory practice for the better. If this issue is not explicitly addressed in the training course, training runs the risk of introducing conflict into the laboratory, which is counter to the objectives of best biosafety practice;
6. Training must recognise the equation: Plans + Behaviours = Outcomes. Most people are pretty good at drawing up plans, but are not so good at adopting the behaviours required to implement the plans. Outcomes do not happen without both plans and appropriate behaviours. For this reason, biosafety training must go beyond theoretical learning into skills and changing behaviours. Furthermore, behaviours are part of the organisational cultural environment. However, one cannot expect to change individual behaviours effectively if nothing is done to change the culture of the organisation. For this reason, Emory launched its On-Site training programmes. The aim of these is to train sufficient personnel at one facility so that the entire culture of the organisation can be changed to support the desired behavioural changes;
7. Experts become complacent in their behaviours, and relearn lessons only when they have an incident or a near miss. This means that laboratory users should have long-term training programmes, with ongoing training in pressurised situations where the trainers can provoke an incident in a controlled and safe environment in order to kick in the expert's relearning before he or she has a real life incident in a dangerous environment. In short, training should provoke incidents in a controlled and safe environment to ensure that laboratory professionals can operate more safely in their real life laboratories;
8. Training programmes have to be constantly changing based on feedback from participants and from new examples from real life. So, before signing up for a training programme, always ask how often the organisers update the programme;
9. Training programmes are not about getting participants to conform to your norms, but about getting the students to learn how to apply best practice principles to their own real life situations. Students will also have their own real life personal problems. Some may not be able to read or write, so need to be able to train based on skills and changed behaviours, and adapt exams to the backgrounds and capabilities of the students, e.g. by practical, or oral exams, rather than reading or written exams; and
10. Credit those from whom you borrow for training ideas. This promotes a collegiate and team approach to learning, and to developing and spreading the science of biosafety.

Mssrs Kaufman and Alderman stated that training only sticks for about 2 years. During the course of a training programme, students' scores will improve from 22% to 98% over a five day course, but given the same test a year later, will only score say 33%. With a second training course, these same students now scoring 33% will again improve to 97% over the period of a five day course, but a year later their score will be at a much higher 55% ,and so on. Thus the baseline skill level increases with ongoing annual training, albeit still with ups and downs between training sessions.

Mssrs Kaufman and Alderman also noted that change is easier to bring from the outside so, even with the best of in-house training programmes, outside trainers will always have a role.

The session ended with a discussion about the biosafety and biosecurity training needs of the MENA area.

The ***second session*** was devoted to a visit to the Emory University Training Laboratory where the participants were given a practical run through the mock lab.

All the participants partook in the exercise of putting on gloves, contaminating them with a simulant, taking off their gloves with eyes closed, and then using black light to show how contaminated their hands were. This made a particularly visual and lasting impression of how behaviour is more important than knowledge in actually taking gloves off correctly without contaminating oneself in the process.

The next exercise had all the participants contaminate their hands with a simulant, go to bathroom and wash their hands. After thorough washing and drying of their hands, black light was used to show where contamination remained – i.e. where are the hardest parts of the hands to clean properly (the cuticles, nails, around rings, cracks, calluses). The black light was then used to show how contaminated the bathroom sink, walls and floor had become. This strongly demonstrated how easy it is to recontaminate one's hands and feet after properly washing, and how one's shoes can track contaminant on the floor from splashes.

For the next exercise, Professor Temsamani suited up in a Tyvek suit, gloves, booties and hood. Mr Kaufman then introduced stress– he unplugged the battery for the hood and dropped it down Professor Temsamani's trouser leg. Professor Temsamani was then required to retrieve the battery pack, rehook it to the belt and plug the power back in, all without opening his Tyvek suit or exposing himself to contamination. The situation is stressful both because airflow in the hood is lost and also because the person heats up quickly without the cooling effect of the airflow. This exercise was repeated a number of times to show how real physical experience of the stressed situation more rapidly improves performance than purely theoretical knowledge of what one should do.

