World Organisation for Animal Health

Ministry of Agriculture
Republic of Indonesia

In partnership with Canada

Behavioural Perspective:

Biosafety determinants

Dr. Jaison Blesson Kolenchery, MORU

Workshop on Biothreat Reduction in South-East Asia, June 2 - 3, 2026

Presentation Outline

- Pathogen value chain
- Importance of including behavioural considerations
- Biases and heuristics
- Social Cognitive Theory
- LABSAFE Project – Introduction
- Next steps

Vulnerabilities in the Pathogen Value Chain

Biological risk exists far beyond the lab bench. A strategic governance approach must secure every stage of a pathogen's lifecycle.



Risk Factors:

Viral spillover caused by inadequate PPE usage, poor animal handling precautions, and lack of personnel monitoring.

Risk Factors:

Leakage, theft, and documentation errors during transit, compounded by inadequate tamper-proof tracking or cold-storage depots.

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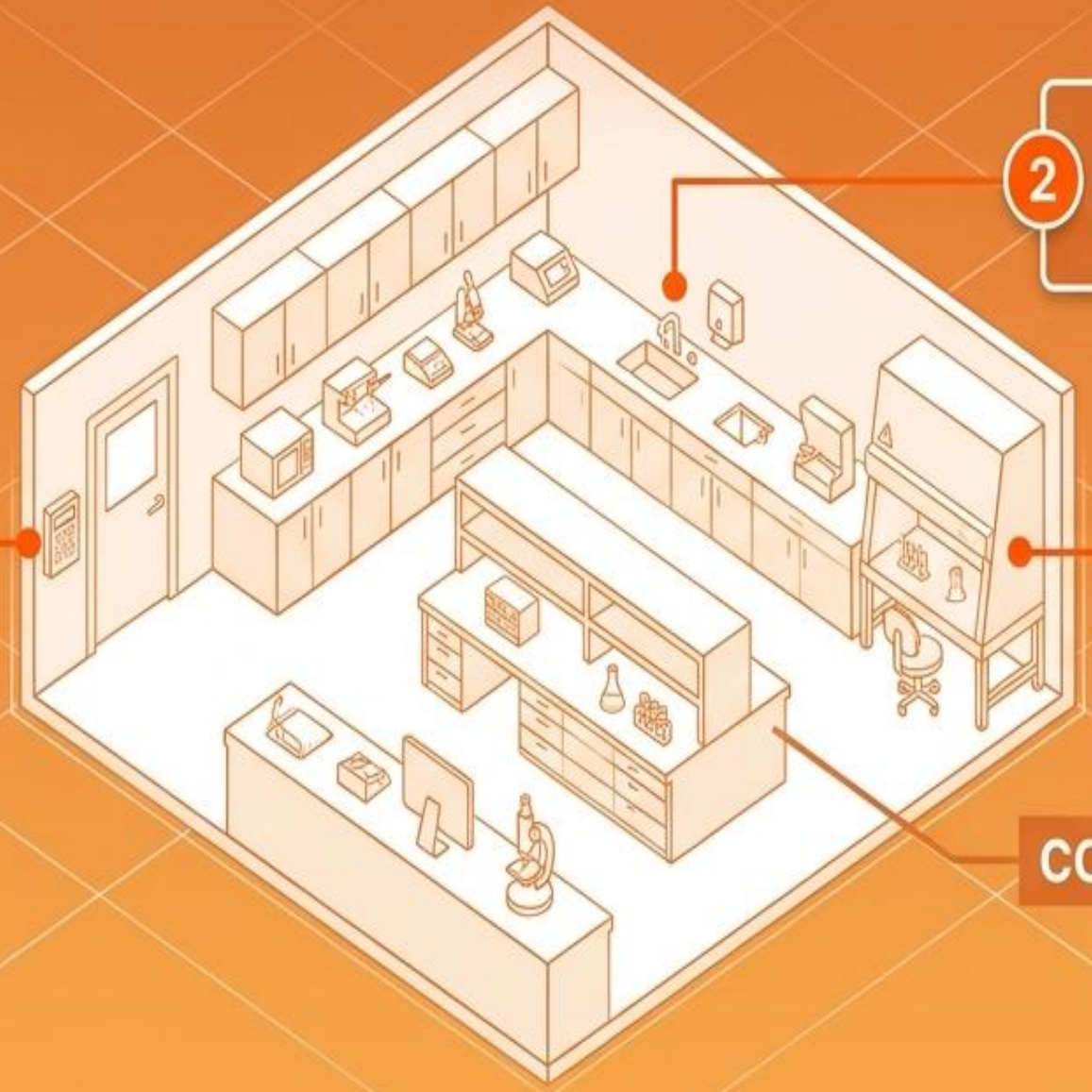
Protocol breaches in BSL facilities, inadequate oversight of gain-of-function modifications, and biobank safeguarding failures.

