Recent Incidences of Global Biosafety and Biosecurity Lapses in Laboratories Need Relook at Implementation of National Policies

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Summary

To practice safe use of bio-medical sciences and to prevent its misuse for bio-terrorism or bio-warfare activities, there is a strong need to adhere to the biosafety measures to protect the health of researchers, the public and the environment; protect against the technologies having the potential to be misused to threaten public health or national security; and abide by a voluntary code of conduct of research, based on the recognized ethical principles and values. The present article highlights the needs to promote capacity building in bio-risk management and promotion of good biosafety and biosecurity practices in India through information and awareness; speedy implementation of regulations and guidelines, education and outreach, risk assessment and risk management preferably through a dedicated Centre or Academy

The Recent epidemic of Ebola caused panic across the world and all efforts are being made to contain its spread. Recent years have also seen incidences of accidents and security breaches at well guarded and well managed bio-containment facilities in USA (Anthrax, West Nile Virus, and Tuberculosis), UK (Foot and Mouth Disease (FMD), USSR (Anthrax), Singapore (Severe Acute Respiratory Syndrome (SARS) and China (SARS) and many other countries.

Episodes of several vials of smallpox being left unattended in an unused storage room and temporarily closure of laboratories in Atlanta as potentially infectious live anthrax bacteria samples were exported to laboratories unequipped to handle them, the accidental contamination of a relatively benign flu sample with a dangerous H5N1 bird flu strain in a CDC laboratory and other such incidences reported in the media have again raised issues of biosafety and biosecurity at workplaces. Courage reported a study from University of Minnesota on 400 incidences of containment problems, spills and needle sticks and other sharp injuries in US government laboratories between 2003 and 2009.[1] Another unofficial report at a meeting in New Delhi in November this year highlighted over 1100 such incidence in USA between 2008-2012. These are issues of major concern. It is easy to extrapolate that if mismanagement of dangerous biological material can happen in USA and other developed countries, researchers in many other labs may also be indiscreet in following the biosafety and biosecurity guidelines and are responsible for causing major potential risks to the environment and human welfare. Many such accidents are under reported in other countries.

The accidental mishandling of the dangerous biological agents and toxins is attributed

more to inadequacy in following the prescribed guidelines in handling of these agents, poor understanding of the prescribed laboratory procedures, poor training of the laboratory associated personnel, transfer to and handling of inadequately inactivated preparations of dangerous pathogens in areas of the laboratory with reduced bio security levels and disposal of infected materials without proper disinfection. Trained Management and Biological Safety Officer with the support of the Institutional Biosafety Committees can effectively address the issues of biosafety in the institutional set ups.

International Outreach

International bodies like WHO, FAO, OIE and other biosafety agencies are associated with safe use of biological agents and toxins and highlight the biological challenges and improved awareness. WHO guidelines on health regulations and various UN formulated guidelines directly or indirectly deal with the management of crops and livestock. National initiatives based on obligations of States under the Biological and Toxins Weapons Convention (BWC) and UN Security Council Resolution 1540-2004 pursue and achieve common objectives of non-proliferation and prohibition to prevent use of bio-sciences for bio-terrorism or bio-warfare.

National Outreach

National biosafety and bio-waste activities are governed by legislation through State Pollution Control Boards. Under the Integrated Disease Surveillance Programme, a network of laboratories with biosafety practices and infrastructure is being set up. A field manual has also been developed for biosafety. All major hospitals have biosafety committees which meet monthly.

The Ministry of Environment & Forests and the Department of Biotechnology (DBT) are responsible for implementation of rules 1989 under the EPI act. DBT released Recombinant DNA Safety Guidelines (1990), Revised Guidelines for Research in Transgenic Plants and Guidelines for Toxicity and Allergenicity Evaluation of Transgenic Seeds, Plants and Plant Parts (1998) and guidelines for "Generating pre-clinical and clinical data for r-DNA based Vaccines, Diagnostics and other biological" (1999).