Mr Kaufman then showed how air flows in a properly operating cabinet and Mr Alderman demonstrated the proper procedure for dealing with finger sticks and

thigh stick. By having Professor Temsamani practice the stick procedure several times, Mr Alderman showed how students learn rapidly with practice, doing procedure faster and better with each successive iteration.

The ***third session*** was devoted to 'Evaluating Organisational Capacity'. Participants participated in an exercise to rate their own skills and the practice of their own laboratory, with the class responses being aggregated in real time. This exercise strongly underscored 'Lesson learned #5', and the fact that awareness raising not only results in students rating their current level of biosafety lower, but also makes them more susceptible to learning and behavioural change.

The ***fourth session*** addressed Standard Operating Procedures (SOP) evaluation and validation. After a discussion of the principles, the group undertook another exercise, with two groups writing an SOP for a simple procedure of folding a piece of paper four times in a given sequence of folds, with the other two groups then trying to implement these SOPs. This exercise underscored both how hard it is to write a precise and unambiguous SOP and how different people will interpret, or misread, the same instructions. In turn, this demonstrated the need for SOPs to be under constant appraisal and revision as necessary to ensure conforming behaviour amongst the SOP's target audience.

Sean Kaufman presents on the lessons learned from Emory University's biosafety training courses. (Photo © Tim Trevan)

Center for Disease Control and Prevention

The participants met with Mr David Bressler and Dr Dwayne Lassky from the CDC from 0930-1230 hours on Tuesday 23 February 2010.

Dr Lassky introduced himself as a consultant to architects and engineers building biocontainment facilities, with expertise in designing work flows, and assessing equipment needs and engineering maintenance requirements. He stressed that facility design only takes safety so far, mainly addressing secondary containment – primary containment must rely mainly on good biosafety practice.

Mr Bressler introduced himself as a virologist who previously worked at USAMRIID in both BSL3 and BSL4 labs on viruses including Ebola. He helped write Emory's BSL4 biosafety training programme. His current role is to oversee public health labs to ensure that they are read for both natural and bioterror incidents. A large part of his responsibilities devolve into training. His experience is that biosafety starts at the lowest level – those working in the laboratory must know why they are supposed to follow SOPs. He stressed that communications were key to successful biosafety programmes, and referred to the LRN network – a secure network through which recognized labs in all 50 states and labs from much of the English-speaking world can communicate on biosafety and biosecurity issues.

Turning to training centres, Mr Bressler reiterated a point made by Mr Kaufman – that the value of mock or 'dry' laboratories is that they allow trainers to train students using controlled accidents – creating an environment for students to learn under stressful conditions without severe consequences. But he noted that training centres are expensive, both in terms of paying to bring people to learn at them and in operating and maintaining them. That said, Mr Bressler considered a properly designed training centre to be invaluable for a number of training needs:

- How to perform risk assessments for agents, equipment and laboratories;
- How to draw up and update unambiguous and effective SOPs.

He suggested that a training centre should comprise:

- A classroom;
- A large open space for large pieces of equipment. He specifically suggested using a mix of different manufacturers' equipment so that students were exposed to different styles of equipment and controls;
- A mock BSL3 facility where students could learn to don and doff personal protection equipment (PPE);
- A mock BSL2 facility;
- Different models of biosafety cabinets so that students learn to identify and use the different types of cabinets; and
- At least one chemical fume hood.

As a money and space saving compromise, he suggested that one could build a large BSL2 mock facility with a "BSL3 procedures room" where BSL3 techniques could be taught and practiced.

Professor Hassar stated that mock facilities were useful and agreed that not all the equipment needed to be fully functioning. But he argued that some important equipment needed to be so that students could learn how to use, for example, a centrifuge safely. He thought that a mock laboratory with some functioning equipment would be a good compromise. He added that another important component of biosafety training that had not yet been mentioned was training for collecting and transporting field samples, and operating field laboratories safely. Mr Bressler agreed that that was an underserved field within biosafety training.

