Investment in biosafety and biosecurity: the need for a risk-based approach and systematic reporting of laboratory accidents to mitigate laboratory-acquired infections and pathogen escapes

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In the realm of high-consequence pathogens, laboratory-acquired infections (LAIs) and accidental pathogen escapes from laboratories can have far-reaching and severe implications for individuals, animals, and the environment. These occurrences are a great concern for a wide range of stakeholders, including laboratory workers, managers, those in the scientific research community and industry, policy makers, political leaders, and the general public. It is vitally important to take all necessary measures to mitigate the risks associated with such occurrences as the consequences of these events can be significant and long-lasting. Therefore, understanding the frequency and causes of laboratory accidents via the use of a systematic and transparent reporting mechanism is essential.

To reduce the occurrence of accidental pathogen escapes, experts recommend implementing an evidence-based approach that prioritises risk-based biosafety, biosecurity, and biocontainment while supporting laboratory sustainability.[1] This method is favoured over a one-size-fits-all approach, which is often inflexible and expensive to implement and maintain. A risk-based approach to biosafety management ensures safety for staff and the community by focusing on pathogen transmission routes, manipulations or procedures, and individuals.[2] This approach is recommended by WHO[3] and the World Organisation for Animal Health,[4] culminating in the Biosafety Research Road Map initiative to identify evidence gaps to guide applied biosafety research.[5] However, resistance to change, unfamiliarity, lack of evidence, and differing understandings of the guidelines can pose challenges when implementing this approach. Furthermore, the availability of adequately trained biosafety professionals experienced in the application of this risk-based approach is frequently limited in low-resource hospital and veterinary laboratory settings.

The occurrence of accidents resulting in LAIs or pathogen escapes is frequently attributed to errors or deficiencies in procedural protocols, highlighting the need for continuous improvement through root-cause analysis of the underlying causes. This approach should help to minimise the risk of LAIs and associated accidents and ensure that laboratory safety is a top priority in the future. Notably, such an approach would depend on (and promote) the formal reporting of laboratory mishaps and occurrences in a non-punitive manner. In addition, a process of documenting infectious pathogen exposure events not resulting in LAIs, together with near misses, should enhance our understanding of adverse occurrences that are preventable through mitigation-control strategies.

Although many nations might be without structured and open reporting systems, where they do exist, they can serve as useful examples. In the USA, reporting of laboratory-related incidents is required under the Occupational Safety and Health Act of 1970, which requires all employers to ensure that workplaces provide safe and healthful working conditions.[6] Under this Act, employers are required to report illnesses and injuries, although these are not necessarily investigated. In the case of the US Federal Select Agent Program, which administers high-consequence pathogens and toxins (known as biological select agents and toxins), the regulations require the immediate reporting of exposure, LAI, or any release outside of a primary containment device.[7] Elsewhere, the Public Health Agency of Canada has implemented the Laboratory Incident Notification Canada surveillance system,[8] the Singapore Ministry of Health has the Biological Agents and Toxins Act 2005 for the reporting of adverse incidents or activities,[9] and the UK's Health and Safety Executive has the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013.[10] To enable the greater sharing of information, these national reporting systems could inform the development of a transparent global reporting system, perhaps under the auspices of the appropriate multilateral international organisations, based on a no-blame model. Such a system could also benefit from the lessons learned from

the nuclear and aircraft industries, for example, which emphasise continual improvement.

On a global scale, investing in risk-based biosafety as part of a broader laboratory core management competency is of the utmost importance. However, there is a scarcity of skilled personnel with applied knowledge who can conduct risk-based assessments. Therefore, it is essential to invest in trained biosafety professionals who can advocate for adequate staffing for biosafety oversight, regulatory compliance, and transparent incident and accident reporting. The integration of accessible biosafety training programmes into higher education curricula is critical for changing the mindset and behaviour of future laboratory workers. Even in well resourced environments, the biosafety field does not have a formalised organisational structure and defined career paths, and there remains debate regarding whether credentials should be based on on-the-job experience, formal qualifications, or a combination of both.[11]

The successful implementation of global risk-based biosafety and biosecurity measures requires both political will and substantial investment in human resources and systems. Only then will a safer environment for laboratory staff and the public be achieved.

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*Stuart D Blacksell, Kathrin Summermatter, Zibusiso M Masuku, Kazunobu Kojima, Emma Ross, David R Harper, Keith Hamilton

stuart.blacksell@ndm.ox.ac.uk

Mahidol-Oxford Tropical Research Medicine Unit, Faculty of Tropical Medicine, Mahidol University, Bangkok 10400, Thailand (SDB); Centre for Tropical Medicine and Global Health, Nuffield Department of Medicine, University of Oxford, Oxford, UK (SDB); Institute for Infectious Diseases, University of Bern, Bern, Switzerland (KS); National Institute for Communicable Diseases of the National Health Laboratory Services, Johannesburg, South Africa (ZMM); Department of Epidemic and Pandemic Preparedness and Prevention, WHO, Geneva, Switzerland (KK); The Royal Institute of International Affairs, London, UK (ER, DRH); World Organisation for Animal Health, Paris, France (KH)

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