From rodent-borne infections to Ebola virus disease: Biosafety, Biosecurity and Risk Assessment Perspectives

Claudio Mafra, DVM, PhD, IFBA[CP]
Paulo Eduardo Brandão, DVM, PhD
Luis (Fox) Ochoa Carrera, MSc, MRM, IFBA[CP]

Know the speakers

Claudio Mafra,
DVM, PhD, IFBA^{CP}

Paulo Eduardo Brandão
DVM, PhD

Luis (Fox) Ochoa Carrera
MSc, MRM, IFBA^{CP}

Global Health Security Fund

PANDEMICTECH

This session

W AS MADE POSSIBLE

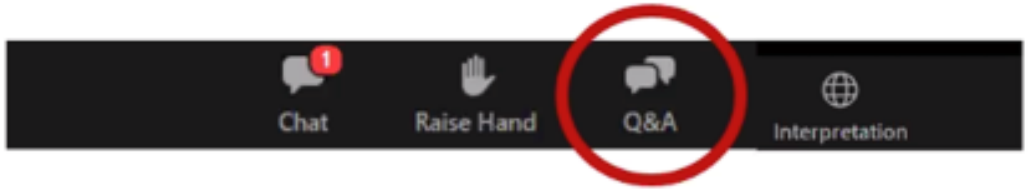
THANKS TO FINANCIAL SUPPORT FROM

Global Health Security Fund

Disclaimer

The opinions expressed in this presentation and on the following slides by nonfederal government employees are solely those of the presenter and not necessarily those of the U.S. Government or institutions. The accuracy or reliability of the information provided is the opinion of the individual organization or presenter represented.

Questions and Chat



Use **Q&A** feature for questions regarding the topic and presentations

Use **Chat** feature for questions regarding IT or logistics, and to introduce yourself

Language(s)

Language of the session will be in Spanish but wait!... Slides and close captions are in **English**

We are expecting to have more languages this year **i.e., Urdu**, **French** and **Portuguese**!

Recordings, materials and feedback

- **This session is being recorded,** and your attendance is consent to be recorded. Recordings will be shared soon.
- **Session materials** including session recordings can be accessed through the platform.
- **Your feedback is important to us.** A survey will be shared at the end of the session.

Data Use

Global Health Security Fund collects registration, participation, questions/answers, chat comments, and poll responses for this webinar. Your individual data will be kept confidential. These data may be used for reports, maps, communications, surveys, quality assurance, evaluation, and to inform new initiatives.

Global Health Security Fund
Code of Conduct

Global Health Security Fund is committed to enabling events at which everyone can participate in an inclusive, respectful and safe environment.

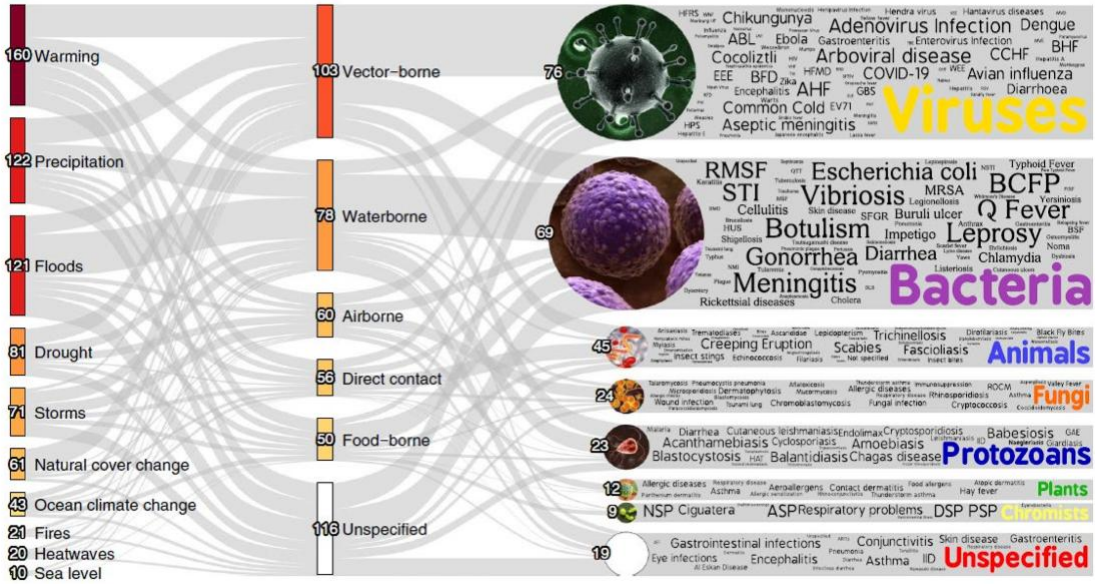
Global Health Security Fund events are guided by the highest ethical and professional standards, and all participants are expected to behave with integrity and respect towards all participants attending or involved in any Global Health Security Fund event.

Agenda

I. Welcome, Introduction, and Global Context
II. Hantavirus: Ecology, Aerosols, and Exposure Risks
III. Biosafety, Laboratory-Acquired Infections, and Occupational Health in Hantavirus Preparedness
IV. Ebola Virus Disease (Bundibugyo): Operational Preparedness and Healthcare Risks
V. Laboratory Biosafety, Specimen Management, and Biosecurity for Ebola
VI. Comparative Risk Assessment and Integrated Preparedness
VII. Future Challenges, One Health, and Organizational Resilience
VIII. Conclusions, Final Reflections, and Q&A

Emerging high-consequence pathogens

- Hantavirus and Ebola Virus Disease (Bundibugyo strain)
- Biosafety
- Biosecurity
- Aerosol Science
- Laboratory-Acquired Infections
- Operational Preparedness
- Healthcare IPC
- One Health Approaches



Mora C et al. Nat Clim Chang 2022;12(9):869-875.

Why hantavirus and Ebola remain operationally important

- High-consequence zoonotic pathogens
- Severe disease potential
- Occupational exposure risks
- Environmental and healthcare interfaces
- Laboratory workflow hazards
- Healthcare-associated transmission risks
- Global health security relevance
- Ecological disruption and spillover concerns
- Preparedness implications for Disease X

Session objectives

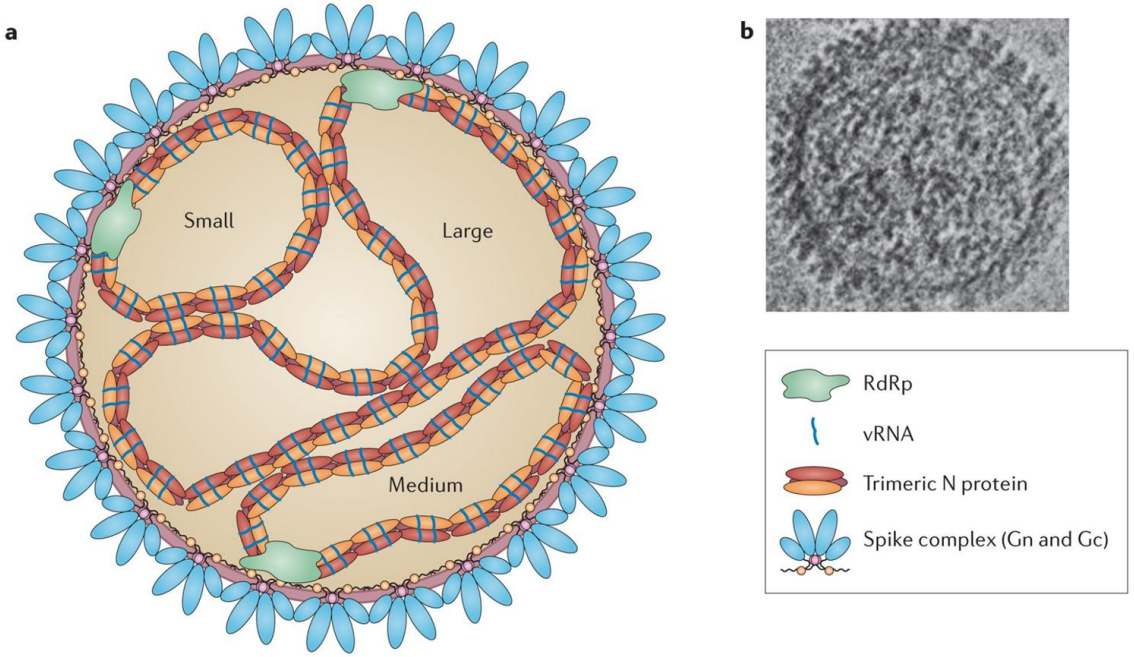
- Explain hantavirus and Ebola preparedness challenges
- Compare transmission pathways and exposure risks
- Identify laboratory and occupational exposure hazards
- Apply risk assessment principles
- Discuss healthcare IPC and biosafety strategies
- Explain biosecurity and operational preparedness concepts
- Describe One Health implications
- Identify organizational vulnerabilities and resilience strategies

