Disasters and Health Systems

Systemic Stressors, Conflict, and Methods for Better Managing Uncertainty

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Systemic Stressors

Demographics and Interconnectedness

What is Risk?

Risk and Resilience

$$\text{RISK} = \frac{\text{Hazard} \times \text{Vulnerability}}{\text{Capacity to Cope}}$$

Resilience Dynamics

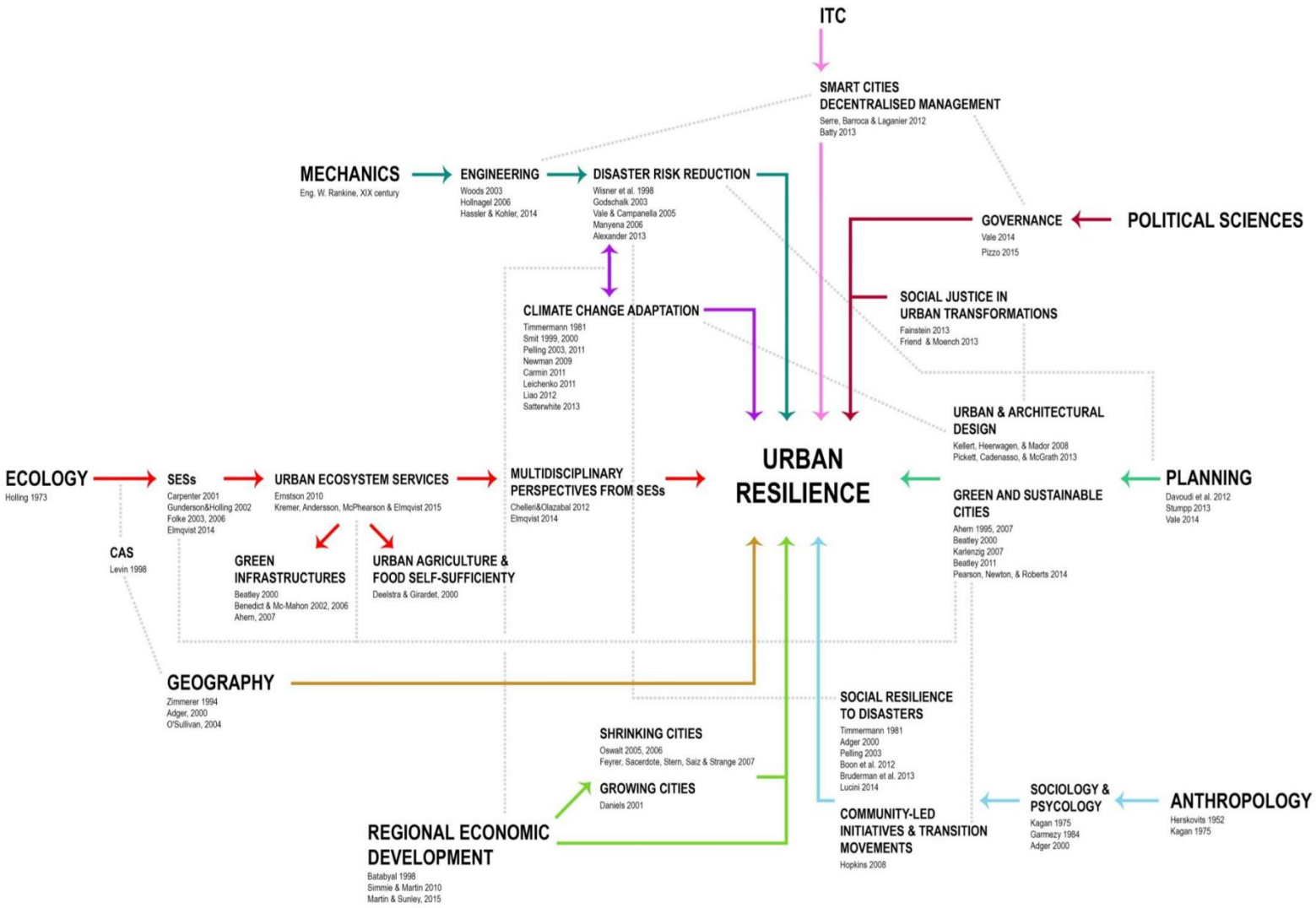
- Different threats based on different community location and environment
  - Amplified by climate change
- Susceptibility to the damaging effects of hazards from exacerbated pre-existing vulnerabilities
- The ability of individuals and communities to respond or bounce-back from disruption

Building Resilience

- Community Resilience is primarily focused on **Vulnerability and Capacity to Cope**
  - Hazards are addressed through mitigation, can also be part of resilience efforts
- Variable across and within communities
- Key domains of resilience include:
  - **Built Environment**
  - **Response/recovery**
  - **Health and social**
  - **Economic**

Source: Ribeiro, David, Eric Mackres, Brendon Baatz, Rachel Cluett, Michael Jarrett, Meegan Kelly, and Shruti Vaidyanathan. "Enhancing community resilience through energy efficiency." American Council for an Energy-Efficient Economy, 2015

There is no single “lever” for resilience



Graphic presented by Lorenzo Chelleri, Ph.D. Urban Resilience Research Network (UR-Net), International University of Catalunya(UIC) at the *Co-constructing knowledge for urban resilience implementation - Workshop* Montreal, Canada 10/2/17

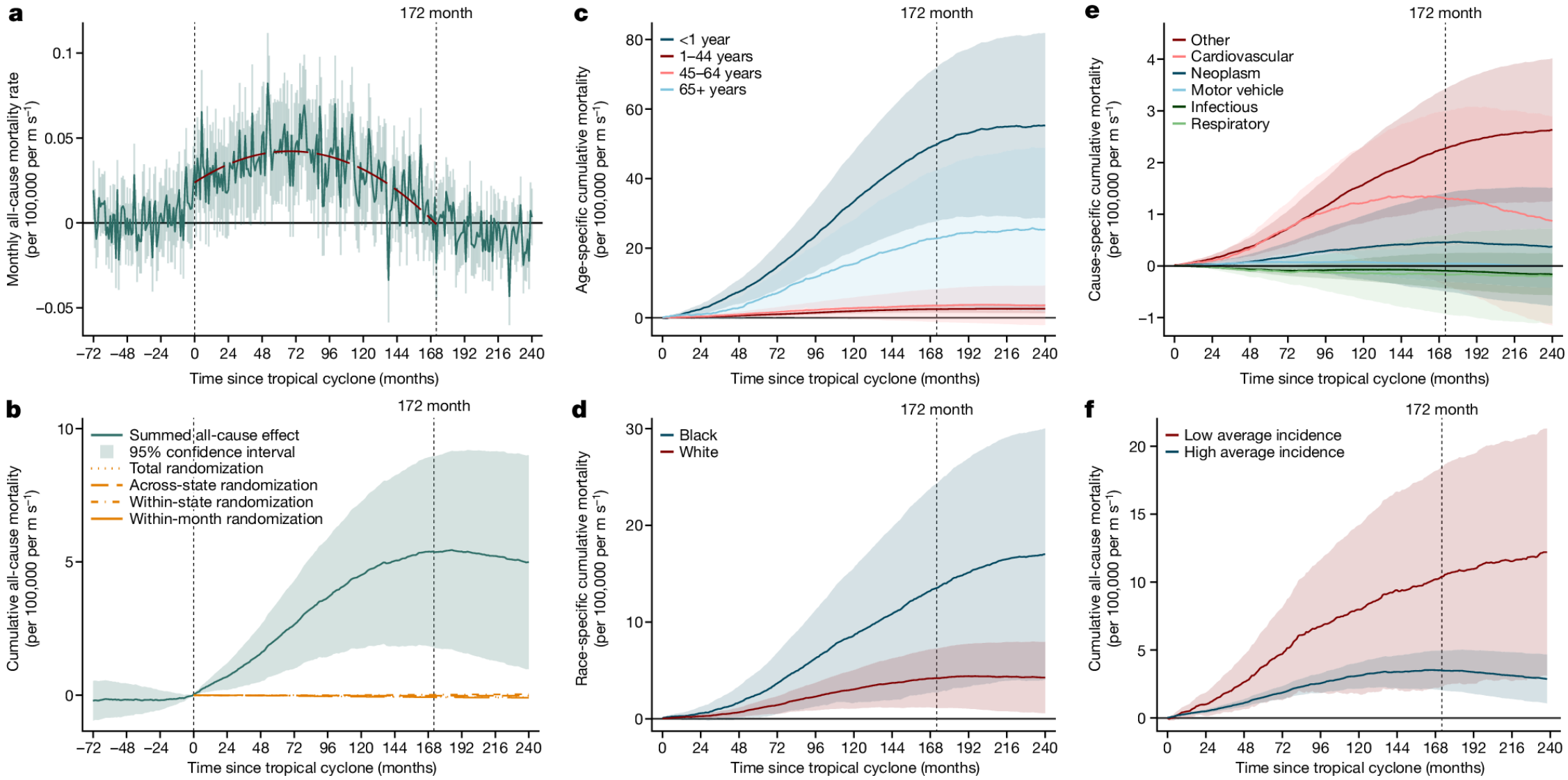
Takeaway #1

Resilience is the experience at the intersection of many different fields of science and civil society bureaucracies. All must be tended to in order to build resilience.