Dr Lassky noted that there was an alternative to the mock laboratory training facility approach. He reported that the Mexicans had recently built an impressive BSL3 facility for the State Public Health Laboratory at Vera Cruz which they used normally for diagnostic work and research but which they closed down once a year to dedicate to biosafety training in a 'wet' environment. Dr Hmoud asked if that meant it was possible to conduct training successfully in a 'working' laboratory. Mr Bressler confirmed it was but that it required the laboratory to be properly decontaminated before training was permitted to start.

Dr Lassky noted that, with the Vera Cruz example, most of the training was conducted in a classroom. He reiterated that most of BSL3 training could be conducted in a BSL2 facility. The main element lost by doing so would be the familiarisation of students with the differences between BSL2 and BSL3, namely the air handling and maintenance of the filters and HVAC systems.

He suggested that the nature of the Regional Training Centre would depend on who was being trained and what was being taught. For example, the Emory setup could not be used to train maintenance engineers. While the Emory facility could be used to train engineers in the use of PPE and how to react to accidents, it could not be used to train them in how to change out HEPA filters and how to decontaminate them.

Dr Lassky suggested that different curricula would be needed for different targets:

- Laboratory Directors; and
- Training the Trainers, who then would teach in-house scientists, laboratory technicians, maintenance engineers and staff, and cleaning personnel. For the in-house training, Dr Lassky stressed the importance of all getting the same basic training, so that each knew what the others were responsible for within the laboratory, but that the emphasis of the course should be adapted to what each profession needed in terms of skills and behaviours.

Mr Bressler agreed that it was important for everyone within the laboratory to be aware of everyone else's biosafety procedures so that everyone knew what lines not

to cross. For example, cleaners need to know what not to do vis-à-vis cabinets and other pieces of equipment.

Mr Trevan noted that Emory taught the importance of skills and behaviours over knowledge, and the dangers of teaching apathy if students could not implement their new learning upon returning to their labs. Dr Lassky said the important issue was changing the culture of the laboratory, which is a combination of knowledge, skills, behaviour and management, hence the need to have buy in for best biosafety practices from the laboratory directors.

Professor Temsamani asked who was trained in decontamination – laboratorians or everyone? Mr Bressler responded that at CDC biosafety training was a requirement for access to the laboratories for everyone. This was an institutional, rather than regulatory, requirement. Dr Lassky agreed. He also noted that:

Regulations ⇒ Implementation ⇒ Compliance Inspections

And that each stage incurred costs. This opened up another sideline business for training centre personnel – conformance and compliance consulting.

Professor Hassar noted that there were two obvious entry points for biosafety training – university students and public health laboratories. He added that, in Morocco, the universities had nowhere near the awareness of, or training in, biosafety issues as the public health laboratories. Mr Bressler agreed that these were indeed the obvious entry points for biosafety training. The Laboratory Response Network (LRN) built on this, linking laboratories in public health, national science foundations, food, environment, water etc… and enabling them to share experiences and learning opportunities. He added that the Eagleston Institute in Maine had been conducting biosafety and biosecurity training for many years and so might well be able to assist with the MENA regional training centres. They also conducted biennial training with the CDC through the Biosafety Symposium. He argued that the experience of CDC and the LRN pointed towards having both Regional Training Centres and places within each country where biosafety training could be conducted.