How the session is organized

- Hantavirus Preparedness
- Ebola Bundibugyo Preparedness
- Comparative Risk Assessment
- Integrated Biosafety and IPC
- Occupational Health and Exposure Management
- Organizational Resilience and One Health
- Future Preparedness Challenges

Hantavirus fundamentals

- Family: *Hantaviridae*
- Enveloped RNA viruses
- Rodent-associated pathogens
- Old World vs New World hantaviruses
- HFRS and HPS/HCPS syndromes
- Reservoir specificity
- Global distribution



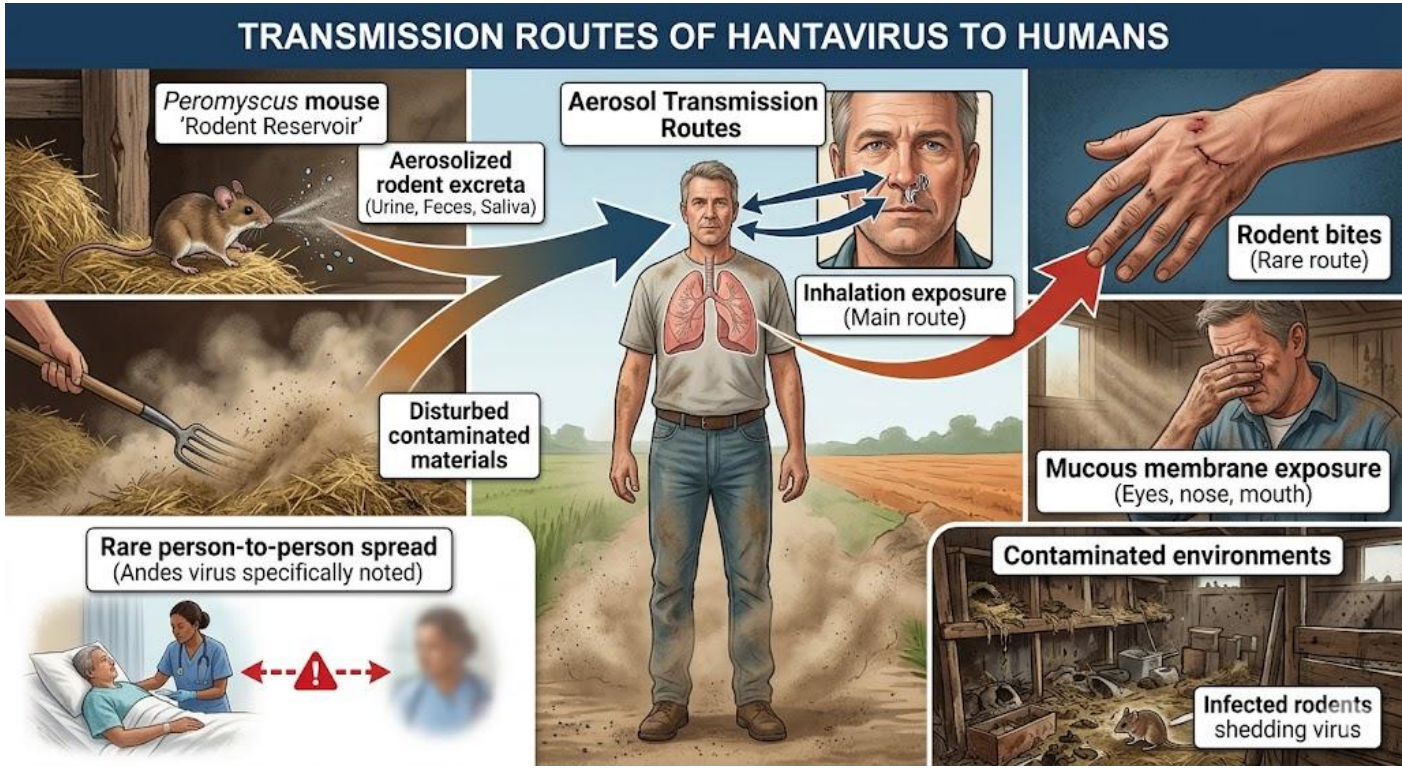
Nature Reviews | Microbiology

doi: 10.1038/nrmicro3066

Primary exposure pathways

- Aerosolized rodent excreta
- Disturbed contaminated materials
- Inhalation exposure
- Mucous membrane exposure
- Rodent bites
- Contaminated environments

- Rare person-to-person spread
- (Andes virus)



Aerosol and environmental risk factors

- Aerosolized rodent excreta
- Particle suspension and inhalation
- Poor ventilation risks
- Environmental persistence
- Aerosol-generating activities
- Cleaning and decontamination implications
- Respiratory protection considerations

Why *Andes* virus is operationally important

- Documented
- person-to-person transmissionClose-contact transmission patterns
- Healthcare preparedness implications
- Contact monitoring considerations
- Occupational health concerns
- Risk communication importance
- Isolation and IPC considerations

Dinámica de Transmisión (R0) y Virulencia por Especie de Hantavirus

Especie de Hantavirus	Región	Síndrome	R0 (Interhumano)	Letalidad (CFR)
Andes (ANDV)	Sudamérica	SPH / SCPH	0.7 – 1.2	25% – 40%
Sin Nombre (SNV)	Norteamérica	SPH / SCPH	0	35% – 50%
Hantaan (HTNV)	Asia / Rusia	FHSR	0	5% – 15%
Seoul (SEOV)	Global	FHSR	0	1% – 2%
Puumala (PUUV)	Europa	Nefropatía	0	< 1%