Morbidity from Disasters

- Tropical Cyclones in the United States
  - Direct Deaths Average (immediate) = 24
    - Easy to measure
      - Case definitions
      - Clear reporting
  - Indirect Deaths Average (within 24 months) = 7,000 – 11,000
    - 3.2-5.1% of all deaths
    - Harder to measure precisely
      - Comparative analyses (expected vs actual), surveys, among other methods used
    - Disproportionately affecting the elderly, the very young, and black Americans (historically marginalized population)

Source: Young, Rachel, and Solomon Hsiang. "Mortality caused by tropical cyclones in the United States." Nature 635, no. 8037 (2024): 121-128.

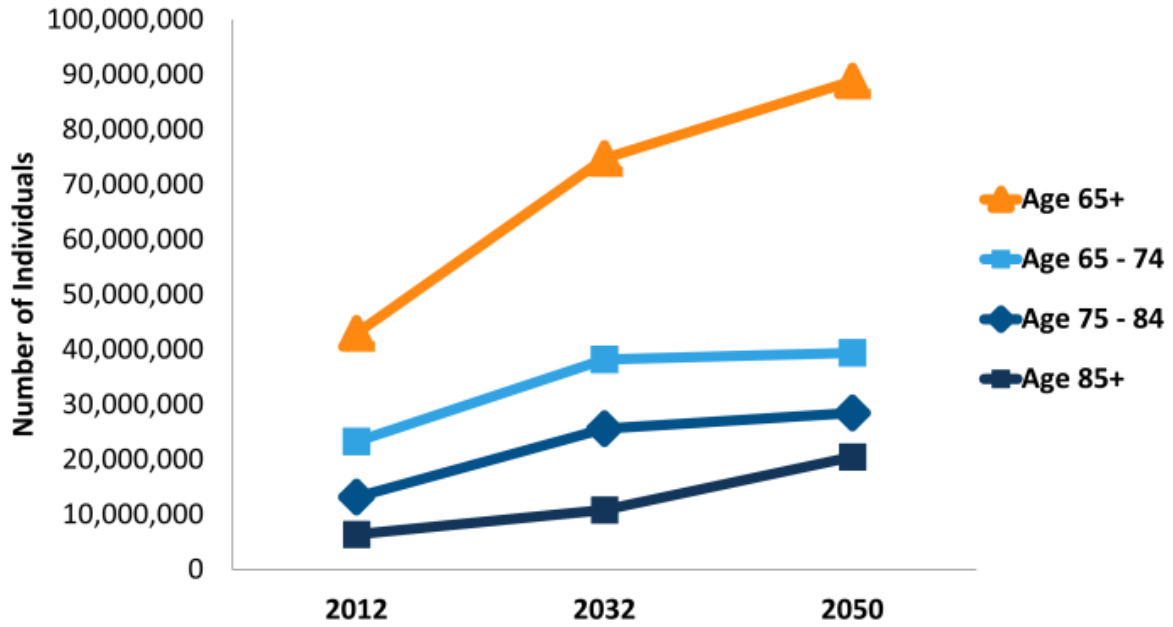


Source: Young, Rachel, and Solomon Hsiang. "Mortality caused by tropical cyclones in the United States." Nature 635, no. 8037 (2024): 121-128.

Chronic Conditions

Figure 1

The 65 and Over Population Will More Than Double and the 85 and Over Population Will More Than Triple by 2050

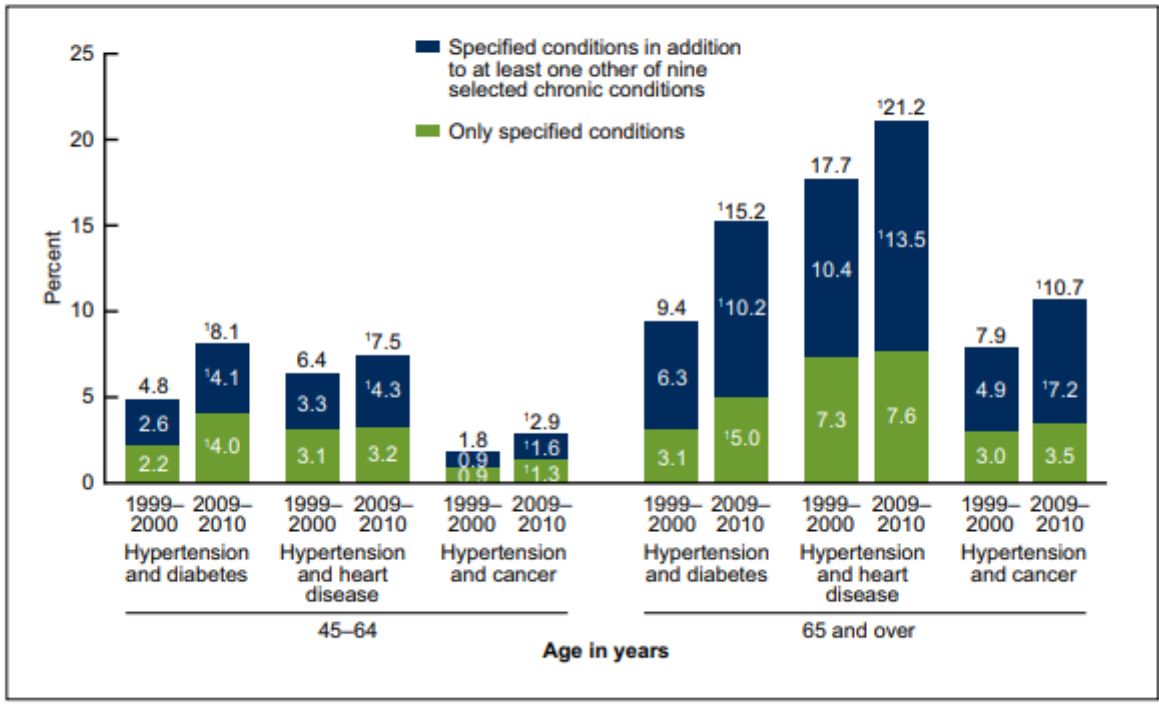


SOURCE: A. Houser, W. Fox-Grage, and K. Ujvari. *Across the States 2013: Profiles of Long-Term Services and Supports* (Washington, DC: AARP Public Policy Institute, September 2012), http://www.aarp.org/content/dam/aarp/research/public_policy_institute/ltc/2012/across-the-states-2012-full-report-AARP-ppi-ltc.pdf.

THE HENRY J. KAISER FAMILY FOUNDATION

The percentage of adults aged 45 and over with the three most common combinations of the nine selected chronic conditions increased over the 10-year period.

Figure 4. Prevalence of the three most common combinations of the nine selected chronic conditions, by age and type of chronic condition: United States, 1999–2000 and 2009–2010



†Significantly different from 1999–2000, $p < 0.05$.
NOTES: Parts may not sum to total due to rounding. Access data table for Figure 4 at: http://www.cdc.gov/nchs/data/databriefs/db100_tables.pdf#4.
SOURCE: CDC/NCHS, National Health Interview Survey.

Primary Care Needs After Disasters

Hurricane Katrina

- 21% of patients reduced or stopped treatment for chronic conditions
  - Lack of access to physicians reported by 41%, followed by medications, insurance, transportation, competing demands
- 95% of primary care sites temporary closed or relocated

Pakistan Earthquake 2005

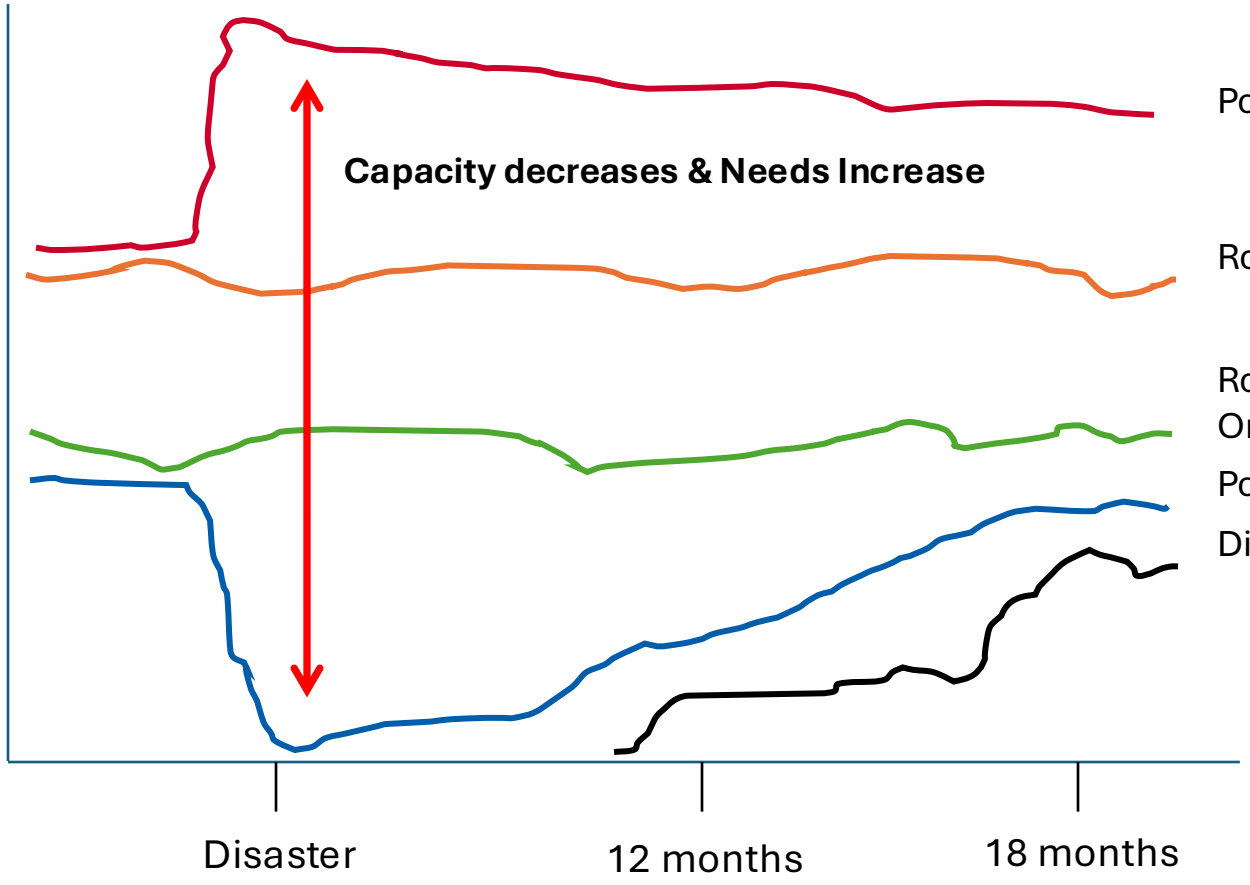
- 80% of those in mountain areas lost access to care
  - 40% in other areas