Dr Bassam then gave a presentation on the Royal Scientific Society of Jordan's (RSS) plans for a Regional Training Centre. He noted that the primary catchment area would be Jordan, Syria, Palestine, Lebanon, Egypt, Iraq and Saudi Arabia. Within Jordan, there were 40 public laboratories, 40 private laboratories and 10 university or environmental laboratories. The concept therefore was to build a Environmental Centre and Biosafety Laboratory. The focus of the training in a mock laboratory would be skills training, and an adjacent service laboratory would provide operational services up to a BSL3 level and conformance and compliance consulting. The Centre would develop a university training module and seek to trigger national regulation to set training and certification requirements for those working in laboratories. Thus the aim would be to start with addressing the national market

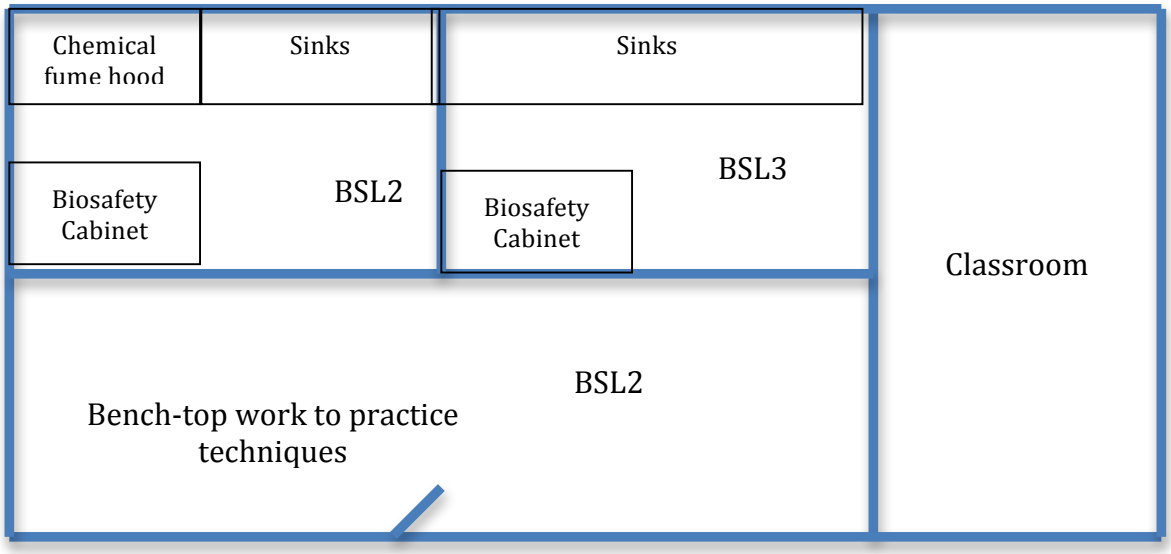
for biosafety training and thereafter to develop the regional market, with training both at the regional training centre and on-site.

Professor Temsamani described current thinking for the Moroccan regional training centre. The idea was for it to teach a more traditional biosafety and biosecurity programme, and for it to be a fully recognised international organisation to ensure availability of visas for faculty and students. Much of the training would be in the classroom, and skills would be taught in a mock laboratory c.f. the Emory setup. However, there would be an institutional link up with the Institut Pasteur of Morocco, so that students could graduate from training in the mock facility to training in a real fully functional laboratory. Professor Hassar noted that, even with mock laboratories, it was important that the structure be finished to the appropriate BSL standard, e.g. the windows should be flush with the wall, the wall finish should be smooth and water resistant etc… so that the students would learn through observation the correct finishes for each BSL. Dr Lassky strongly agreed, and said that this was especially so for the hand free sinks and tap design.

Based on the foregoing discussion, Dr Lassky offered up two training laboratory designs for the participants.