One Health dynamics


Oligoryzomys longicaudatus

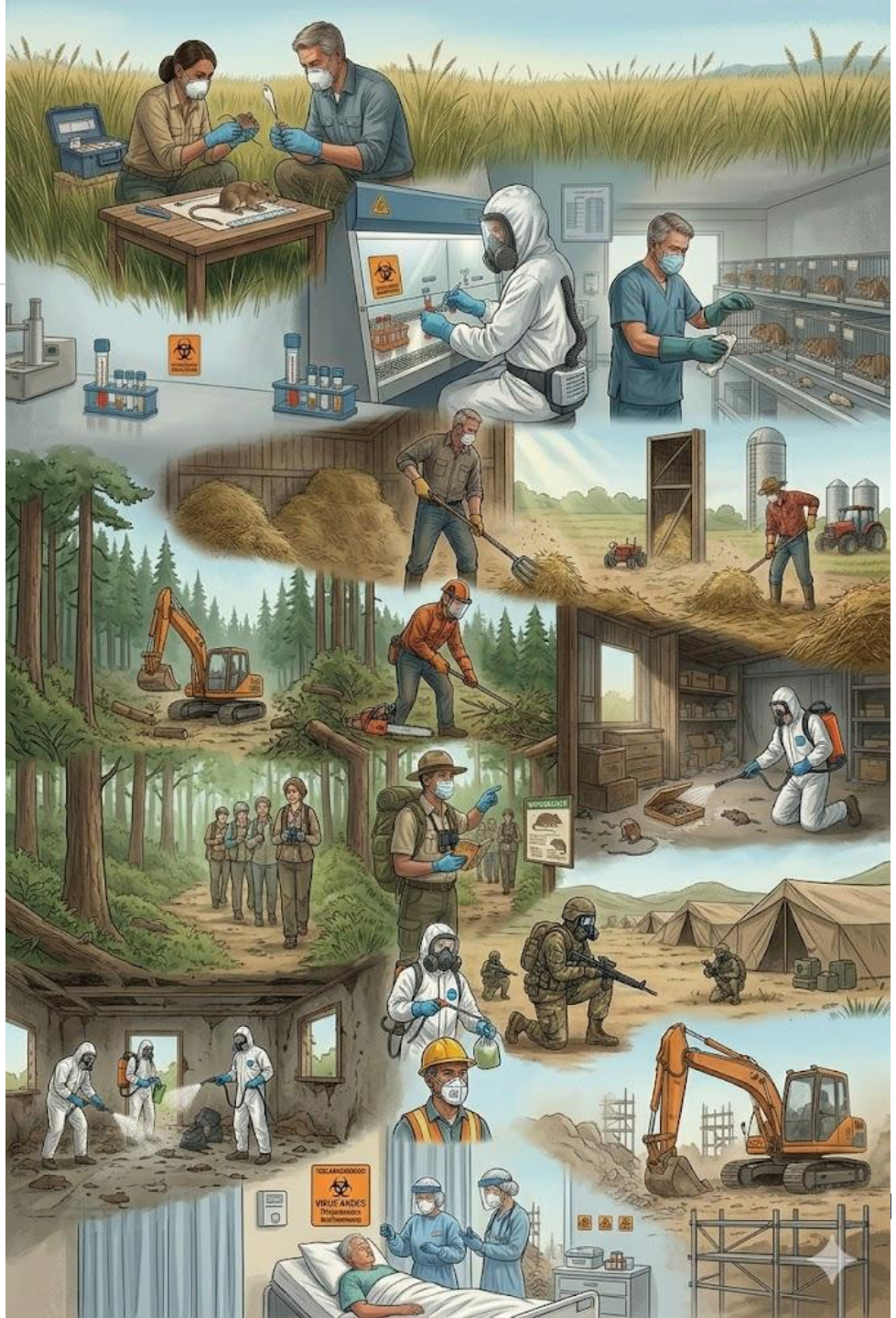
- Rodent reservoirs
- Persistent viral shedding
- Environmental contamination
- Human–animal–environment interface
- Climate and ecological drivers
- Land-use changes
- Spillover risk amplification

Global Health Security Fund

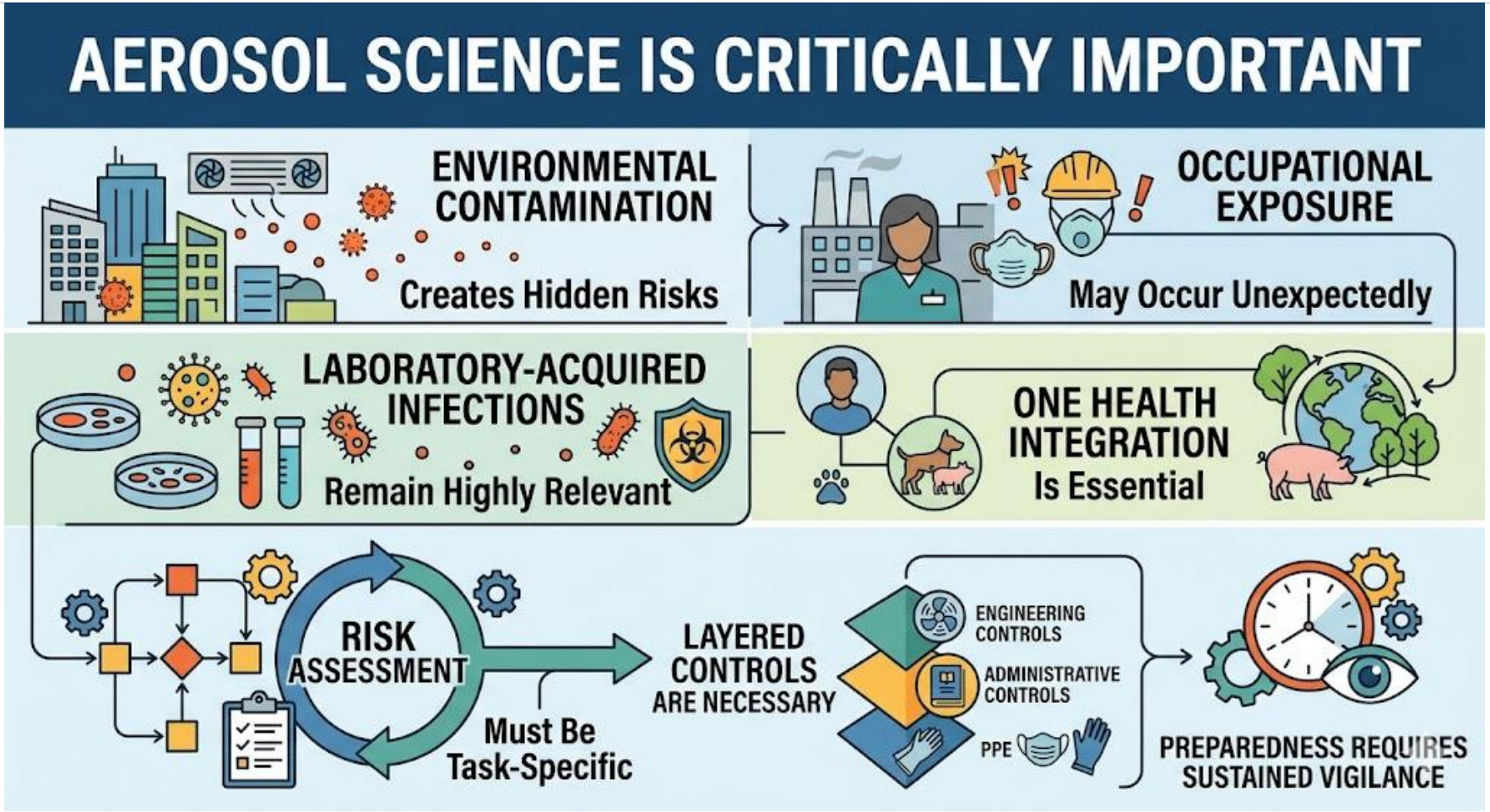
PANDEMICTECH

High-risk occupational groups

- Wildlife researchers
- Laboratory personnel
- Animal facility staff
- Agricultural workers
- Pest control personnel
- Forestry workers
- Military personnel
- Environmental cleanup teams
- Construction workers
- Healthcare personnel
- Naturalists