Other Disasters

- Repeated damage to primary care system due to disasters in Iran
- Rebuilding primary care priority after 2004 Asian Tsunami

Sources: Kessler (2007), Sood et al (2016), Chan & Griffiths (2009), Schwartz et al (2006), Ardalan et al (2013)

Vulnerable Population Needs after a Disaster



Post-disaster needs of vulnerable populations

Routine needs of vulnerable populations

Routine capacity of Human Service Organizations (HSO)

Post-disaster capacity of HSO's

Disaster community management capacity

Takeaway #2

Primary and secondary care, as well as social support systems are critical in environments where trauma centers are also highly impacted

Children and Disasters

Children as Bellwethers of Recovery

- Children are particularly vulnerable to disasters
  - Limited capacity to mobilize resources
  - Dependent on others for their wellbeing
    - Household, school, larger environment
- Children serve as a bellwether indicator of successful recovery, or a lagging indicator of systemic community dysfunction and failed recovery
- After Katrina, more than 37% of children reported to have a clinical mental health diagnosis
  - Nearly 5 times more likely as pre-Katrina cohort to exhibit serious emotional disturbance

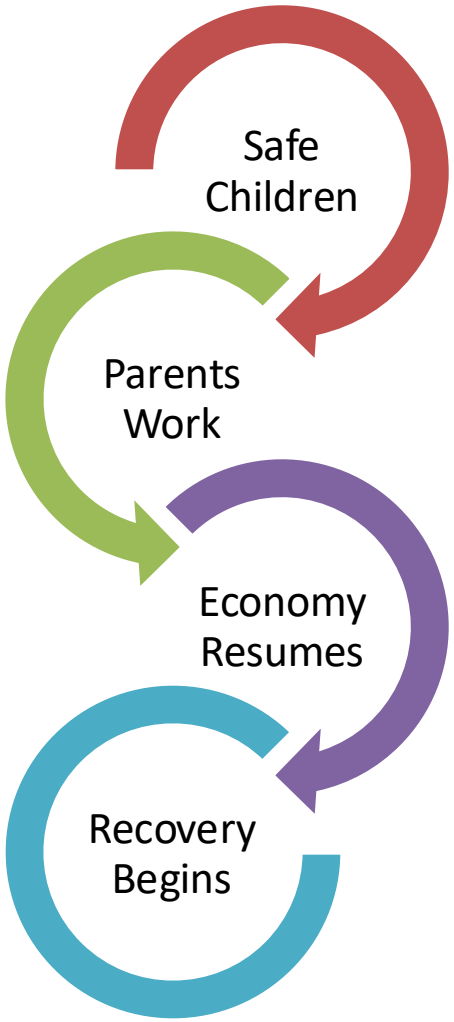
Abramson, Park, Stehling-Ariza, Redlener, 2010, Children as Bellwethers of Recovery: Dysfunctional Systems and the Effects of Parents, Households, and Neighborhoods on Serious Emotional Disturbance in Children After Hurricane Katrina, Columbia University Academic Commons, https://doi.org/10.7916/D8M90KB7

Gulf Oil Spill – 2010

- Cohort of 720 parents and caregivers
  - Data collected 2018-2019
- 60% reported child had a physical health problem
  - respiratory symptoms, vision problems, skin problems, headaches, and unusual bleeding
- 4.5 times more likely to have health or mental health problems
- 3 times more likely for children whose parents had been exposed or who lost incomes or jobs as a result of the spill

Sources: Beedasy et al (2020), also https://blogs.ei.columbia.edu/2020/07/15/deepwater-horizon-child-health-impacts/

Child-Focused Community Resilience Coalitions



Takeaway #3

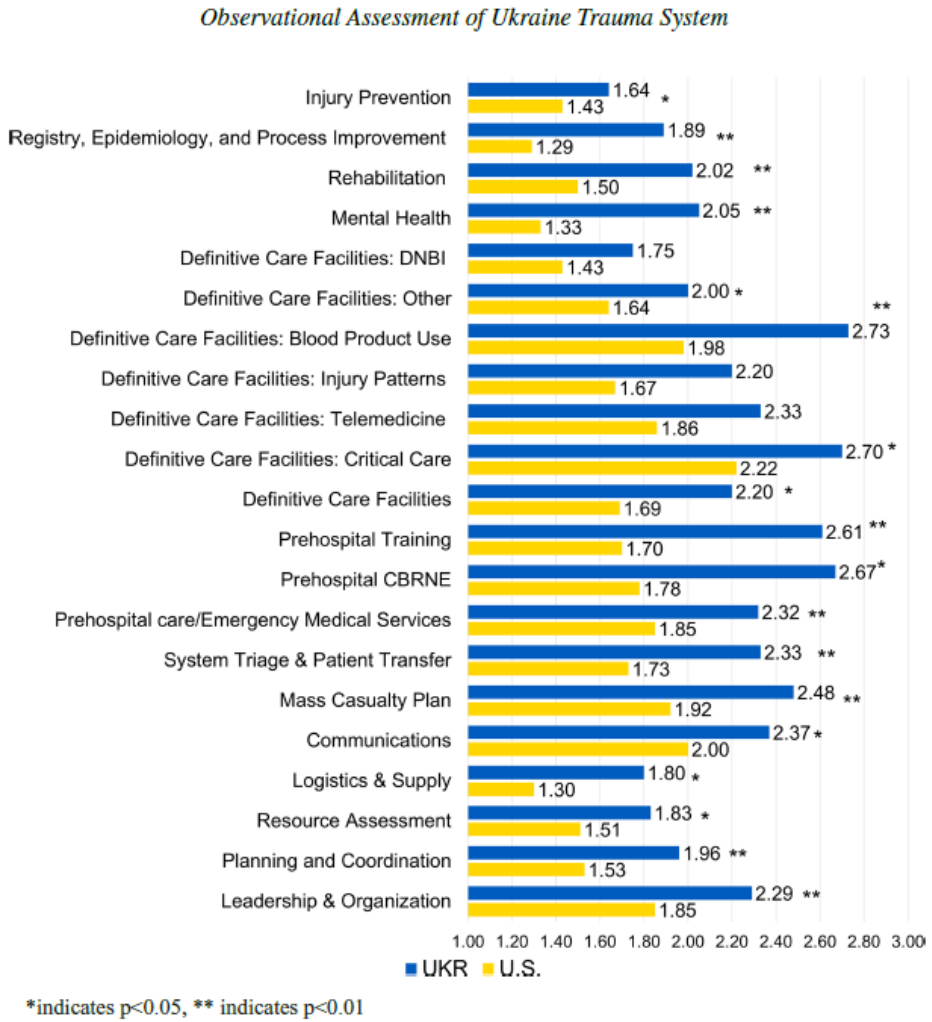
Children are bellwethers of civil society. Focus on them, and you focus on whole of community.

Medical Systems Response in Ukraine

Innovations and Blurring Lines Between Combat and Civilian Casualty Care

Ukraine Trauma System Assessment

- Ukraine's healthcare system was undergoing major health system reforms that would improve resource allocation and ultimately ensure a higher standard of care within medical facilities.
- The Russian invasion paused these reforms and disrupted healthcare causing/exposing
  - Disruptions in the medical supply chain
  - Under-preparedness for large-scale combat operations
  - Inadequate training
  - Outdated equipment, and
  - Attacks on infrastructure.
- Limited access to care in areas
- Increasing patient care needs beyond combat injuries
- 1 ="no aspect met" 3 = "completely meets" satisfactory compliance



Source: Koehlmoos, Tracey Pérez, Jessica Korona-Bailey, Luke Juman, Miranda Janvrin, Amandari Kanagaratnam, Tiffany E. Hamm, Oleh Berezyuk, and Lynn Lieberman Lawry. "Assessing the Trauma System in Ukraine Through the Perspectives of International Healthcare Volunteers and Ukrainian Healthcare Workers: Application of an Observational Tool." Military Medicine (2025): usaf132.