Risk Factors:

Improper disposal breaching biocontainment; lack of comprehensive segregation, packaging, and validation protocols.

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The Physical Deficit: Where Equipment Meets Behavior



Defining the Core: The Dual Mandate of Biological Risk Management

A mature laboratory system requires both. Strong biosafety without biosecurity leaves vulnerabilities to deliberate misuse; strong biosecurity without biosafety fails to protect workers.

BIOSAFETY

Core Focus

Preventing unintentional exposure, infection, or accidental environmental release.

The Threat Environment

Human error, equipment failure, spills, aerosols, bites/scratches, and poor handling.

Key Controls

- Good microbiological practices (GMP)
- Safety cabinets & containment
- Personal Protective Equipment (PPE)
- Validated decontamination & waste



The Evidence-Based Intersection

Both domains reject rigid, generic templates. They rely entirely on continuous, documented Risk Assessment. Controls must be dynamically proportionate to the actual work being performed, the specific biological agent, and the local laboratory context.

BIOSECURITY

Core Focus

Preventing intentional loss, theft, diversion, or malicious release of materials and data.

The Threat Environment

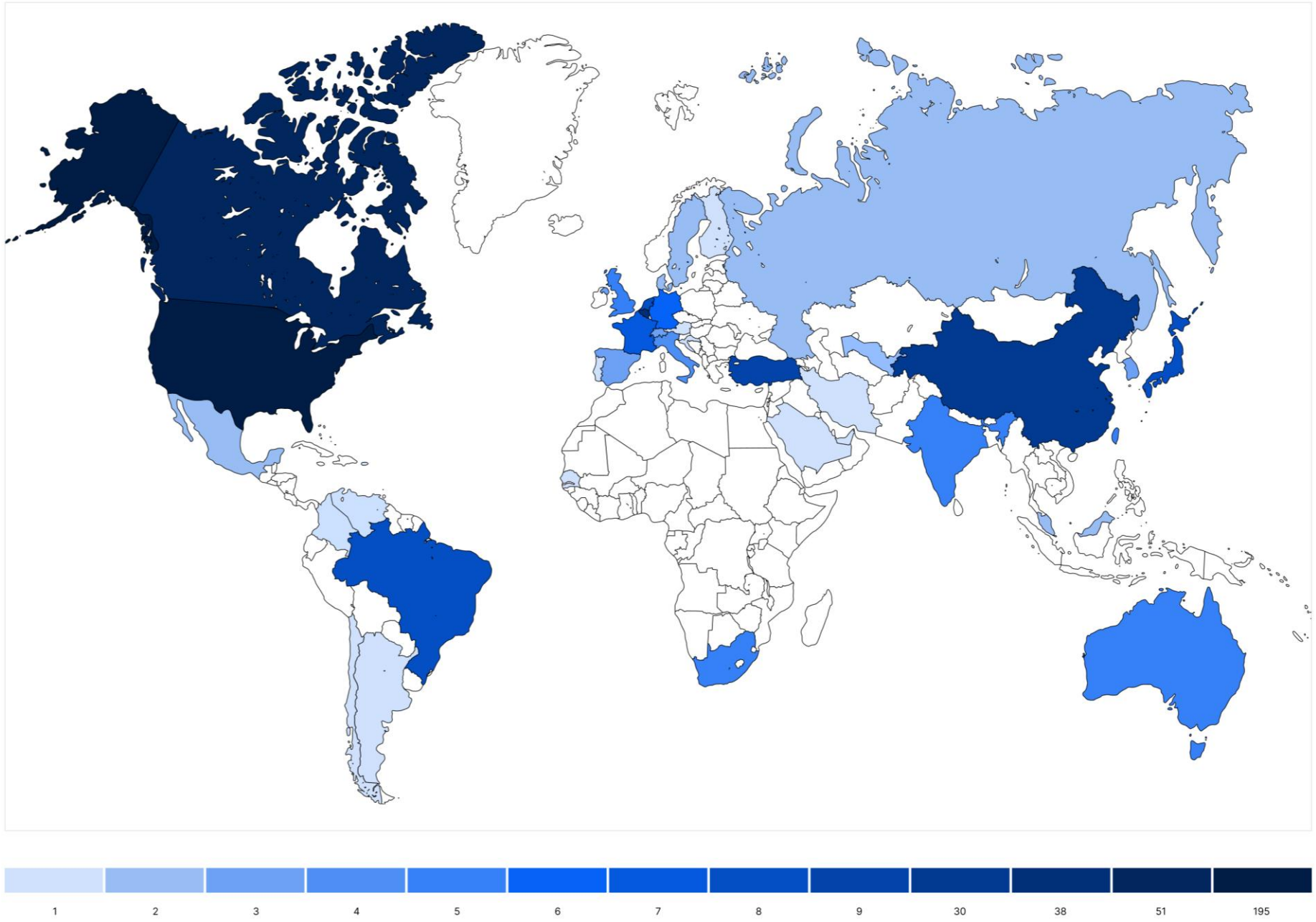
Insider threats, external theft, cyber-attacks, unauthorized access, and dual-use diversion.