Major lessons from hantavirus preparedness

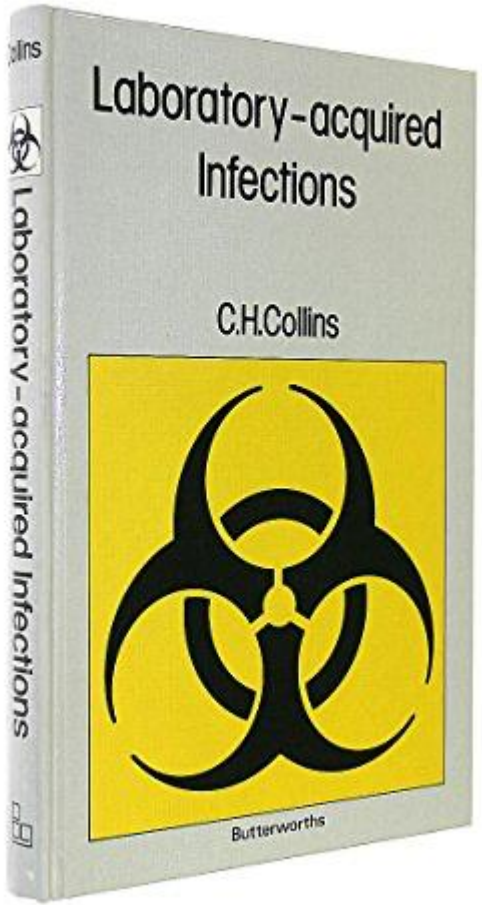


Historical laboratory lessons

- Documented hantavirus LAIs
- Aerosol-generating procedures
- Cage cleaning and bedding changes
- Necropsy and tissue processing
- Centrifugation risks
- Contaminated environmental materials
- Importance of engineering controls

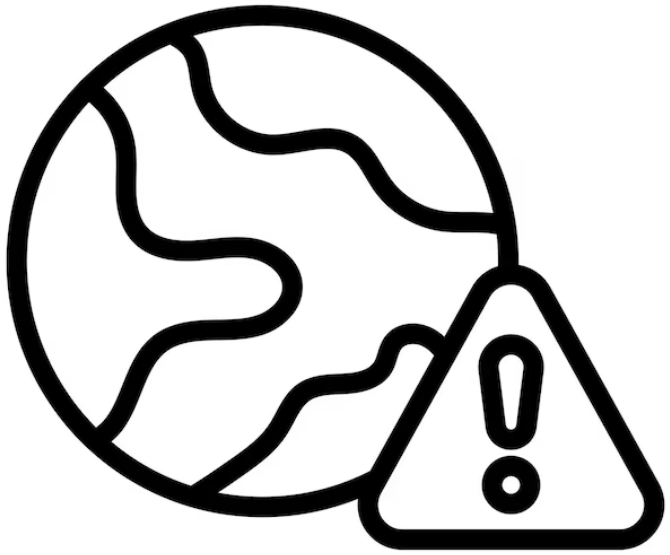
Core hantavirus biosafety strategies

- Risk assessment
- Aerosol containment
- Biological safety cabinets
- Sealed centrifuge rotors
- Respiratory protection
- Wet cleaning methods
- Environmental decontamination
- Restricted access



Environmental risk reduction

- Avoid dry sweeping
- Wet disinfection before cleaning
- Ventilation before entry
- Respiratory protection
- Waste handling precautions
- Rodent exclusion strategies
- Environmental monitoring
- Occupational exposure prevention



Hantavirus risk assessment questions

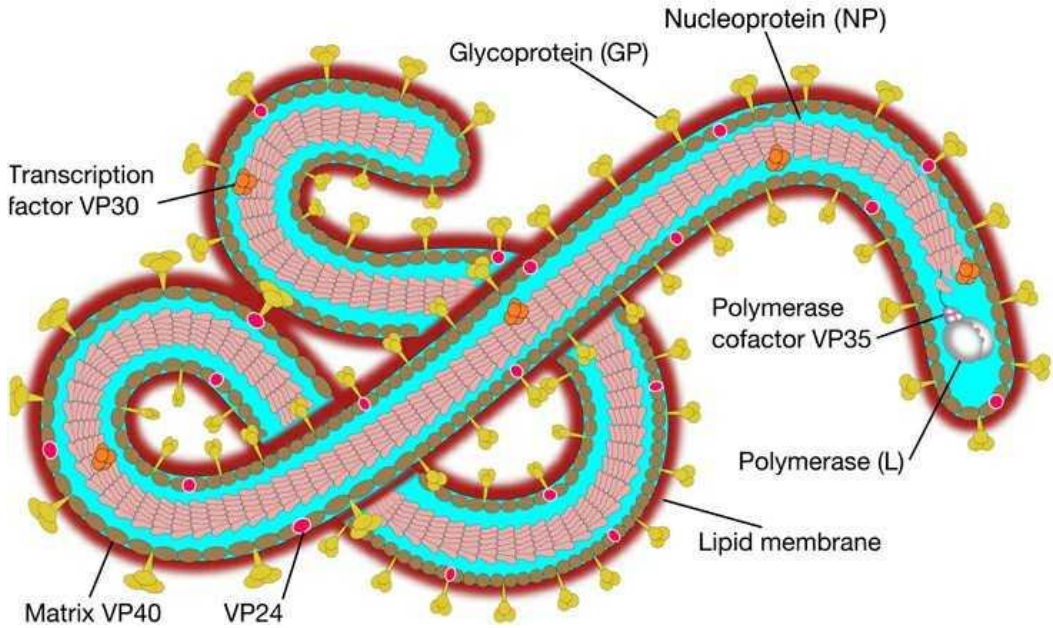
- What procedures generate aerosols?
- What environmental contamination exists?
- What engineering controls are available?
- Are workers trained and competent?
- Is respiratory protection adequate?
- What emergency procedures exist?
- How will exposures be reported?
- What occupational monitoring is required?

What is unique about hantavirus?

- Rodent reservoir dependence
- Environmental contamination
- Aerosolized excreta exposure
- Field biosafety relevance
- Environmental persistence
- Strong ecological drivers
- Occupational exposure outside healthcare
- Andes virus person-to-person exception

Ebola virus disease fundamentals

- Family: *Filoviridae*
- Severe viral hemorrhagic fever
- Six ebolavirus species
- Bundibugyo ebolavirus focus
- High-consequence pathogen
- Healthcare-associated transmission risk
- Laboratory and specimen handling hazards
- Global health security relevance



Operational importance of *Bundibugyo* virus disease

- First identified in Uganda (2007)
- Severe healthcare implications
- Diagnostic ambiguity
- Delayed recognition risks
- Healthcare amplification potential
- Occupational exposure concerns
- Laboratory preparedness challenges
- Cross-border preparedness implications

Major Ebola transmission pathways

- Direct contact with blood and body fluids
- Contact with contaminated surfaces
- Healthcare-associated transmission
- Unsafe burial practices
- Laboratory and specimen exposure
- Environmental contamination
- Aerosol-generating procedures
- Occupational exposure during care