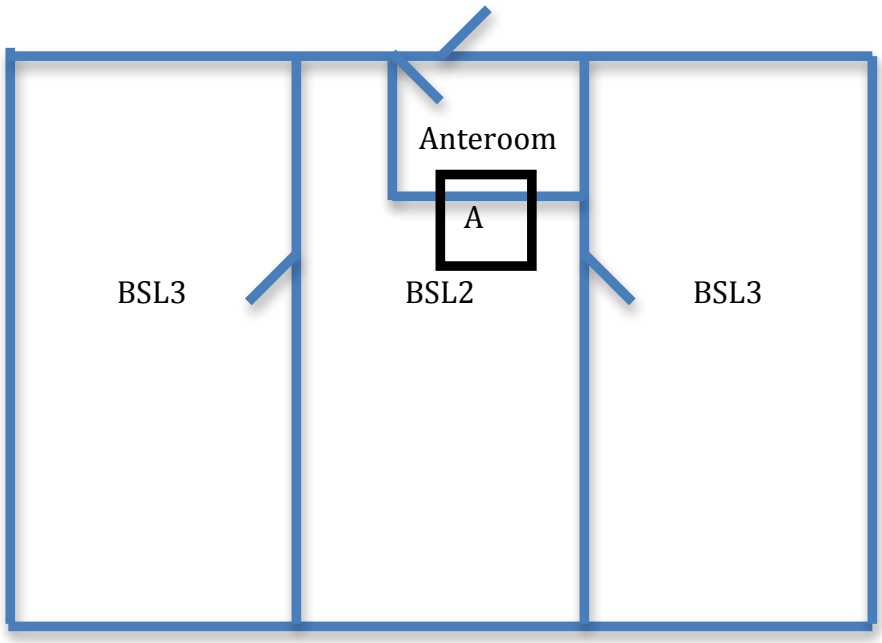
A glove box biosafety cabinet at Emory University's biosafety training facility. (Photo © Tim Trevan)

Option 1



NB International Health Regulations (IHR) allow the use of a BSL2 as the anteroom to a BSL3 laboratory. This design could be used with or without operating laboratories and animal rooms.

Option 2



(A = autoclave)

University of Texas Medical Branch, Galveston TX (UTMB)

The visit to UTMB was set up at the kind suggestion of Professor Stanley Lemon then John Sealy Distinguished University Chair and Director of the Institute for Human Infections and Immunology at UTMB. Given his pending departure from UTMB, the meeting was hosted by Professors Jim LeDuc and Tom Ksiazek.

Professor LeDuc introduced UTMB and its biosafety training programme. It is a medical and nursing school which combines a graduate programme and laboratory training. It is not a typical science university. It has pursued an interest in infectious diseases since the mid 1990s. With so many laboratories on its campus, it needed to develop its own training programme and facility. This has developed into a major biosafety and biosecurity training programme which it now can offer to personnel from other institutions.

Professor Ksiazek introduced himself has having previously been Director of the Special Pathogen Program at CDC. Before that, he worked at USAMRIID, in numerous US military field laboratories in Taiwan, Indonesia and Egypt, and conducted field research and outbreak investigation in the Congo, Uganda, Chile and Argentina. His personal interests therefore lay in both laboratory and field work, especially in developing countries where there were no operating BSL laboratories. For example, in Saudi Arabia, for lack of adequate facilities, he had to set up a Rift Valley Fever (a BSL3 pathogen) programme in BSL2 laboratories and in Australia he did BSL4 work in a BSL2 lab.

He noted that there were two types of fellowship available at UTMB:

- Sponsorship of a junior scientist looking to graduate to BSL3/4 research. This programme would support the scientist in getting his or her laboratory skills and certification up to the required level;
- Training facility maintenance engineers. Maintenance of BSL3/4 facilities is technically challenging and requires specific training.

All post-graduate students seeking to work in a laboratory must pass the appropriate training. They all start with the BSL2 training, as a bare minimum. After a suitable period working in a laboratory at that level, they may then progress to the next level of training, and so on up to BSL4. Mentoring was a continuous component of the training and a very important part of the process.

Professor Ksiazek then took the participants on a tour of the old BSL2 and BSL3 laboratories which were being refurbished. The notable feature of this tour is that laboratories need not be large rooms, but that prior design of the water systems and power outlets was key to laboratory functionality.