Key Controls

- Inventory accountability & tracking
- Physical & digital access control
- Personnel reliability & culture
- Secure transport & chain-of-custody

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Published Biosafety Incident Records 2000-2025



The Empirical Reality of Laboratory-Acquired Infections

Analysis of **250 reports** and **712 human cases** (2000–2024) reveals **vastly divergent risk profiles** between research and clinical environments.

Clinical workers face a 4.76x Higher Relative Risk of developing an infection upon exposure compared to research personnel.

Research Laboratories

1,632 | Total Exposures

276 | Confirmed Cases (16.9% Attack Rate)

8 | Fatalities (Higher Case Fatality Rate: 2.9%)

Primary Pathogen Threats:

Brucella spp. (99 cases), Hantavirus (47 cases), and SARS-CoV-1 (5 cases).

Clinical Laboratories

282 | Total Exposures

227 | Confirmed Cases (Massive 80.5% Attack Rate)

5 | Fatalities (Case Fatality Rate: 2.2%)

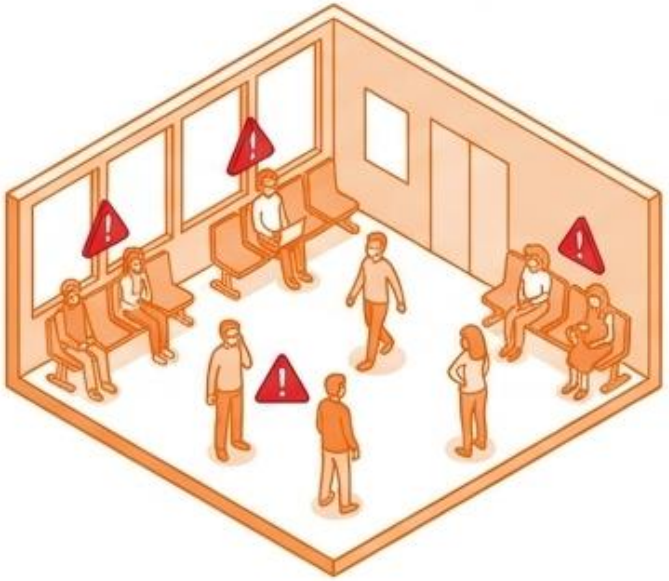
Primary Pathogen Threats:

Staphylococcus spp. (126 cases) and Mycobacterium spp. (29 cases).

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The Universal Failure Point is the Human Factor

PUBLIC HEALTH



Erratic adherence to pandemic protocols and social distancing.