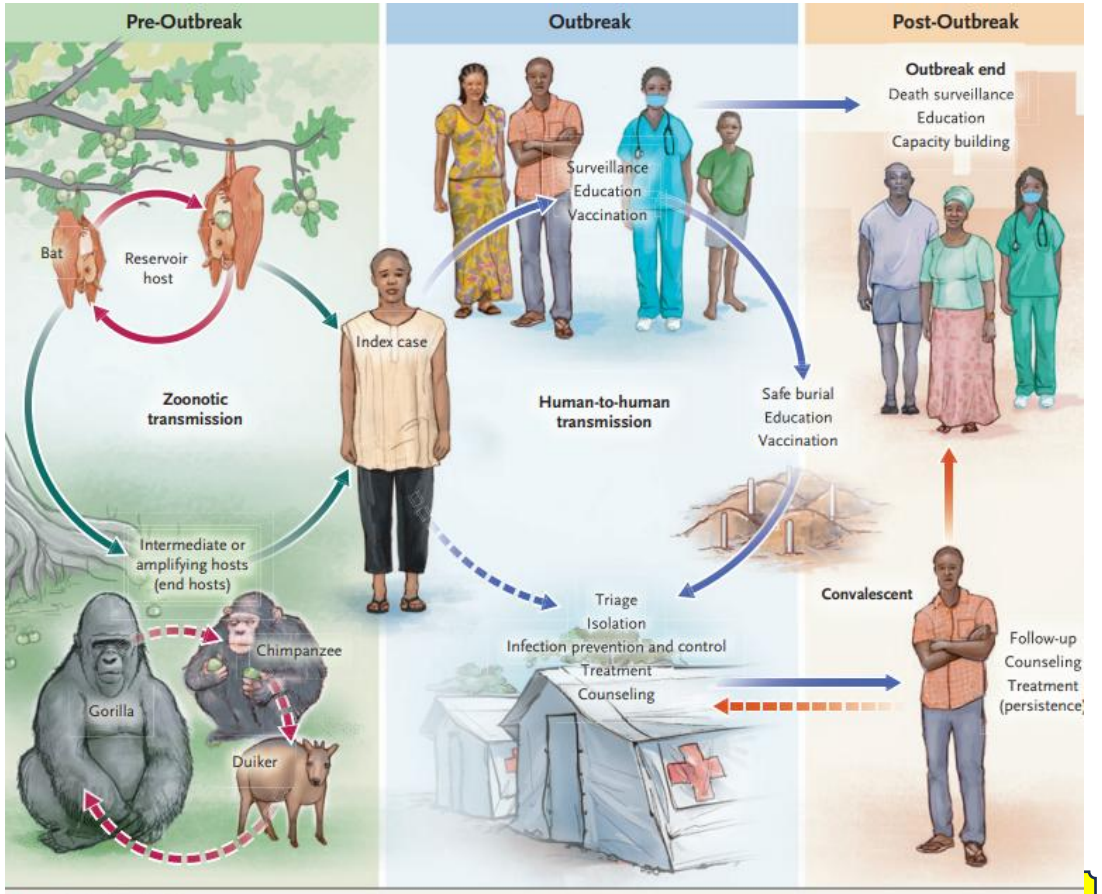


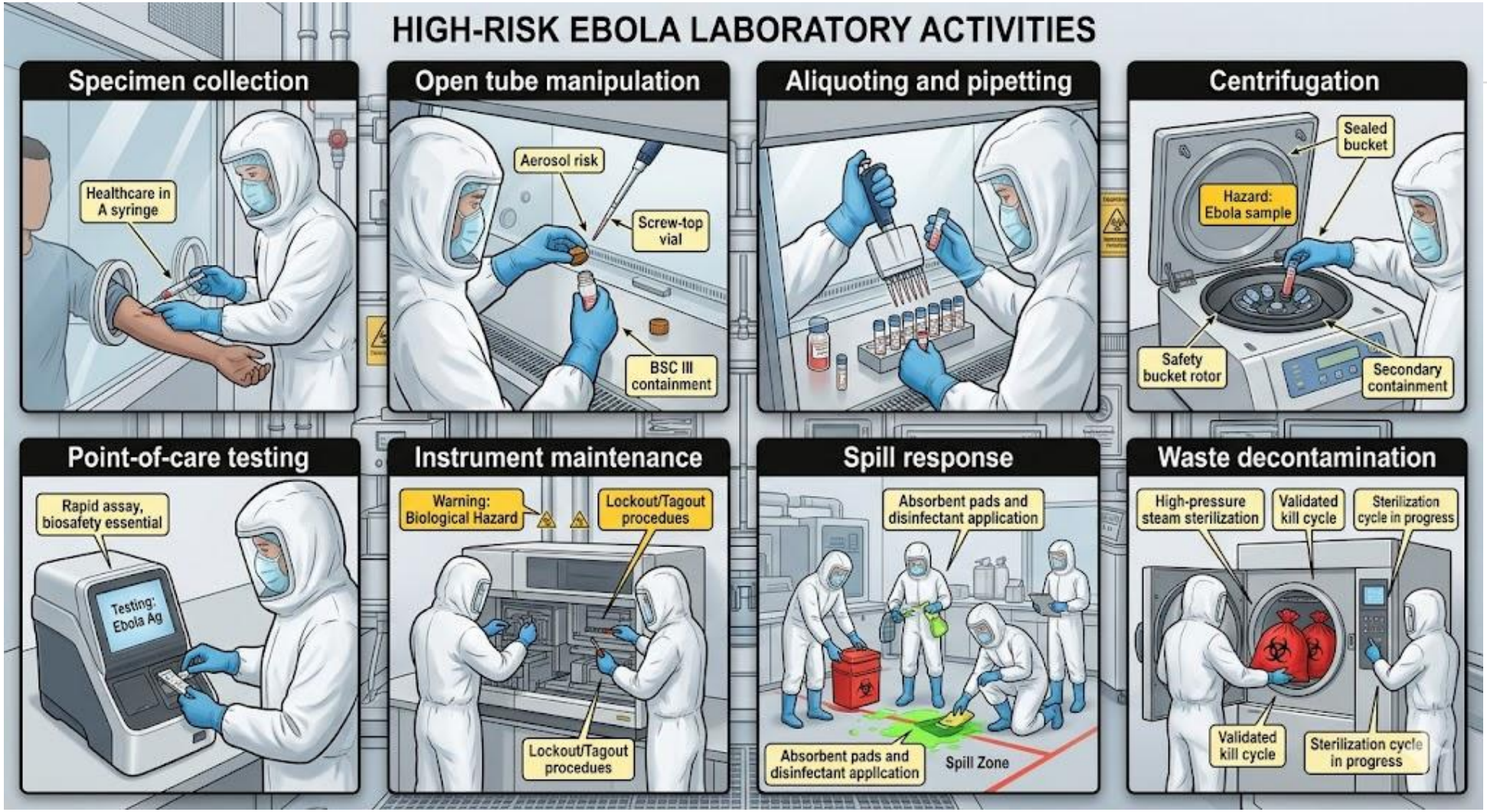
Figure 2. Outbreak Phases.
Shown are the key elements of the three phases of an Ebola virus outbreak, including control measures.

doi: 10.1056/NEJMra1901594

Transitioning from environmental exposure to healthcare amplification

- Hantavirus emphasizes aerosolized environmental exposure, rodent ecology, field biosafety, environmental contamination.
- Ebola emphasizes healthcare-associated transmission, diagnostic ambiguity, workflow risk, healthcare IPC, operational coordination.

High-risk Ebola laboratory activities



Identify–isolate–inform

- Identify suspected cases early
- Isolate promptly using appropriate precautions.
- Inform infection prevention and control, occupational health, laboratory leadership, public health authorities and emergency management.

Critical IPC components

- Standard and transmission-based precautions
- PPE competency validation
- Observer systems
- Doffing safety
- Environmental cleaning
- Cohorting and movement restriction
- Waste management
- Exposure reporting pathways

Specimen management and transport

- Specimen collection safety
- Triple packaging systems
- Category A transport requirements
- Chain-of-custody procedures
- Spill response planning
- Courier communication
- Laboratory coordination
- Secure transport systems

Essential occupational health elements

- Exposure definitions
- Rapid reporting pathways
- Confidential medical evaluation
- Symptom monitoring
- PPE breach response
- Respiratory protection programs
- Mental health support
- CAPA and near-miss systems