Combat Related Injuries

- Combat operations not been seen in recent conflicts
  - Trench warfare
  - High-intensity largescale combat
- Data-driven trauma management system needed to catalogue and adapt

- Injury types
  - Polytrauma
    - Blast
    - Fragment
    - Traumatic Brain Injuries (TBI)
    - Burns
    - Landmine-associated amputations
  - Most common to extremities, face, neck, and TBI

Source: Lawry, Lynn Lieberman, V. Mani, T. E. Hamm, M. Janvrin, L. Juman, J. Korona-Bailey, J. Maddox, O. Berezyuk, A. J. Schoenfeld, and T. P. Koehlmoos. "Qualitative assessment of combat-related injury patterns and injury prevention in Ukraine since the Russian invasion." BMJ Mil Health (2025).

Non-Battle Injuries

- Survey across Civ/Mil healthcare
- About half saw patterns of injury not a direct result conflict
  - Associations between environment, equipment, and battle conditions
  - Cardiovascular complications, acute cholecystitis, appendicitis, falls, fractures and pain management issues, exacerbation of chronic diseases, pulmonary disease, gastroenterology issues, urology issues, hernias, flu, respiratory illness, cancer, joint and back pain, and antimicrobial resistance
  - Cold weather injuries
  - Sporadic diarrheal disease
  - Mental health issues (incl PTSD)

Source: Lawry, Lynn Lieberman, Amandari Kanagaratnam, Ashleigh Roberds, Jessica Korona-Bailey, Luke Juman, Miranda Janvrin, Zoe Amowitz et al. "A qualitative assessment of disease and non-battle injuries in Ukraine since the Russian invasion." Conflict and Health 19, no. 1 (2025): 1-12.

Telemedicine Use

- Telemedicine use has rapidly increased in Ukraine during the current conflict particularly in the scope of providing trauma care when numerous specialties are needed.
  - Consult with providers with previous personal or professional relationships
    - Primarily in Ukrainian with Ukrainians, but some in English and International
  - Especially when unable to evacuate
- Primarily messaging apps
  - Connectivity issues with video
- Challenges with:
  - Connectivity
  - Signal interception (hacking)
  - Signal locating (targeting)
- Development of a unified, secure telemedicine system with mechanisms for integrating multinational medical support would aid in providing swift medical care to persons injured in the conflict or unable to access a specialty provider in their proximity.

Table 2. Interview guide section headings and questions pertaining to telemedicine.

Definitive Care Facilities: Telemedicine
Do you use telemedicine to help care for critically ill patients or patients requiring specialist assistance?
Who is providing telemedicine support—(higher level UKR hospital, NGO, Foreign assistance, etc.)?
Is communication done in Ukrainian?
What types of telemedicine are you using?
What types of devices are you using?
What are the top 3 reasons for telemedicine consultation?
What specialties are being consulted and why?
Where do you perform telemedicine?
What are the challenges to using telemedicine?
What security concerns prevent your use of telemedicine?

Source: Koehlmoos, Tracey Pérez, Amandari Kanagaratnam, Jessica Korona-Bailey, Zoe Amowitz, John S. Maddox, Tiffany E. Hamm, Oleh Berezyuk, and Lynn Lieberman Lawry. "Use of telemedicine for trauma care since the Russian invasion of Ukraine: A qualitative assessment." *Journal of Telemedicine and Telecare* (2024): 1357633X241288299.

Takeway #4

Distinctions between civilian and military health systems and continuum of care quickly blur, and new paradigms need to be established and evolve together.

Psychosocial Support Interventions for Children

- 6-day psychosocial recovery camps using a mother-child intervention model with 4 goals:
  - Providing safety away from armed conflict
  - Screening children at risk for posttraumatic stress disorder (PTSD), with referrals for evaluation and treatment;
  - Presenting and reinforcing stress management skills;
  - Arranging ongoing support and follow-up

Table 1. Traumatic Experiences of Children Reported at Camp Intake

Experience	No. (%) (N = 1291)[a]
Lived within 30 km (18 miles) of hostilities	644 (49.9)
Internally displaced persons	891 (69.0)
Had a close relative in the war	300 (23.2)
Lost a close relative in the war	108 (8.4)
Lost their home	430 (33.3)

Table 2. Changes in Children Reported Following Intervention

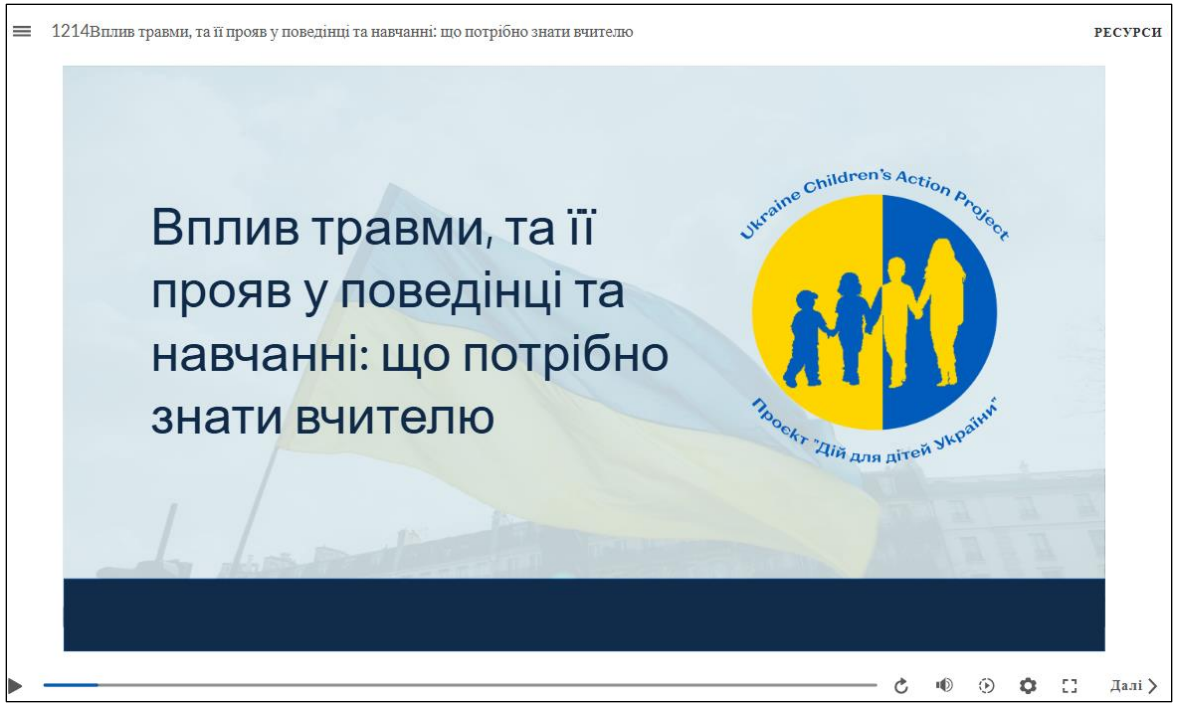
Change	No. (%) (N = 1291)[a]
Overall psychosocial state improved	968 (75.0)
Able to enjoy activities again	891 (69.0)
Less dependent on gadgets	852 (66.0)
More physical activity	775 (60.0)
Better communication with other children	710 (55.0)
More hugs	529 (41.0)
Less isolated	426 (33.0)
Sleep improved	232 (18.0)

Source: Redlener, Irwin, Khrystyna Dudashvili, Oksana Viontsek, Roy Grant, and Eva Roca. "Intervention for psychological trauma in children impacted by war in Ukraine." *JAMA Network Open* 8, no. 3 (2025): e253057-e253057.

Preparing Teachers to Work with Children

- Online self-paced course:
  - Module 1: Introduction to Trauma.
  - Module 2: What are the symptoms of a traumatized child?
  - Module 3: How educators can support children who have experienced trauma.
  - Module 4: What can be done in the classroom and school to incorporate trauma-informed practices and policies?

- ***Nearly 2,000 teachers completed the course within its first month***. Positive anecdotal feedback on modality, design, and impact in classroom. Additional data pending