80%

of laboratory infections are attributed to human not equipment failure

CONTROLLED LABS

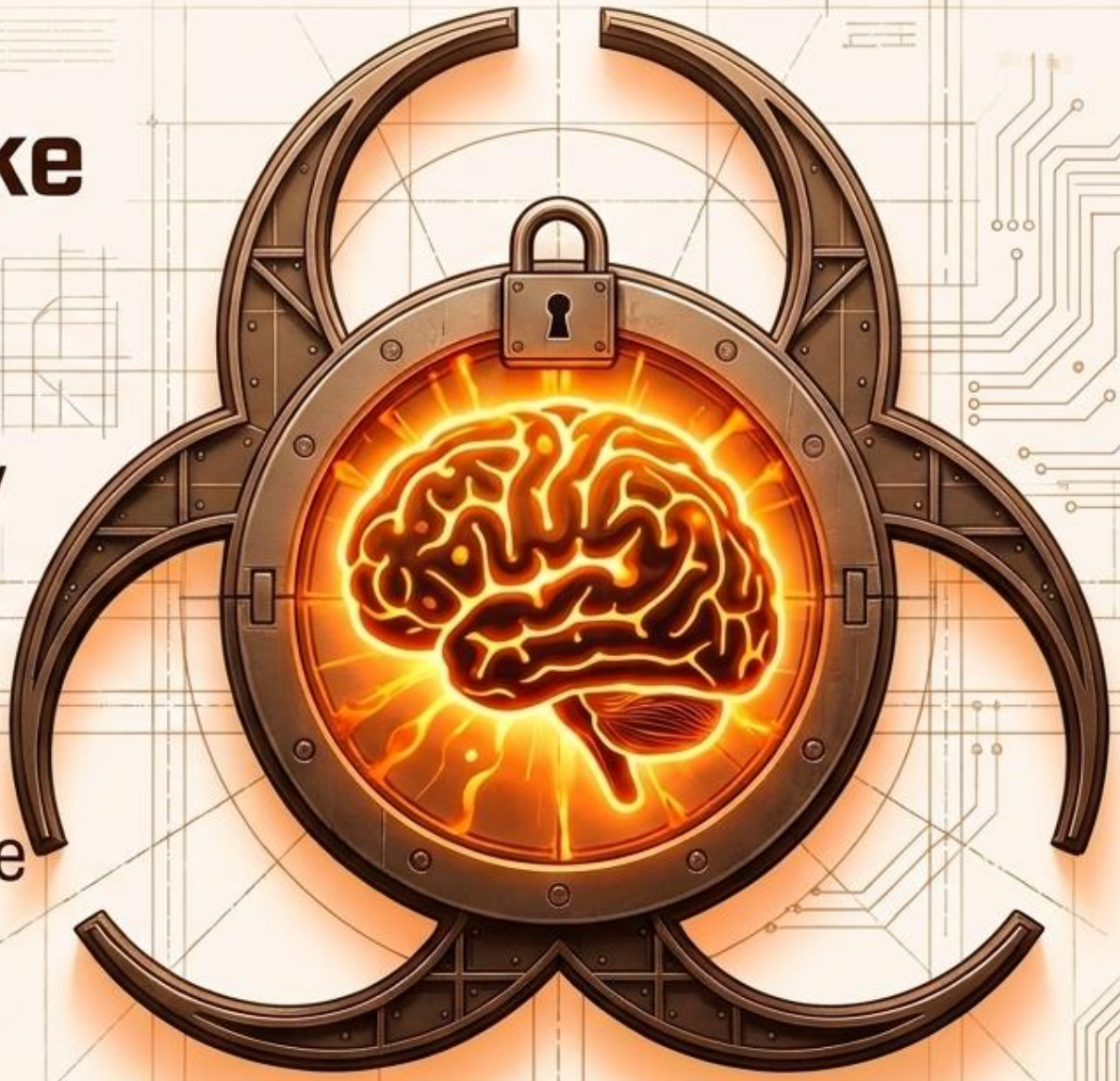


Human failure in rigid, high-security BSL-2 environments.

Despite mandatory rules and severe risks, non-compliance is ubiquitous. To fix systemic biosafety, we must first decode the psychology of adherence.

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Cognitive Hazards: Why Smart People Make Dangerous Mistakes



Why do highly educated, rigorously trained scientists cause **nearly 70% of these incidents**? They are victims of universal human **cognitive biases**. Training and baseline education alone cannot override **hardwired mental heuristics**.

REFERENCES: [1] Biosafety and Biosecurity Journal, Vol. 4, Issue 2, 2022.
[2] National Institute of Health, 'Laboratory Safety & Human Factors' Report, 2023.

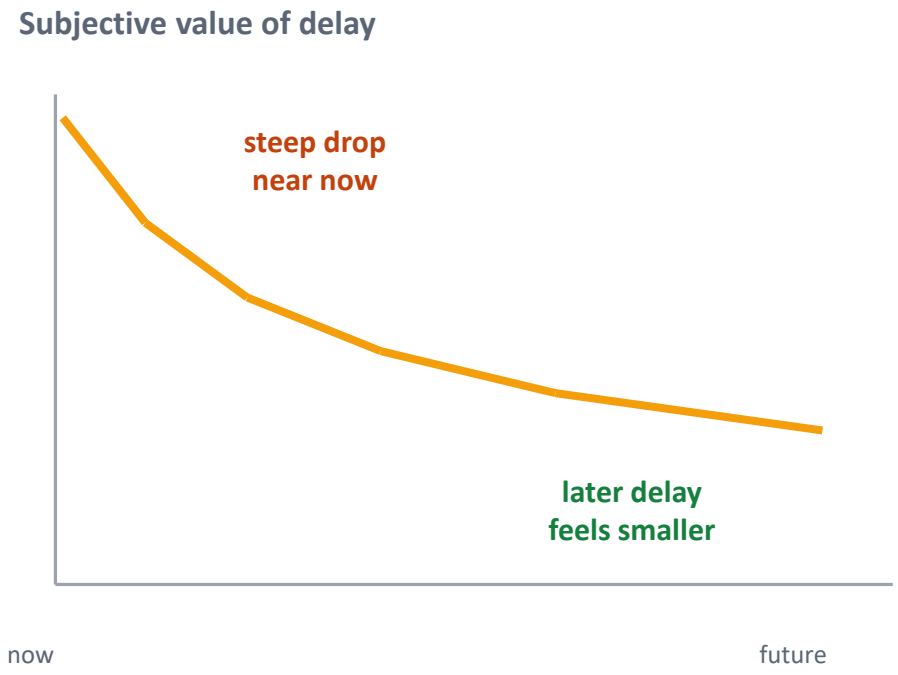
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$100 today	vs	$110 in one week
$100 in 52 weeks	vs	$110 in 53 weeks

$100 today vs **$110 in one week**

$100 in 52 weeks vs **$110 in 53 weeks**

Same $10 gain. Same one-week wait. Different decision when “now” disappears.