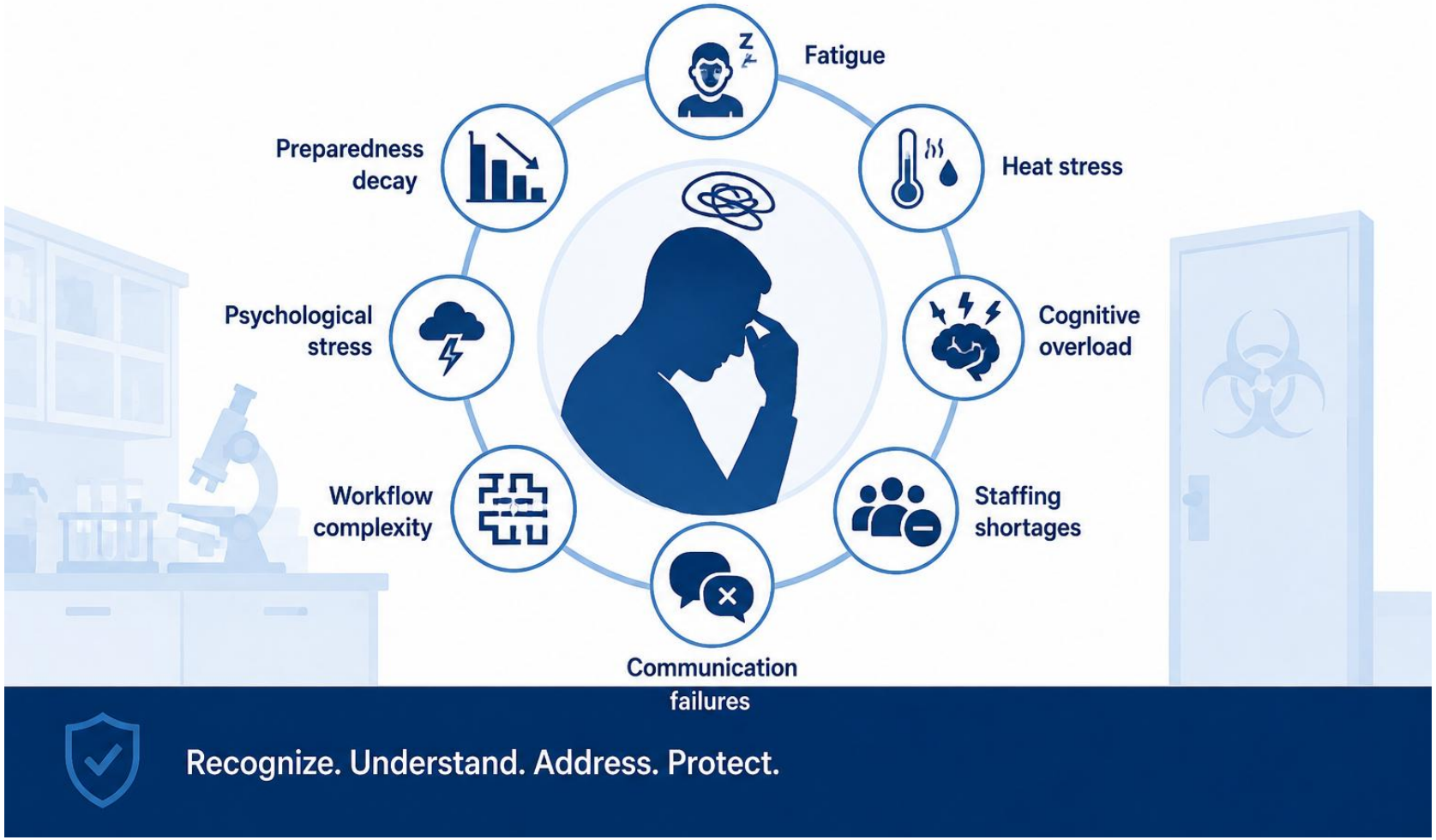
Global Health Security Fund

PANDEMICTECH

Preparedness is more than PPE

Preparedness is a whole-system approach.
Every element matters. Together, we are ready.

Human factors that increase exposure risk:



Global Health Security Fund

PANDEMICTECH

Biosecurity considerations

Global Health Security Fund

PANDEMICTECH

What is operationally unique about Ebola?

Ebola control depends on coordinated clinical, laboratory, operational, and community readiness.

Global Health Security Fund

PANDEMICTECH

Major lessons from Ebola preparedness

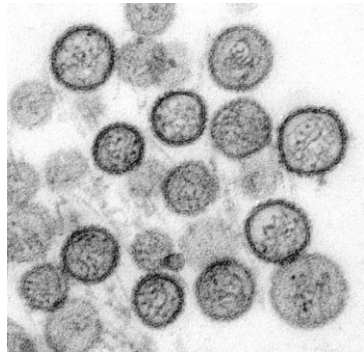
Preparedness is not just planning.
It is people, processes, systems, and trust working together.

Comparing Hantavirus and Ebola preparedness

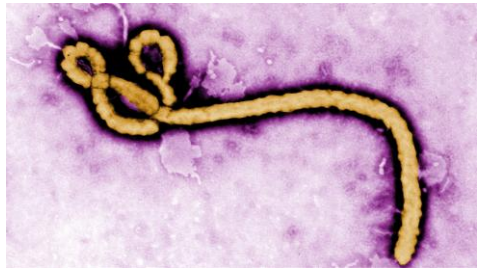
- **Hantavirus:** environmental aerosol exposure, rodent ecology, field biosafety, environmental contamination.
- **Ebola:** healthcare amplification, clinical workflows, healthcare IPC, specimen management.
- ***Shared themes:*** occupational safety, risk assessment, human factors, organizational resilience.

Hantavirus vs Ebola transmission

- ***Hantavirus:*** aerosolized rodent excreta, environmental exposure, rodent reservoirs, environmental persistence, field and wildlife interfaces, Andes virus has rare person-to-person transmission.



- ***Ebola:*** direct body fluid contact, healthcare-associated exposure, human-to-human transmission, clinical contamination, healthcare amplification, sustained transmission possible.



Occupational risk comparison

- ***Hantavirus:*** field researchers, wildlife personnel, agricultural workers, environmental cleanup teams, laboratory animal staff.
- ***Ebola:*** healthcare workers, laboratory personnel, EMS personnel, environmental services, mortuary teams.
- ***Shared risks:*** PPE failures, workflow errors, human factors, communication failures

Biosafety differences and similarities

- ***Hantavirus:*** aerosol containment focus, environmental contamination, rodent-associated exposure, field biosafety importance.

- ***Ebola:*** clinical containment focus, healthcare IPC dependency, specimen workflow complexity, waste management intensity.