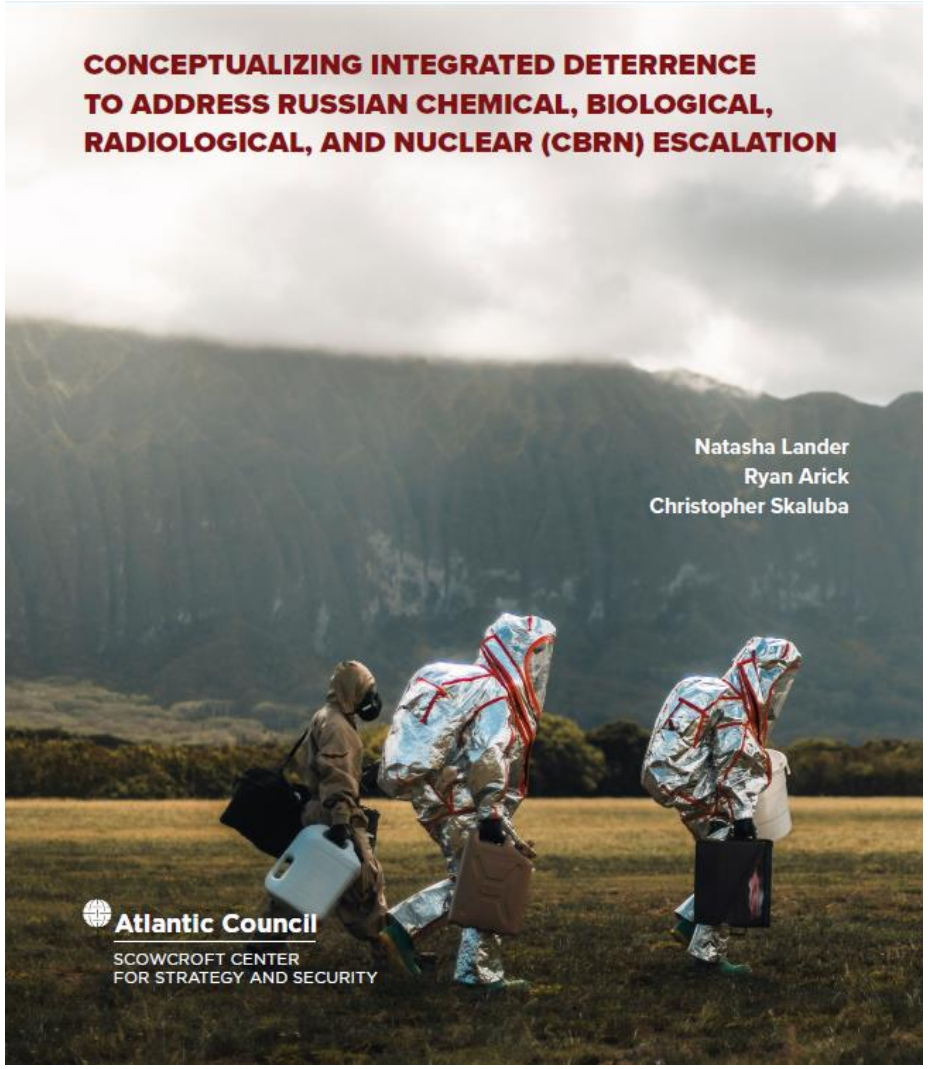


https://ucap.help/educational-courses/

Takeway #5

All civil society partners have a role in supporting health and mental health resilience.

- “The hollowness of Russia’s conventional capability, combined with its military doctrine and dangerous rhetoric, reinforces the important role that CBRN capabilities will likely play in Russian defense strategy in the coming years. However, there is currently a gap in US and European understanding of the manifestation of this risk in the near-to mid-term.”



Source: Lander, Arick, Skaluba. “Conceptualizing Integrated Deterrence to Address Russian Chemical, Biological, Radiological, and Nuclear (CBRN) Escalation." *Atlantic Council. October 26, 2023*

Weapons of Mass Destruction

Scenario 1: High Regime Stability and Strong Conventional Warfare Capabilities

Conditions: The Russian threat is acute due to the country's strong military capabilities and stable regime, which enjoys significant support at home. These characteristics could make the use of CBRN weapons more attractive to Russia, especially as a method to complement its conventional military strength.

Key Perspectives:

- Russia may employ technological advances, such as bioengineering, artificial intelligence, machine learning, and additive manufacturing, alongside strong conventional capabilities to increase its CBRN capabilities, especially with respect to tactical nuclear weapons and bioengineered weapons.
- Russia might also use CBRN weapons to demonstrate strength or as a means to expend fewer conventional forces in times of conflict.

Scenario 2: High Regime Stability and Weak Conventional Warfare Capabilities

Conditions: The Russian regime maintains control over political and social life, potentially drawing from continued authoritarianism and political repression. However, with weakened conventional power, Russia may turn to drastic measures to achieve its goals, including employing CBRN weapons.

Key Perspectives:

- To offset weak conventional capabilities, Russia may consider using CBRN weapons in targeted instances—such as political assassinations or direct attacks on critical infrastructure—with greater incentives to create unconventional weapons not governed by international norms.
- Russia may look to augment its nuclear capabilities to prop up its military power. Russia could refuse to relinquish control of its nuclear weapons arsenal or agree to future arms control treaties as a last means to maintain global legitimacy and offset the global posture of the United States.

Source: Lander, Arick, Skaluba. "Conceptualizing Integrated Deterrence to Address Russian Chemical, Biological, Radiological, and Nuclear (CBRN) Escalation." *Atlantic Council. October 26, 2023*

Weapons of Mass Destruction cont.

Scenario 3: Low Regime Stability and Weak Conventional Warfare Capabilities

Conditions: Russia's regime becomes more fragile as its conventional capabilities weaken, raising the specter of instability in Eurasia. These factors leave fewer options for Russian decision-makers to achieve their geopolitical goals and, as such, Russia may employ CBRN weapons in both targeted assassinations and on the battlefield to achieve its geopolitical agenda.

Key Perspectives:

- With an unstable regime and weak conventional capabilities, Russia could lose its position as a world power, setting it on a course toward isolationism and instability. Its participation in and support for multilateral institutions, including arms control regimes and disarmament treaties that monitor compliance regarding CBRN weapons, are in question.
- Russia may place greater emphasis on its existing nuclear capabilities as a deterrent, consider isolated use of chemical and biological weapons to target political opponents, or employ tactical nuclear weapons against key targets to compensate for conventional weakness.

Scenario 4: Low Regime Stability and Strong Conventional Warfare Capabilities

Conditions: The Russian regime is vulnerable to both the Russian public and the international community, which could cause Russian decision-makers to rely on all available means to restore power and legitimacy, including through its strong conventional warfare and existing CBRN capabilities.

Key Perspectives:

- To reestablish or defend its regime stability from further erosion, Russia will seek to suppress democratic movements and growing support for opposition candidates. As a solution, Russia may turn to targeted CBRN attacks using chemical agents to neutralize opponents and further deter efforts that would challenge the Russian regime.
- As Russia's central authority weakens, illegal markets may surface where organized crime groups and terrorist organizations transport and transfer CBRN weapons, materials, and technology to malign actors, thus broadening the possibility of CBRN escalation and conflict beyond Russia.

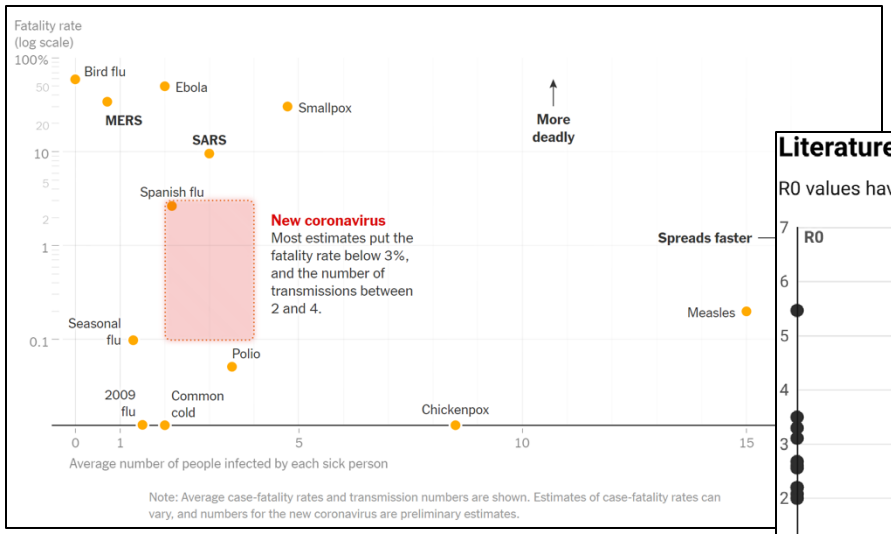
Source: Lander, Arick, Skaluba. "Conceptualizing Integrated Deterrence to Address Russian Chemical, Biological, Radiological, and Nuclear (CBRN) Escalation." *Atlantic Council. October 26, 2023*

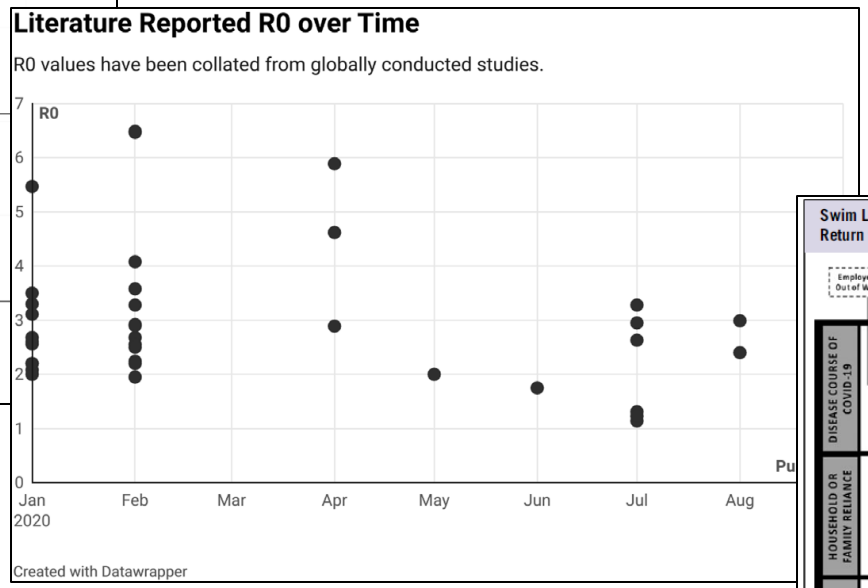
Takeway #6

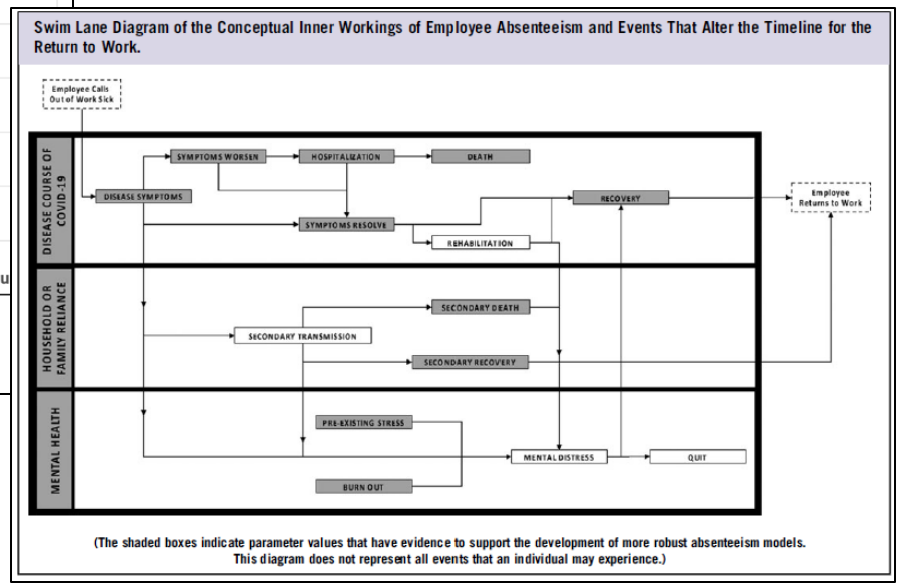
Weapons of Mass Destruction remain a real threat.