A dedicated dynamic & interactive website on biosafety by DBT reflects national and international guidelines, national rules & procedures with dynamic interaction with Institutional Biosafety Committees (IBSC) and advices regulation of modern biotechnology with objectives of protecting environment including human and animal health from the unintended adverse effects of GMOs and products thereof. Another website on "Indian GMO Research Information System (IGMORIS)" provides information on research work going on in Indian laboratories and IBSCs at various public funded institutions, universities, private R&D institutions and industries. An institutional framework comprising competent authorities overlooks the issues of biosafety in the country. Mashelkar Committee Task Force on r-pharma, 2006 recommended Procedure for Regulation of Recombinant Pharma Products derived from Living Modified Organisms (LMOs).

The biosecurity programmes involving responsible conduct and oversight of life sciences research is covered under the Prevention of Terrorism Act, 2002 and the Weapons of Mass Destruction and their Delivery Systems (Prohibition of Unlawful Activities) Bill, 2005. Export of SCOMET items requires a license under the Foreign Trade (Development and Regulation) Act, 1992 (FTDR Act).

M.S. Swaminathan Task Force (2003) recommendations to set up an independent National Biotechnology Regulatory Authority (NBRA), to regulate GMOs and the Agricultural Biosecurity Bill, 2013 to establish an integrated national biosecurity system covering plant, animal and marine issues may further combat threats of bioterrorism from pests and weeds. The Biomedical Waste Management & Handling Rules, 1998; ICMR Guidelines on Code of Conduct for Research Scientists engaged in biomedical research involving microbial or other biological agents; the Ethical Guidelines (2000) for the biomedical researchers and the Ethical Policies by DBT on the Human Genome, Genetic Research and Services (2002) sets the guidelines on principles and integrity, management and handling of biomedical wastes. However, the implementation arms are not very strong.

Magnitude of Problem in India

In India, the task to ensure biosafety and biosecurity in all public and private sector institutions involved in research and development and human healthcare and agriculture including animal and marine sciences is enormous. In human healthcare itself, there are more than 800 medical and healthcare R&D institutions; 575 medical colleges, 350 universities, more than 15,000 pharmaceutical and biopharmaceutical industries and unlimited number of healthcare entities and diagnostics laboratories handling biomedical wastes. Laboratories handling research on highly pathogenic organisms follow good laboratory practices and decontamination and disinfection procedures and a number of containment laboratories have been set up under human and animal health sectors. However, the concept of biosafety and biosecurity is not fully understood by each and every establishment handling infectious pathogens. To implement biosafety guidelines and to mitigate biological threats, a holistic approach is required on part of the administrative and technical authorities to adopt a systemic approach for successful bio-risk management. A scientific, rigorous, transparent, efficient, predictable and consistent regulatory mechanism and protocol for bio-safety and bio-security evaluation and related system need to be followed to meet these objectives.

Biosafety during lab work is an important concern in developing countries. A cross sectional study on the safety measures being adopted in clinical laboratories of India showed that a substantial number of laboratories do not follow the best practices as prescribed.[2] Another study in Pakistan showed that nearly 50 percent of the laboratories were lax as far as implementation of best practices are concerned.[3]

Containment Facilities

An important element of control for laboratory containment and research product protection is strict adherence to laboratory biosafety containment practices and good microbiological practice (GMP) based on widely accepted aseptic practices. In India a number of containment laboratories for human and animal health safety are being planned and about 30 such biosafety laboratories of the level of BSL3 or BSL2+ currently under operation, mostly at the laboratories of CSIR, ICMR and DRDO, vaccine industries and other research institutes. Two BSL4 facilities in India are already functional. While each laboratory requires a different level of management to bio-safety and bio-security, the premises, materials and workers in these labs, however, remain poorly supervised and managed by less trained personnel.

Risk Mitigation Strategies

Increased number of global incidence of mismanagement of dangerous pathogens at workplaces has necessitated revisiting the existing regulations on biosafety and biosecurity in the country and strict implementation of these laws. All out efforts should ensure that such research is conducted in accordance with the highest standards to focus on prevention of accidental or unintentional exposures to or releases of pathogens and toxins so as to protect workers including researchers, public, animals and the environment from accidents. Identification of technologies with potential to be misused and putting in place measures to protect against intentional theft, misuse, or release of biological materials must be prioritised.