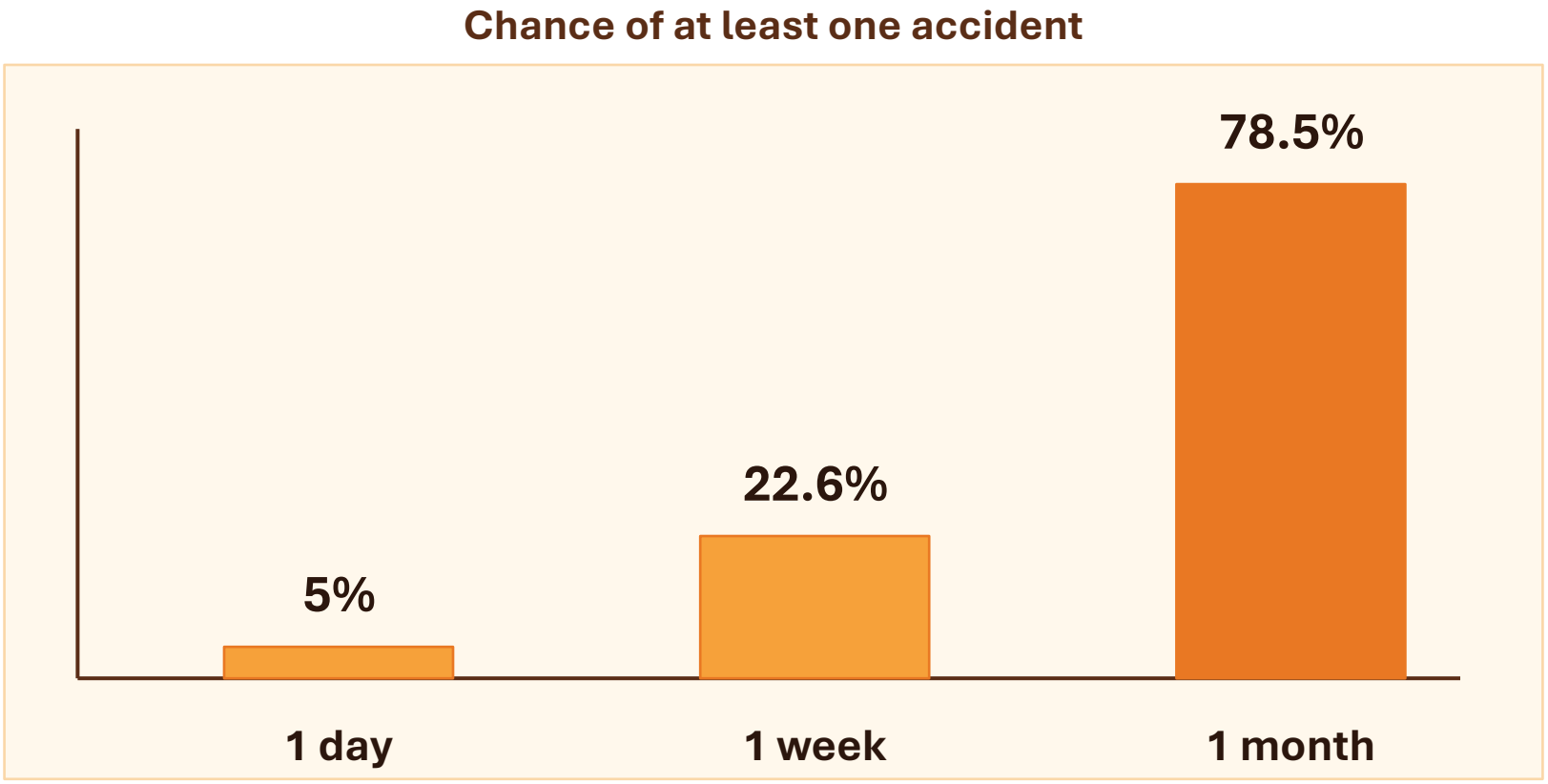


The Cognitive Hazard Matrix

Cognitive Bias	Laboratory Symptom	Threat to Biosecurity
The Attitude-Behaviour Gap	Professionals routinely shortcut slow rules to save time.	High baseline education does not guarantee physical compliance.
Optimism Bias (Expertise Immunity)	Veteran researchers falsely believe their elite skills exempt them from standard rules.	Systematic underestimation of personal risk and leaks.
Goodhart's Law	Workers game the system by hiding minor incidents to protect funding.	Zero-accidents strict targets lead to unreported hazards.
The Omission Bias	Viewing passive neglect (delayed logging, improper disposal) as safe.	Critical everyday threats are masked from official view.
Hyperbolic Discounting (Present Bias)	Choosing a small immediate reward (skipping airlock checks to go home).	Immediate comfort overrides abstract, long-term infection risks.