Managing Uncertainty

Evidence Exists, but So Does Uncertainty





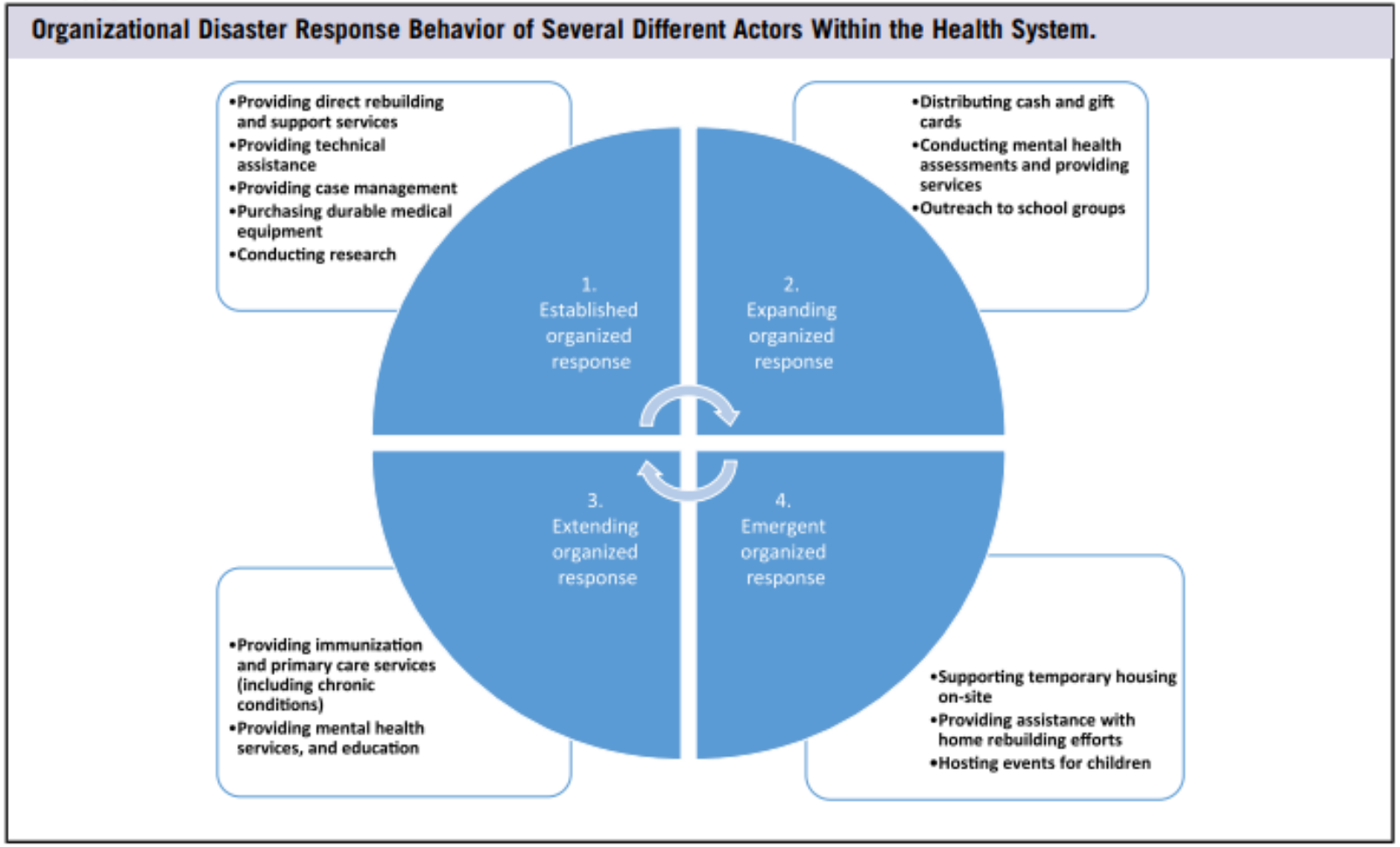


Sources: Sheikh, K., Watkins, D., Wu, J., & Gröndahl, M. (2020). How Bad Will the Coronavirus Outbreak Get? Here Are 6 Key Factors. The New York Times. https://www.nytimes.com/interactive/2020/world/asia/china-coronavirus-contain.html ; Saxena, G., Ratner, J., Schlegelmilch, J., White, Z., Wongsodirdjo, K., Aguilar, S., ... & Paaso, A. (2022). Integrating Data Variability Into Contemporary COVID-19 Decision Support. *Disaster Medicine and Public Health Preparedness*, *16*(5), 1743-1744. ; Source: White, Z., Schlegelmilch, J., Ratner, J., Saxena, G., Wongsodirdjo, K., Aguilar, S., ... & Bahramirad, S. (2021). Current data gaps in modeling essential worker absenteeism due to COVID-19. *Disaster medicine and public health preparedness*, *15*(4), e10-e11.

Emergent Partners in Disaster Response

FIGURE 1

Organizational Disaster Response Behavior of Several Different Actors Within the Health System.



Source: Schlegelmilch, J., Sury, J., Brooks, J., & Chandler, T. (2019). A philanthropic approach to supporting emergent disaster response and recovery. Disaster medicine and public health preparedness, 1-3. https://academiccommons.columbia.edu/doi/10.7916/d8-bkbq-g780

Emergent Strategy in Health and Medical Preparedness

And what happens when the disasters overlap?