The participants then met with Drs Dee Zimmerman and Anne-Sophie Brocard from UTMB's Biological and Chemical Safety Program. They described their training course. The course elements are:

1. Classroom teaching on theory
2. Laboratory skills evaluation conducted in a mock laboratory
3. Remedial skills training as necessary
4. Mentoring training in a functioning laboratory
5. Skills evaluation
6. Certification and access to the laboratories of the BSL achieved in training.

Personnel background security checks are conducted during the training period and prior to conveying access to the labs.

These courses are very trainer intensive, given the emphasis on mentoring and constant monitoring of technique during laboratory work sessions. At the BSL2 level, each trainer monitors just 2 students in the lab. At BSL3 and BSL4, this drops to one to one. Furthermore, attention spans make laboratory sessions of more than two hours hard on both students and trainers.

Drs Zimmeraman and Brocard concurred with the Emory findings that skills drop off as time passes from the last training session, and hence that a programme of retraining is required for laboratorians in order to maintain their skills. They also concurred with Emory and Dr Lassky from CDC that it is a matter of organisational culture, rather than just skills and behaviour. In the case of UTMB, as with CDC, establishing this culture was helped by having an institutional requirement of training and certification before access to laboratories was granted.

After this, the participants were treated to an extraordinary tour of UTMB's fully constructed BSL4 facility, the Galveston National Laboratory (GNL) by Professor Ksiazek and Engineer Miguel Grimaldo, the Director of Institutional Biocontainment Resources at GNL (the engineer in charge of facility maintenance, safety and security). The visit's timing could not have been better – the facility had been fully commissioned, but not yet certified. So it was 100% ready to operate, but not yet in operation, so the participants could visit every part of the laboratory.

The lasting impression is of the exacting engineering standards for a BSL4 laboratory – how airtight the building must be, the implications for this in terms of wiring and plumbing, the need to autoclave all outgoing waste water, the need to HEPA filter all incoming air and double HEPA filter all outgoing air, the sheer size and noise of the air handling systems on the roof, and the amount of power needed to operate it all. Added to this were stringent physical security requirements, with both biometric access locks and extensive security monitoring systems. The participants were informed that the utilities budget for the facility was $3,000,000 per annum!

Engineer Grimaldo also informed the participants of his work in Haiti in helping them, even before the earthquake, to develop low technology and low cost solutions to operating laboratories safely while handling pathogens for which they were not designed.

Follow Up

As a result of this trip, the ICLS has asked its interlocutors at the visited facilities if they would be willing to serve as advisors on separate Advisory Panels for facility design and for curricula development. Everyone asked responded in the affirmative:

Volunteers for a Facility Design Advisory Panel	Volunteers for a Curricula Development Advisory Panel
1. Mr Lee Alderman, Emory University 2. Dr Dwayne Lassky, CDC 3. Engineer Miguel Grimaldo, UTMB	1. MrSean Kauffman, Emory University 2. Dr David Bressler, CDC 3. Mr Rod Frazier, CDC 4. Dr Anne-Marie Brocard, UTMB

The draft of this report was presented to the BBIC Steering Committee at its meeting in Abu Dhabi 18-19 May 2010.

With regards to the Advisory Panel on Facility Design, it was suggested that representatives from the European Biosafety Association (EBSA), Fondation Merieux, and the Kazakstan laboratory should also be invited to serve on this panel.

It was noted by committee members that the visit had been to some very sophisticated facilities whereas biosafety and biosecurity did not need to be that sophisticated. It was pointed out that Kazakstan has an unsophisticated laboratory comprised of a classroom with some 30 booths in which students were taught classical technique.

Another comment was that the emphasis in the report was on retraining professionals with substandard skills, whereas it was equally important and in many ways more productive to concentrate on instilling good practice and technique into newcomers to the field (e.g. university students) before they learned bad habits. In that way, the next generation would never have learned bad technique – for them good technique would be 'normal'. It was also emphasised that students should not be taught a set of rules of 'right' and 'wrong' ways to do things, but rather a set of principles and practices which they could apply to their own environment.