Accident Risk: More Events, Higher Chance

Assumption: each event has an independent 5% accident risk.



Why it rises

You are not taking one risk. You are repeating the same risk many times.

Formula

$$1 - 0.95^{n}$$

n = number of ride days

Law of Really Large Numbers

A tiny chance can become likely when there are enough opportunities.

One chance

1 in 1,000,000

Very unlikely

Many chances

100,000,000 tries

Now it should happen

Expected result

≈ 100

occurrences

Simple rule: expected events = probability × number of opportunities

Rare per attempt does not mean rare overall.

Social Cognitive Theory: A Dynamic Framework for Behavior Change

Key Constructs for Intervention

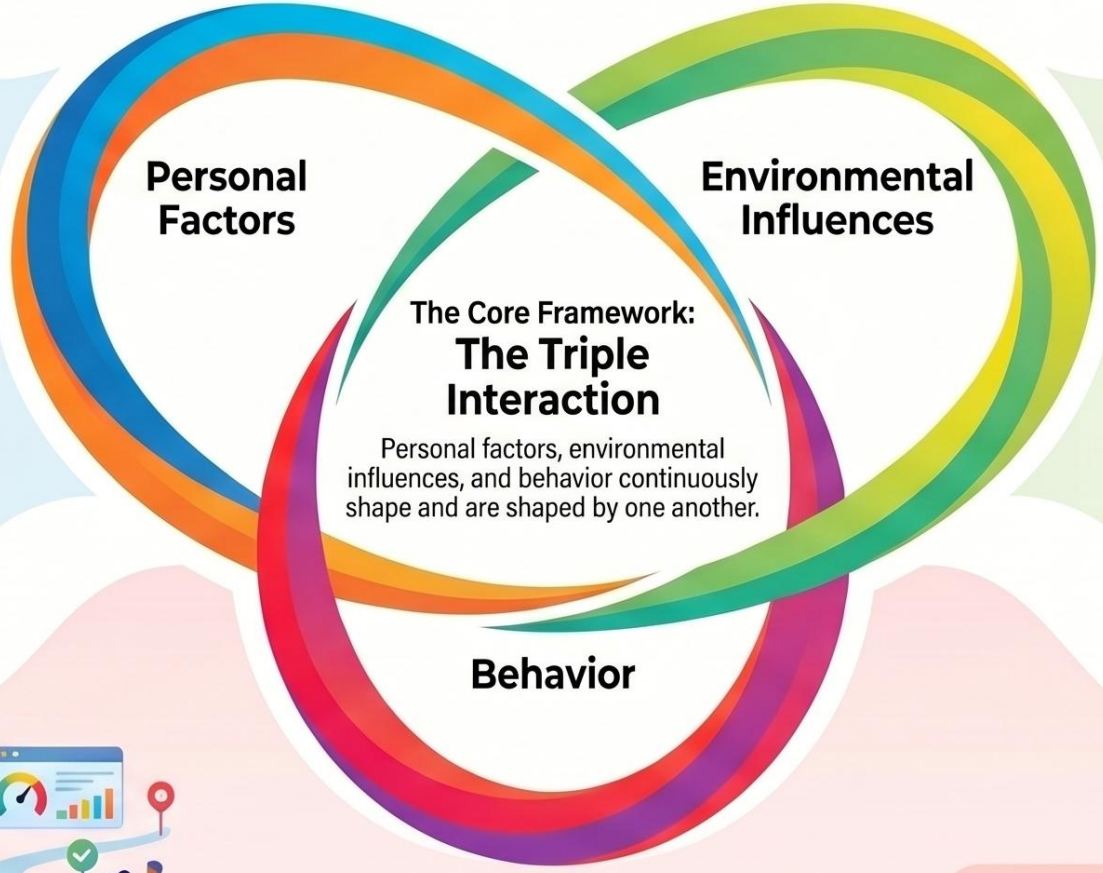
Multi-Targeted Change: Effective interventions should simultaneously target individual knowledge, internal attitudes, and the external environment.