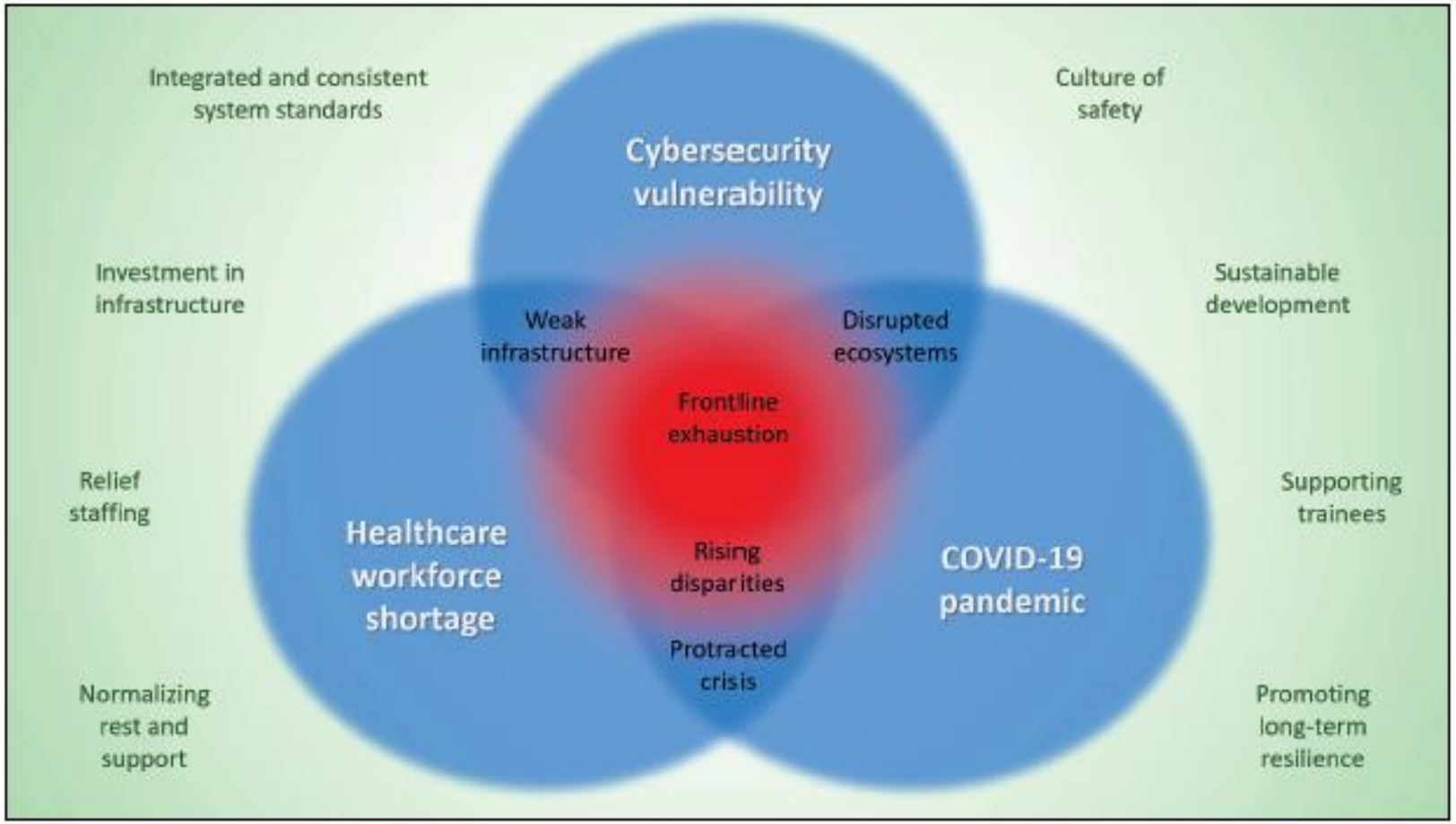
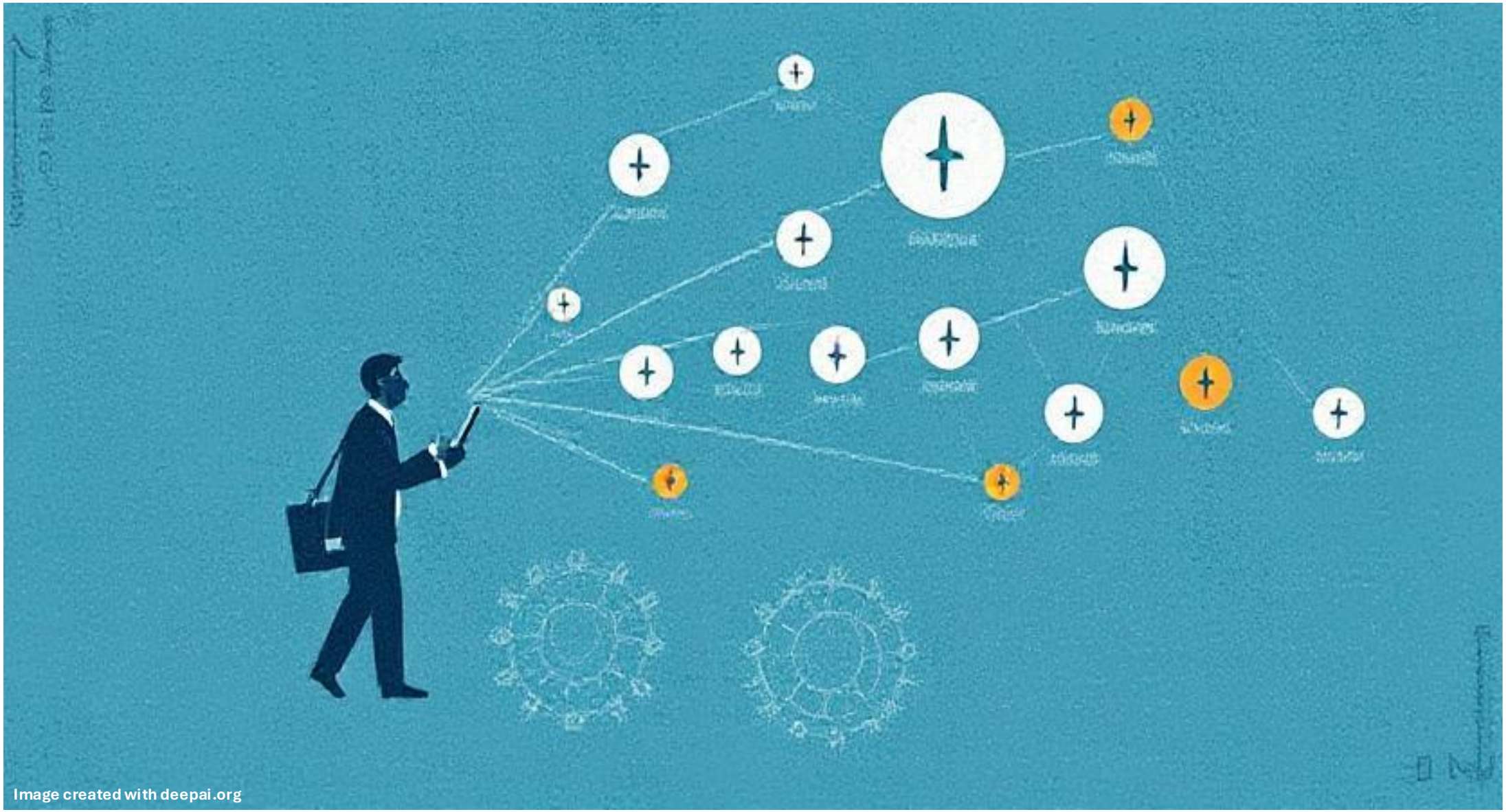


Figure 4 Common vulnerabilities and protective factors in pandemic, cyber and workforce shortage crises in healthcare

Source: Klindienst, J., Ayanian, S., Schlegelmilch, J., & Akselrod, H. (2022). Preparing for compounding crises: Staff shortages and cyber-attack vulnerability in the era of COVID-19. *Journal of Business Continuity & Emergency Planning*, *16*(2), 103-120.

The Strategy Paradox



Integrating Uncertainty into Planning

Figure 3: SOARS Framework with Integration of Uncertainty

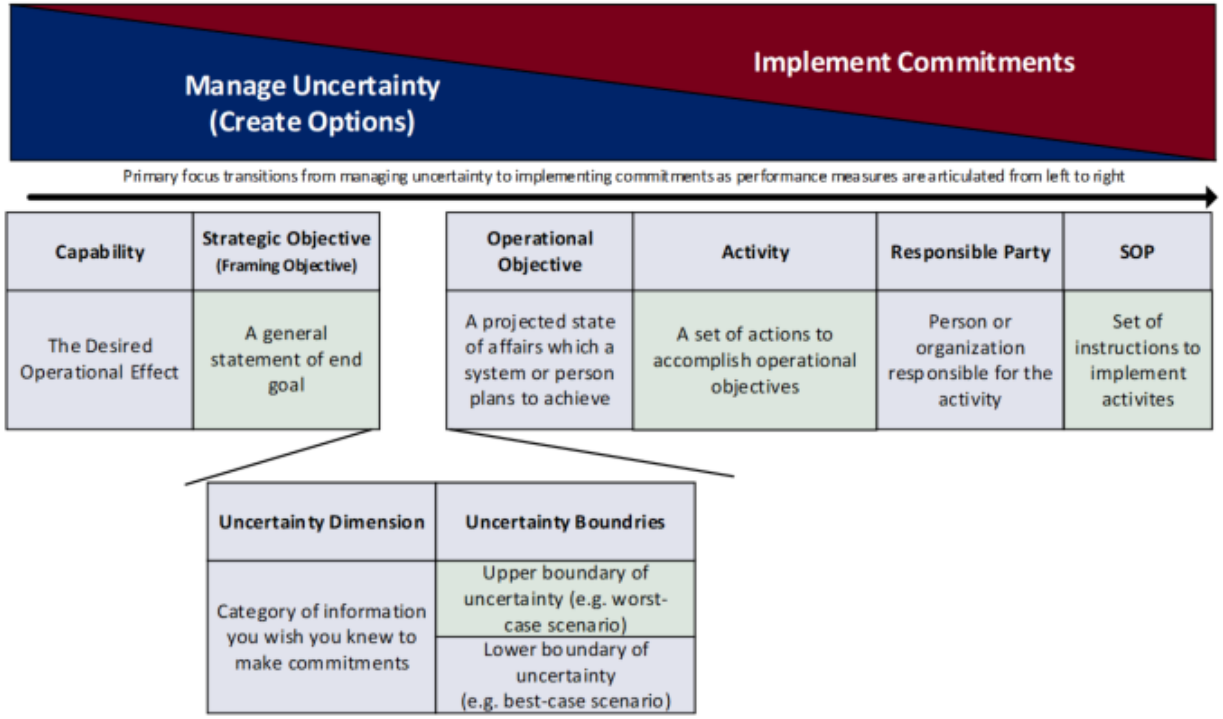


Figure 2: Organizational levels and relationship to managing uncertainty Adapted from Raynor [29]

Organizational Level	Strategic Balance	Strategic Question	Strategic Objective
Board	Manage Uncertainty (Create Options)	What could threaten our survival?	Flexibility
Corporate			
Business Unit		What could undermine our strategy?	Hedging
Function	Implement Commitments	What could derail our project?	Learning

Source: Establishing a Foundation for Performance Measurement for Local Public Health Preparedness, Journal of Disaster Medicine and Public Health Preparedness– In Press, adapted from Raynor ME. The strategy paradox: Why committing to success leads to failure (and what to do about it). Crown Business; 2007 and Keim ME. An innovative approach to capability-based emergency operations planning. Disaster Health. 2013;1(1):54-62

Tools to Support Humans Making Decisions

Coronavirus Pandemic (COVID-19)

PHASE: ACCELERATION / RE-ACCELERATION

INFORMATION NEEDED

DECISIONS NECESSARY	THREAT INFORMATION	CONTEXT

• ***Implement*** Group A Interventions as necessary
• ***Implement*** Group B Interventions as appropriate
• ***Initiate*** Group C Interventions as appropriate
• ***Identify*** additional interventions that may be necessary
	• **What is the severity of the virus (e.g. hospitalization and fatality rates)?**
	• **What is the current rate and trend of transmission in the area?**
	• **What is the rate of transmission for the virus?**
	  • **What is it forecasted to peak?**
	• **What is the attack rate/likelihood of infection?**
	• **What is the average duration of the illness?**
	  • **What is the duration for more serious cases?**
		• What social distancing measures are in place by local/state governments?
		  • **How effective is it? For how long as this trend held?**
		• What are the measures implemented in surrounding areas?
		• How long have control measures been in place?
		  • **How long are they expected to be in place?**
		• What is the capacity/reliability of testing?
		• What is the availability of personal protective equipment?
		• What is the availability of pharmaceutical countermeasures?