Scientists involved in bio-medical sciences shoulder larger responsibilities and need to abide by a voluntary code of conduct of research, based on the recognised ethical principles and values and comply with the requirements of international conventions and treaties relevant to their research work.

In India, laboratory safety has to be an integral part of overall safety programme in hospitals and all this can be achieved by having a quality control programme in hospitals in general and laboratories in particular. Accreditation has to be made necessary and all laboratories can be graded as per their performance against a set of predetermined standards.

Awareness to large number of people involved in research and development of practices and procedures for both laboratory biosafety and laboratory biosecurity and biological waste management would require a systematic and holistic approach that may include:

- Improved understanding and management of the risks associated with accidental and deliberate misuse of biological agents,
- Develop strategies for biorisk management for R&D in bio-sciences and biotechnology in public and private sectors,
- Understand need of large number of academic and research institutions in basic sciences, medicine, healthcare, agriculture, environment etc.,
- Outreach to large number of hospitals, laboratories and healthcare providers,
- Outreach to growing biotech and pharmaceutical industries and their scientists in R&D
- A system of checks and balances could provide the assurance that the advances in life sciences are only used to protect life and not to destroy it. Issues requiring consideration may include:
- Increased awareness of risks of bio-terrorism, bio-safety, biothreat identification, prevention, and response among scientists and managers,
- Develop training programmes and materials for educating scientists on laboratory biorisk management for bio-safety and bio-security,
- Establish in universities and scientific institutions procedures to monitor research activities and mechanisms to prevent dissemination of information likely to be utilized for bio-terrorism,
- A bottom-up approach in formulation and implementation of bio-safety and bio-security policies through direct involvement of scientists,

- Adoption of policy of outreach to industry to inform and involve it in the process of evolution of bio-safety and bio-security policies,
- Training curriculum in bio-waste management and environment risk management of pharmaceuticals,
- Ensure good microbiological practices for responsible conduct and oversight of life sciences research that can threaten public health or national security,
- Awareness of and compliance with the requirements of international conventions and treaties relevant to their research work,
- Establish legal and institutional procedures and mechanisms for monitoring and regulation,

Here, Government level oversight can be aimed at policy for bio-risk management; the international level structured Global Bio-risk Management Curriculum has been developed and is a good reference for this task.

Government Efforts

The Ministry of Environment and Forests (MoEF), Government of India, is implementing a GEF/World Bank funded project on Capacity Building on Biosafety in context of the Cartagena Protocol. The project covers the assessment, management and long term monitoring and documentation of the risks to the sustainable use of biodiversity and to human health potentially posed by the introduction of Living Modified Organisms (LMOs). The project aims to strengthen the legislative framework and operational mechanisms for biosafety management, enhance capacity for risk assessment and monitoring, establish the biosafety database system and biosafety clearing house mechanism, support centres of excellence and a network for research, risk assessment and monitoring and establish the Project Coordination and Monitoring Unit (PCMU).

Biotech Consortium India Ltd. (BCIL) supported by DBT, organizes workshops on National Consultation on Biosafety aspects related to Genetically Modified Organisms; supports programmes on capacity building activities in biosafety including preparation of research documents, organizing conferences, workshops on key policy issues and publishing monthly newsletter "The South Asia Biosafety Program (SABP)".

Biorisk Management

The bio-risk management approach comprises biosafety, laboratory biosecurity and ethical responsibility by reducing the risk of unintentional exposure to pathogens and toxins or their accidental release; reducing the risk of unauthorized access, loss, theft, misuse, diversion or intentional release of microorganisms; and those suitable measures have been adopted and effectively implemented. It is important that a framework for continuous awareness raising for biosafety, laboratory biosecurity and ethical code of conduct, and training is provided.

Laboratory bio-risk management as defined under CWA 15793:2011 on laboratory biosafety and biosecurity includes the analysis of ways, development of strategies and their implementation to minimize the likelihood of the occurrence of bio-risks; methodology used to organize and analyze scientific information in order to estimate the probability and severity of an adverse effect (assessment) and measures to minimize this effect (mitigation); and establishing policies and practices for risk management in the lab (day to day as well as emergencies).