Self-Efficacy: The Power of Belief

Building a person's confidence in their ability to perform a specific, task-related behavior.

Strategy: Break behaviors into small, measurable steps to allow for "small wins."





Observational Learning

Utilizing credible role models who reflect the target population to demonstrate and encourage new behaviors.

Strategy: Facilitation Strategy: and skill-based training to make new behaviors easier.



Self-Regulation through Goals

Promoting behavior control via self-monitoring, realistic goal-setting, and the enlistment of social support.

Strategy: Incentive Motivation Strategy: (cash, prizes, coupons) to encourage initial participation.

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LABSAFE MORU
Mahidol Oxford Tropical Medicine Research Unit

Moving from Theory to Practice: The LABSAFE Project

The Laboratory Assessments of Facility and Environment (LABSAFE) Project is a multinational initiative aimed at developing an evidence base for Biorisk Management. It focuses specifically on understanding the human causes of biosafety lapses and translating translating global data into predictive behavioral models.





References

1. World Health Organization, (2020). Laboratory biosafety manual.
2. Reason, J. (1990). Human error. Cambridge University Press.
3. Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Prentice-Hall.

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LABSAFE: Preliminary Findings on Human Error

Early data from 32 survey responses and 23 in-depth interviews reveals the startling reality of everyday laboratory behavior and its direct correlation to pathogen exposure.



32 Survey Responses

19 laboratory staff interviews

4 Associated Clinic Interviews





Insufficient procedures / training: 76.2% personnel exposure risk.



Failing to use primary containment where necessary: 75% personnel exposure risk.



Improper waste disposal: 70% personnel exposure risk.



Inattention to safety or quality of work: 68.2% personnel exposure risk.

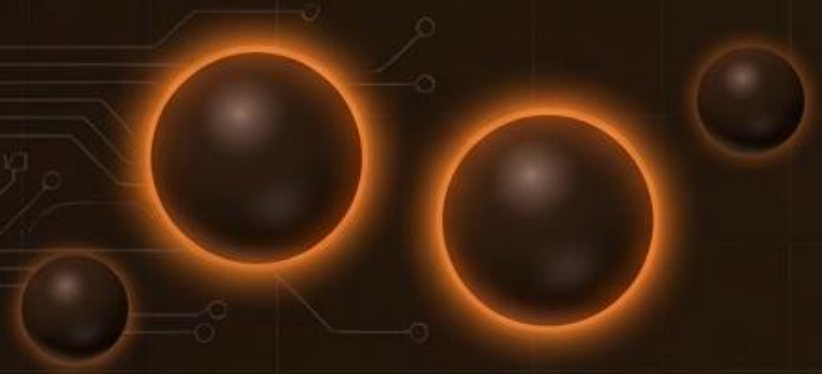


References / Data Sources:
32 Survey Responses; 23 In-depth Interviews (19 Laboratory Staff, 4 Associated Clinic St

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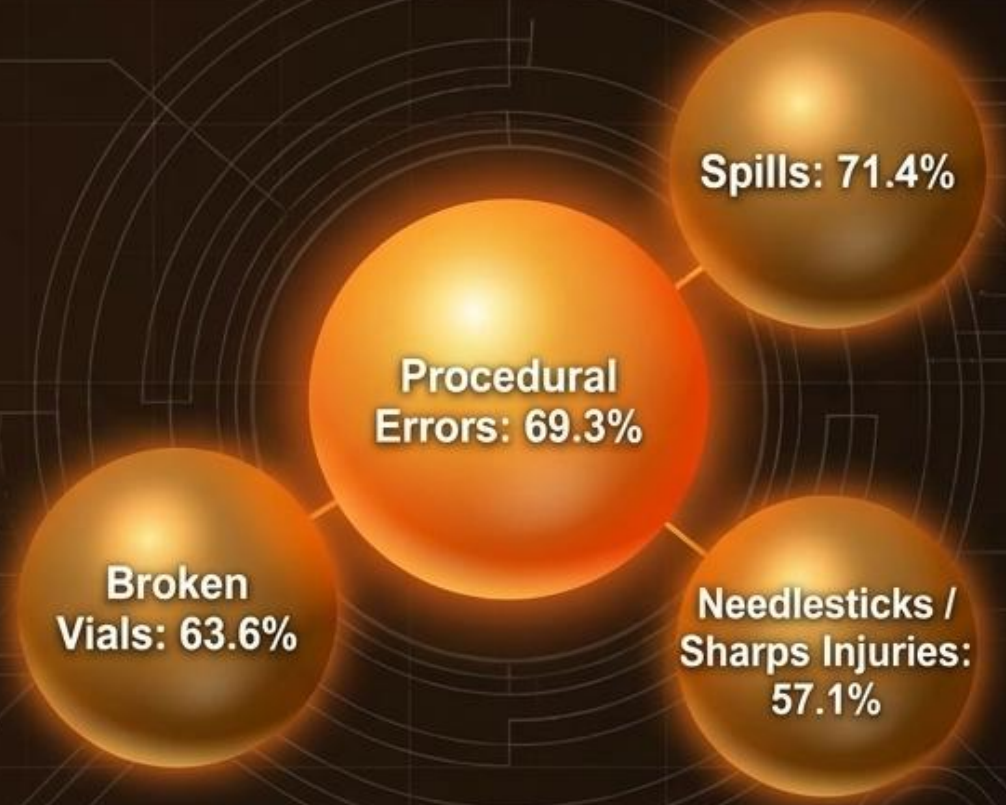
When Protocols Fail: The Reality of Risk