ACTION NEEDED

LEADERSHIP COORDINATION	ANALYTICAL SUPPORT

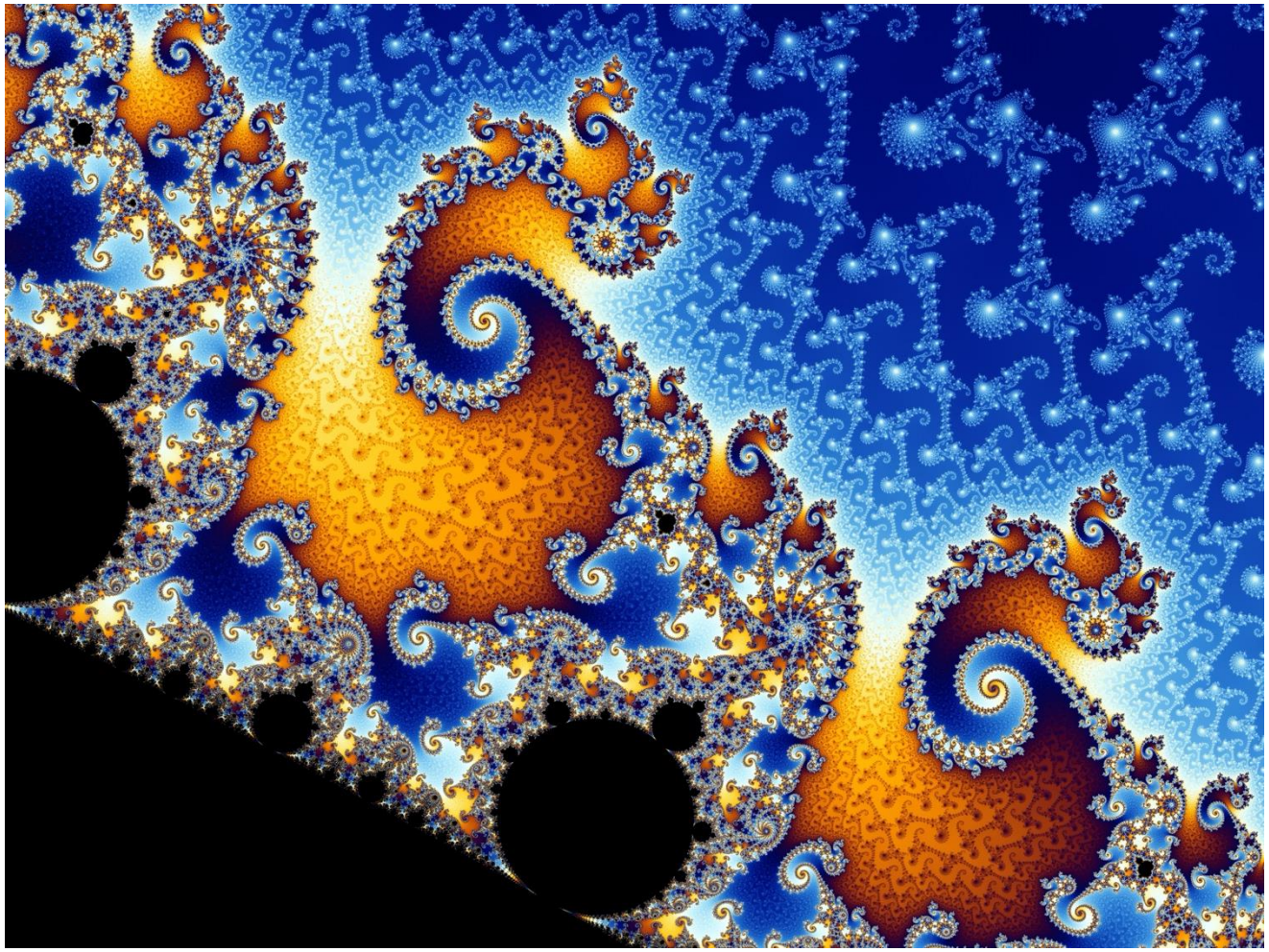
• Monitor absenteeism among all staff with particular attention to essential functions
• Implement additional interventions as appropriate
• Cross-train staff for re-assignment if necessary
  • Re-assign staff to essential functions as needed
• Identify operations at high risk for infection; and mitigation strategies
• Monitor changes in electricity loads due to changing consumer patterns
• Monitor/modify distribution operations to meet changes in consumer demand
• Modify distribution operations for increased resilience in the event of worker absenteeism
• Enhance employee communications and resources to support health and mental health at work and home
	• Update/Calibrate model(s) regularly to:
	  • Analyze current epidemiological curve(s) amd project rates of increase and potential peaks
	  • Evaluate ComEd absenteeism and illness relative to community-wide spread
	• Monitor absenteeism for trends and clusters of potential infection
	• Model transmission scenarios (no change, significant reduction, significant increase, etc)
	  • Utilize available epidemiological research to inform scenario development
	• Recommend additional interventions based on epidemiological analysis
	• Where possible, analyze risk for certain job functions (e.g. Travel)

Figure 4: Example synchronisation matrix: Acceleration phase

Source: Schlegelmilch, J., Paaso, A., Ratner, J., Saxena, G., White, Z., Aguilar, S., ... & Bahramirad, S. (2021). Using analytics to support a utility's initial response to the COVID-19 pandemic amid an uncertain evidence base. *Journal of Business Continuity & Emergency Planning*, *14*(3), 226-238.

From Determinism to Chaos: Building a More Dynamic Resilience

1 + 1 = 2

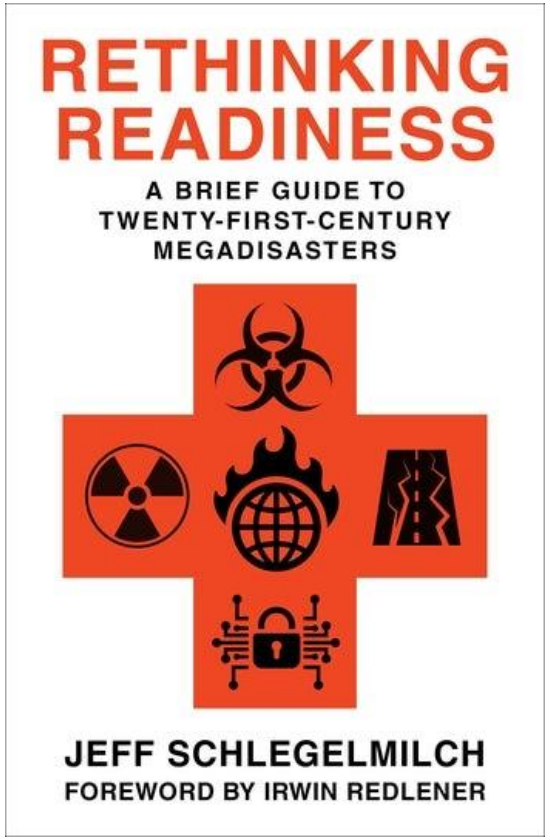


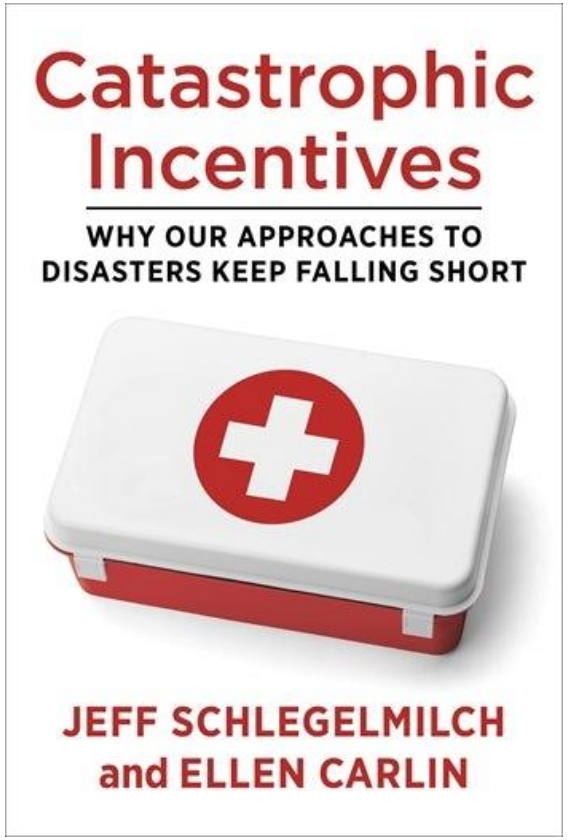
Source: https://commons.wikimedia.org/wiki/File:Mandel_zoom_11_satellite_double_spiral.jpg

Takeaway #7

Precision is over-rated and can be misleading. Look to each other and create options for a more dynamic and lasting resilience.

Thank you!





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