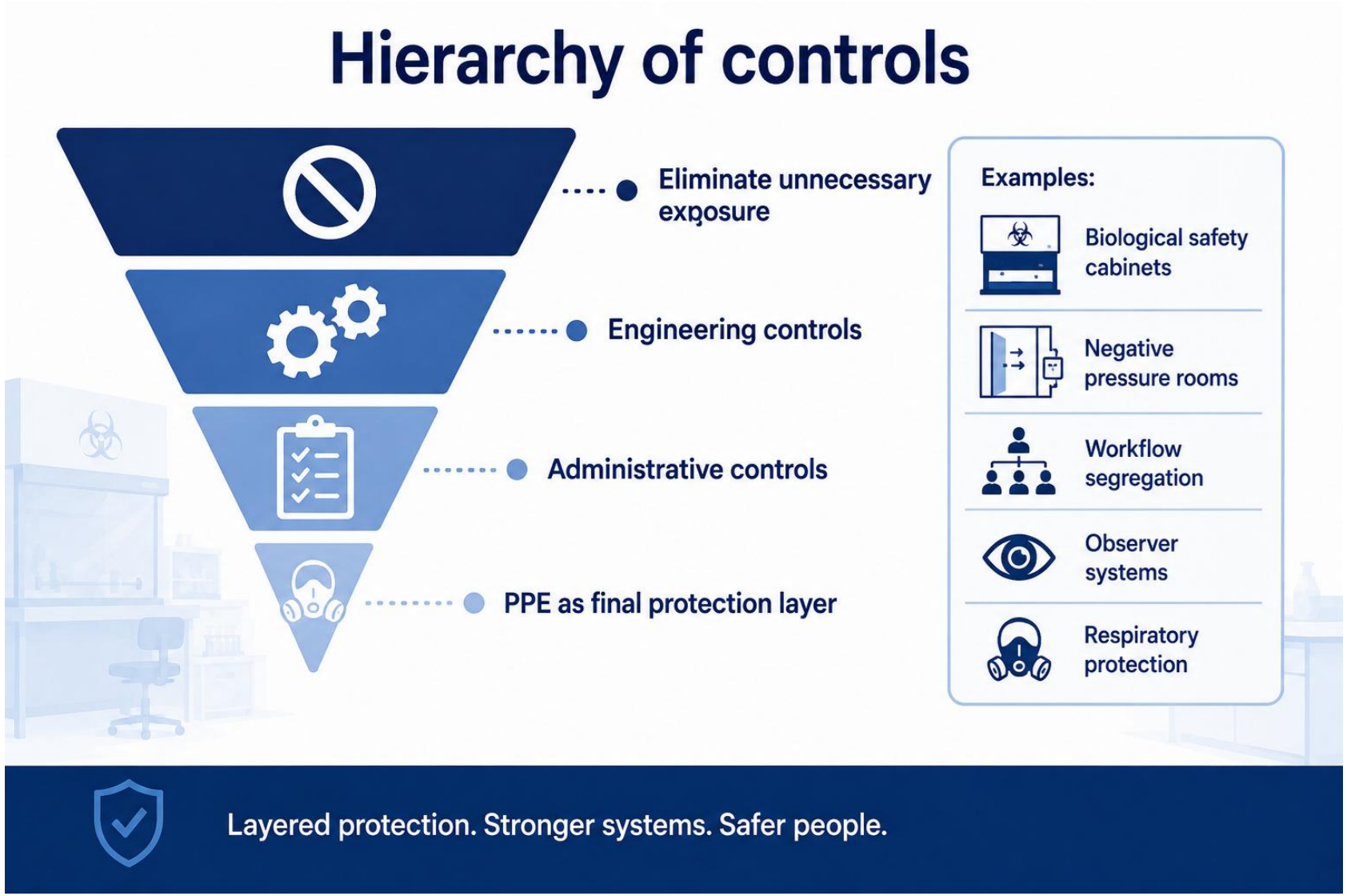
- ***Shared needs:*** risk assessment, engineering controls, training, competency validation

Laboratory exposure comparison

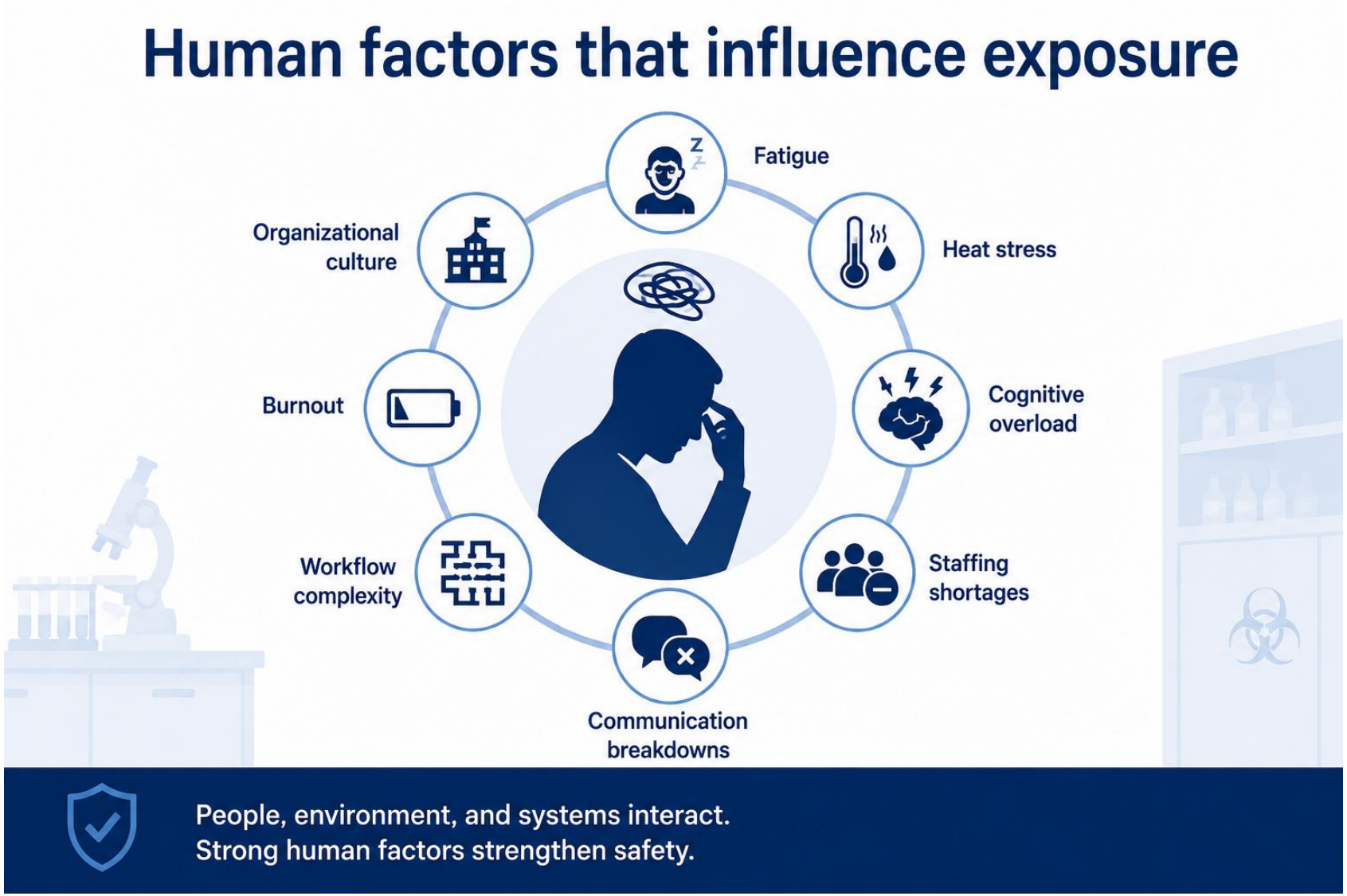
- ***Hantavirus:*** animal facilities, cage cleaning, tissue homogenization, aerosol-generating procedures.
- ***Ebola:*** specimen manipulation, open tube workflows, centrifugation, point-of-care testing.
- ***Shared laboratory risks:*** aerosol generation, workflow failures, spill events, inadequate containment

Core risk assessment principles

- Risk-based controls
- Pathogen hazards
- Procedure-specific risks
- Aerosol and splash potential
- Environmental conditions
- Engineering controls
- Staff competency
- PPE usability
- Emergency response capability
- Occupational monitoring