The representative from EBSA noted that in the UK and Europe, the idea of a training passport had taken off and been found useful - as laboratorians gain training, so their passports are updated to record achievements.

As for shared training/working laboratory facilities, it was argued that, where training programmes shared laboratory space with service providers, there was a tendency for the training to get squeezed out, especially during emergencies. This argued for the creation of dedicated training facilities.

There was a short debate on the shower/no shower issue. The question was asked "why would showers be needed – i.e. why were laboratory users getting contaminated and why were they not containing the risk at source?" It was suggested that designing all laboratories with showers might lead laboratorians to become complacent about primary containment and hence let their bench top techniques slip. Rather, it was argued, the specific biosafety and biocontainment features and procedures for each facility should be designed on the basis of a dedicated risk assessment of doing the planned research in that given laboratory space.

The committee noted that there was a real shortage of expertise in how to design BSL3/4 laboratories within the region. It was argued that facility design should be affected by affordability, risk assessment and research needs. It was agreed that a "How to assess biosafety and biosecurity training needs" handbook would be useful in this regard.

Finally, as a note of precaution in drawing up plans for training and laboratory facilities in the region, it was stressed how expensive BSL3 facilities were to operate. That problem was an order of magnitude higher for BSL4 facilities.

Conclusion

The ICLS remains ready to assist the Regional Training Centre Feasibility Committee (RTCFC) in its further deliberations on the subject of biosafety and biosecurity training centres in the MENA region. The ICLS further stands ready to assist to the extent it is able any of the member countries of the RTCFC which decide to proceed with establishing a regional training centre, particularly with regards to establishing Advisory Panels to offer expert advice on facility design and curricula development and to facilitating communications with these panels.

The Steering Committee at its meeting in Abu Dhabi recommended the following with regards to establishing regional training centres:

- Training should instill good practice and technique into newcomers to the field (e.g. undergraduate students) as well as retrain laboratorians;
- Training should focus on a set of principles and practices which trainees could adapt to the specifics of their own environment;
- Training passports should be adopted as a useful way of recording laboratorians' training level in real time;
- A "How to assess biosafety and biosecurity training needs" handbook should be written for use by laboratories and universities; and
- The group should establish two Advisory Panels of experts: one on Training Facility Design and the other on the Training Curricula Design.

Appendix 1 – Visit Itinerary

Sunday 21 February

1. Various times per personal ticket, arrive at Atlanta airport

Monday 22 February

1. 0800: Breakfast in the hotel.
2. 0900-1530: All day programme at Emory University. Departure from hotel at 0845.
3. 2000: Dinner for participants and presenters.

Tuesday 23 February

1. 0830: Breakfast in the hotel.
2. 0900-1230: Meeting in the hotel with CDC representatives from the Division of Bioterrorism Preparedness and Response to talk about biosafety and biosecurity training programme design (David Bressler) and from the Office of Health and Safety to discuss laboratory design (Dwayne Lassky).
3. 1500-1700: Meeting in the hotel with Rodrick Frazier and Ritchard Parry CDC/OD/OWCD re biosafety training in the MENA region. (cancelled, replaced with Regional Training Centre Feasibility Committee meeting)
4. 2000: Dinner for participants and CDC presenters.

Wednesday 24 February

1. 0800: Breakfast in the hotel
2. 1130: Departure from hotel to Atlanta Airport en groupe.
3. 1506: Arrival at Hobby Airport
4. 1545: Transfer en groupe to Galveston TX.
5. 1645: Arrival at The Tremont House.

Thursday 25 February

1. 0800: Breakfast in the hotel
2. 0900-1600: Programme at UTMB on biosafety training and design and operation of laboratories. Meet in hotel lobby at 0845.
3. Evening: Dinner for participants and presenters.

Friday 26 February

1. 1100: Pick up from hotel for those departing from Houston Bush International Airport.