What happens when human behavior compromises the pathogen value chain? Data spanning from 2000 to 2021 shows that procedural errors are the root cause of the vast majority of lab-acquired infections, dwarfing engineering failures.



Equipment Failure

Vulnerability Heatmap



Personnel Exposure Risk

Source: Analysis of Lab-Acquired Infection Data (2000-2021).

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Shifting from Reactive Prohibition to Proactive Oversight

Abandoning promising pathogen research creates new global vulnerabilities. We must replace blanket prohibition with comprehensive, evidence-based governance.



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Executing the Strategy: A 4-Pillar Action Plan

Moving beyond rule-based compliance to a dynamic, risk-based approach that safeguards workers, data, and the community.

Conduct Contextual Assessments: Evaluate specific biological materials, procedures (e.g., aerosol-generating vs. sealed), and personnel competence.

Identify Vulnerabilities: Map out physical access points, digital networks, and transport vulnerabilities.

Avoid Generic Templates: Tailor assessments to the exact activities being performed, updating them whenever work variables change.



Implement Layered Defenses: Combine engineering controls (facility design, sealed rotors), administrative rules, and PPE.

Secure Information & Inventory: Establish robust cyber-hygiene, precise sample tracking, and controlled physical access points.

Manage Dual-Use Research: Institute strict ethical oversight for research that could be misapplied to cause harm.

Develop Incident Plans: Draft specific protocols for spills, exposures, prolonged power/freezer failures, and cybersecurity breaches.

Conduct Practical Drills: Test procedures under pressure to reveal hidden gaps in communication, equipment availability, and decision-making.

Review & Recover: After an incident, investigate root causes, implement corrective actions, and immediately update institutional risk assessments.

Build a 'No-Blame' Culture: Encourage staff to report near-misses, missing materials, or equipment failures without fear of reprisal.

Ensure Task-Specific Competence: Move beyond one-time inductions; require ongoing, practical training for specific laboratory tasks.

Establish Clear Accountability: Ensure leadership provides resources while biosafety officers and lab managers oversee daily, practical compliance.

The Ultimate Goal: Effectiveness over bureaucracy.

Choose controls that are proportionate, practical, and sustainable to ensure long-term safety and security across the entire laboratory ecosystem.

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Next Steps: A Risk-Driven Global Framework

"One size does not fit all." We must move beyond historically reactive stances and punitive compliance.



Predictive Behavioral Framework

Integrating Behavioral Science

Transition: Evolve from standard hardware compliance to proactive, predictive models that detect lab-associated outbreaks based on leading behavioral risk factors.

Integrate: Embed psychological safety and behavioral science directly into institutional oversight bodies and standard operating procedures.

Develop: Establish semi-quantitative methods to evaluate the efficacy of organizational culture and training interventions.

References:

1. WHO (2020). Laboratory Biosafety Manual, 4th Edition.
2. Reason, J. (2000). Human error: models and management. BMJ.
3. Edmondson, A. C. (1999). Psychological Safety and Learning Behavior in Work Teams. Admin. Sci. Q.

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LABSAFE Team & Partners



Prof Stuart Blacksell

Health and safety expert and supervisor

MORU Tropical Health Network

Nuffield Department of Medicine, University of Oxford

Mahidol University



Dr Jaison Kolenchery

Co-principal investigator

MORU Tropical Health Network

Nuffield Department of Medicine, University of Oxford



Dr Bhensri Naemiratch (Poy)

Social science advisor

MORU Tropical Health Network

Mahidol University



Dr Wirichada Pan-ngum (Pan)

Mathematical and modelling advisor

MORU Tropical Health Network

Mahidol University



Sandhya Dhawan

DPhil student; Biosafety and biosecurity consultant

MORU Tropical Health Network



Dr Kazunobu Kojima

Global biorisk policymaker

World Health Organization

World Organisation for Animal Health

Ministry of Agriculture
Republic of Indonesia

In partnership with Canada

Thank you!