Human factors that influence exposure



Global Health Security Fund

PANDEMICTECH

Global Health Security Fund

PANDEMICTECH

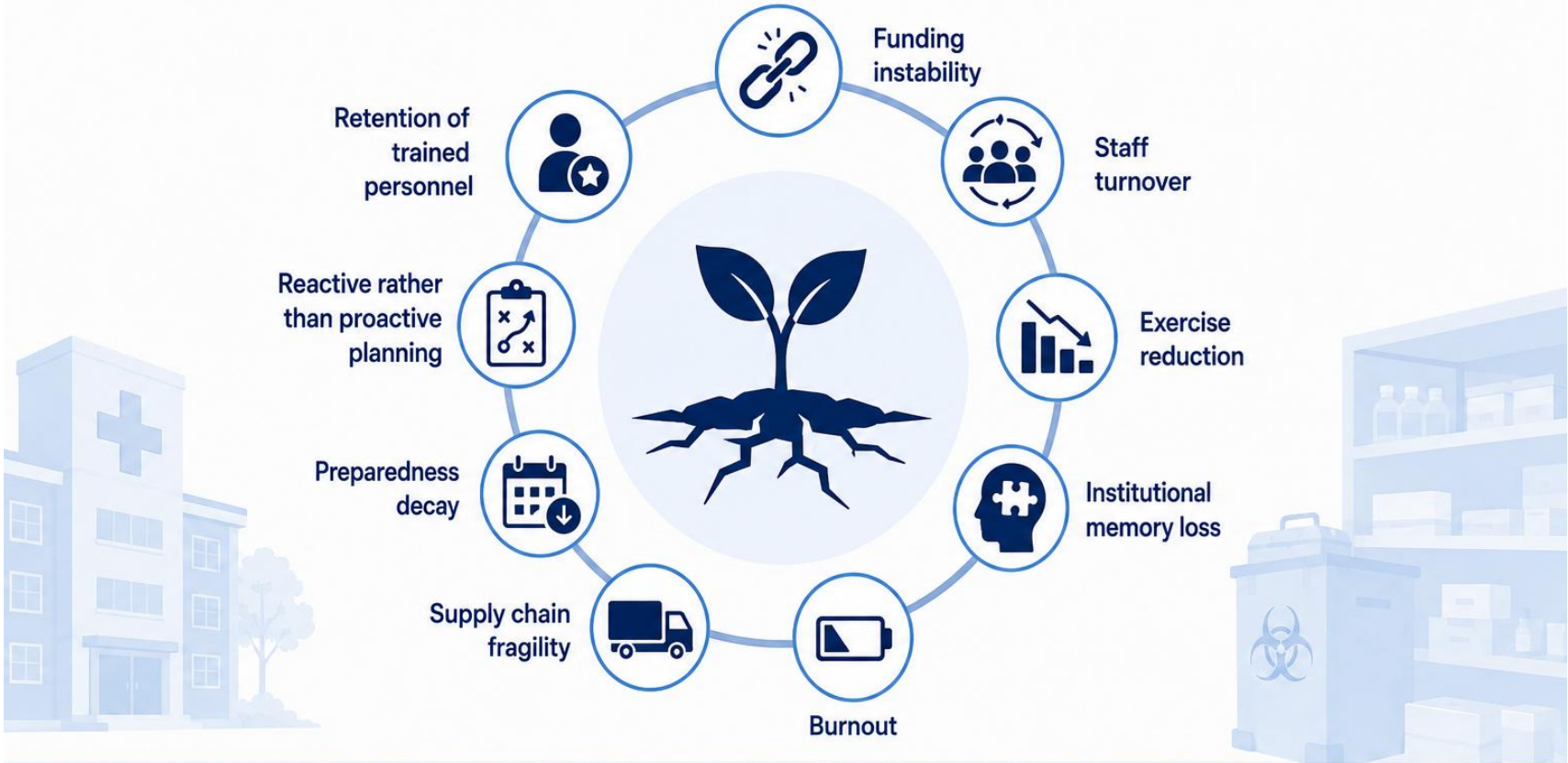
One health preparedness integration

Connected sectors. Shared responsibility. Stronger preparedness.

Global Health Security Fund

PANDEMICTECH

Major sustainability challenges



Sustaining preparedness requires commitment beyond crises.
Consistency today ensures readiness tomorrow.

Global Health Security Fund

PANDEMICTECH

Shared lessons from both diseases

Different diseases. Shared risks. Stronger together.
Learning today. Protecting tomorrow.

Global Health Security Fund

PANDEMICTECH

Emerging preparedness challenges

The threats are evolving. Preparedness must evolve faster.
Anticipate. Adapt. Act together.

Global Health Security Fund

PANDEMICTECH

Global Health Security Fund

PANDEMICTECH

Characteristics of resilient institutions

Resilient institutions anticipate, adapt, and endure.
People. Systems. Partnerships. Purpose.

Key operational comparison

- ***Hantavirus:*** environmental aerosol exposure, rodent ecology, field biosafety, environmental contamination.
- ***Ebola:*** healthcare amplification, clinical workflows, healthcare IPC, specimen handling complexity.
- ***Shared preparedness themes:*** risk assessment, occupational safety, human factors, laboratory workflow risk, communication systems, organizational resilience

Final key takeaways

- High-consequence pathogen preparedness is a systems challenge
- Aerosol and environmental exposure remain critically important
- Healthcare systems may amplify transmission
- Occupational health must remain central
- PPE alone is insufficient
- Human factors strongly influence exposure risk
- One Health integration is essential
- Preparedness must remain active between outbreaks
- Organizational resilience requires continuous commitment

What we have done well

- Increased global biosafety and IPC awareness
- Stronger healthcare IPC infrastructure after COVID-19
- Expanded high-consequence pathogen preparedness programs
- Improved laboratory biosafety and specimen management systems
- Better integration of occupational health and worker protection
- Increased use of simulation exercises and drills
- Greater recognition of One Health approaches
- Improved international collaboration and surveillance
- Stronger emphasis on risk assessment and biorisk management
- More attention to workforce resilience and mental health

What we still need to improve

- Preparedness fatigue after outbreaks decline
- Funding instability and reactive planning
- Workforce shortages and burnout
- Unequal global preparedness capacity
- Persistent communication failures
- Weak integration between systems and agencies
- Overreliance on PPE instead of layered controls
- Limited sustainability of training and exercises
- Ongoing misinformation and public mistrust
- Insufficient long-term investment in resilience

Minimum preparedness package for high-consequence pathogens

- Clear risk assessment process
- Defined notification and escalation pathways
- Trained personnel and competency validation
- Appropriate PPE and respiratory protection program
- Specimen handling and transport procedures
- Exposure reporting and occupational health support
- Environmental cleaning and waste management plans
- Communication and incident management structure
- Access to public health coordination
- Routine exercises and drills
- After-hours activation protocols

Common operational mistakes and preparedness failures

- Assuming PPE alone equals preparedness
- Poor communication and unclear escalation
- Delayed recognition of suspected cases
- Routine processing of high-risk specimens
- Dry sweeping contaminated environments
- Weak doffing observation and PPE fatigue
- Failure to report near misses or exposures
- Infrequent exercises and unrealistic drills
- Fragmented coordination between departments
- Underestimating human factors and burnout

Risk-based decision-making and after-hours readiness

- Use proportional controls
- Avoid overreaction and underreaction
- Base decisions on risk assessment
- Prepare for nights, weekends, and holidays
- Define after-hours escalation pathways
- Identify backup staffing and surge support
- Clarify laboratory and transport procedures
- Practice uncertainty and incomplete information
- Support calm, transparent communication

Discussion and Q&A

- What are the greatest biosafety vulnerabilities in your institution?
- Are healthcare and laboratory preparedness systems fully integrated?
- How frequently are high-consequence pathogen risk assessments reviewed?
- What lessons from COVID-19 improved preparedness?
- What operational barriers remain unresolved?
- How sustainable is your preparedness program?
- How effectively are One Health principles integrated?
- What workforce resilience gaps remain?

Global Health Security Fund

PANDEMICTECH

Q&A

Global Health Security Fund

PANDEMICTECH

Upcoming events (2026)

Global Health Security Fund and PandemicTech

International Workshop | ISO 35001 & ISO/TS 7446 Implementation

When: June 16 & 17, 2026 | 7:00–8:30 pm EST
Registration link:

Free event

https://us02web.zoom.us/webinar/register/WN_rM9Yke0bQm65KDNjV0xaZA#/registration

BioPrevail

Biological Preparedness and Resilience through Evolution and Innovation of Laboratories

Thank you for your attention!