An effective bio-risk management programme would involve bio-risk assessment including, investigation into the nature of the biological materials and the procedures used to store, handle, and transfer and dispose those materials. This may include review of research proposals and identify hazards that the biological materials can cause in a laboratory. Bio-risk management procedures may determine the control measures, or mitigation strategies, to be used to minimize or eliminate the defined risk. Risk assessment and the concept of continual improvement on bio-risk management can efficiently address issues relating to biosafety and biosecurity

Bio-risk mitigation would include actions and control measures that are put into place to reduce or eliminate the risks associated with biological agents and toxins. It determines what can be done to manage the identified bio-risks. These control measures are grouped under the categories of elimination or substitution, engineering controls, administrative controls, practices and procedures, and personal protective equipment.

A critical mass of dedicated human resource is required to implement provisions of bio-risk management, which requires:

- Developing training curriculum for stakeholders, including policy makers, management bio-risk advisors, scientists, laboratory management, laboratory and industrial workforce,
- Organising training programs, workshops to train-the-trainers,
- Organising training programmes on bio-threats and bio-risk mitigation strategies for law enforcement official,
- Developing training implementation strategies including regional training centres,
- National Coordination Centre to oversee implementation of bio-risk management programmes.

Dedicated Training Facility

A panel discussion at the International Meeting on Host Parasite Interactions held at National Institute of Animal Biotechnology, Hyderabad on July 15, 2014 highlighted the issues involved with biosafety and biosecurity procedures faced by various stakeholders. Experts stressed on issues of information and awareness; implementation of regulations and guidelines, education and outreach, capacity building, risk assessment and risk management. In order to increase awareness and training on safety & security in research institutes, academia & industry, it was strongly recommended to the Government of India to have a fresh look at the implementation of the existing laws governing the biosafety and biosecurity to enforce effective bio-risk management in the country and filling in necessary gaps in capacity building. It was further suggested to set up a Bio-risk Management Training Academy (BRMTA), which would provide India an advantage and understanding on bio-risk management in the biotechnology sector.

The Objective of BRMTA would be to promote capacity building in bio-risk management and promotion of good biosafety and biosecurity practices in India through education and training, information dissemination and knowledge sharing in pursuit of the benefits of life science research. This will also ultimately foster culture of responsibility and code of ethics among the

researchers. The mandate of BRMTA may include:

- Ensuring bio safety measures so that research is conducted in accordance with the highest standards to promote safe, secure and responsible use of dangerous biological agents and toxins that have high-consequence for its potential to be dual use research of concern,
- Developing of programmes for awareness of the prohibition and requirements for bioterrorism preparedness to inter-alia industry, scientific and technological communities, armed forces,
- Developing specialized courses in bio-risk management; related policies, applicable regulations, audits, inspections etc.;
- Special courses to manage challenges and opportunities associated with facility risk assessment; laboratory certification; reporting laboratory-associated infections,
- Organising education & training programmes; short-term courses; workshops and symposia; and conferences (national and international),
- Preparing guidelines for medical surveillance and evaluation system,
- Wide dissemination of information through updated technical guidance documents, safety manuals, biosecurity plan, safe practices and standard operating procedures and emergency response plans,
- Outreach to large number of beneficiaries including individuals, institutions and industries through electronic media and periodic newsletters,
- Advising the Government of India about issues related to biological disaster management, international collaboration on bio-risk management and developing risk mitigation strategies,
- Establishing and strengthening collaborations with international bodies and other similar institutions involved with risk assessment and management programmes or developing curriculum in the area to improve understanding and management of the risks associated with accidental and deliberate misuse of biological agents.

Endnotes:

1. Courage K. H., Nearly 400 Accidents with Dangerous Pathogens and Biotoxins Reported in U.S. Labs over 7 Years, 2011.
2. Mustafa A., Farooq A. J., Quadri G.J. and Tabish S. A., Safety in Laboratories: Indian Scenario, Int. J Health Sci (Qassim), 2008, 2, 112-117.
3. Sadia Nasim et al. Bio safety perspective of clinical laboratory workers: a profile of Pakistan J Infect Dev Ctries 2012; 6(8):611-619.