Strengthening Healthcare Disaster Preparedness and Resilience through Implementation Science: A Case Analysis of the Medical Response Surge Exercise (MRSE)

by

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Dedication

This dissertation is dedicated to the victims and survivors of unjust, human-caused chronic hazards that continue to plague our world, including but not limited to genocide, violence, homelessness, poverty, slavery, sexism, and racism, as well as to those affected by acute hazards—whether labeled natural or human-made. Hazards have the potential to create polycrises: first through the hazard itself, second through the failure of an effective response, and prolonged recovery efforts. While this work cannot serve as reparations for the past, it is my hope that it may be used as a tool to mitigate disasters upstream and help shape a future in which "all [people] are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty [including Justice and Equity], and the pursuit of Happiness."

This dissertation is also dedicated to future generations. My hope is that these ideas can be put into practice or inspire new knowledge, so that what we do today not only responds to the crises of our time but meaningfully transforms the conditions that create them.

Lastly, this is dedicated to disaster practitioners, including the research participants of this study, who dedicate (and in many cases sacrifice) their lives to protect their communities—family, friends, neighbors, and strangers.

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—

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Table of Contents

Dedication ii

Acknowledgments iii

List of Tables xiv

List of Figures xvi

List of Appendices xviii

List of Abbreviations xix

List of Acronyms xx

Abstract xxi

Chapter 1 Introduction 1

1.1 Background and Significance 1

1.2 Dissertation Overview 5

1.3 Literature Review 5

1.3.1 Disasters, Public Health Emergencies, and Health System Impacts 7

1.3.2 Disaster Preparedness, Exercises, and Evaluation in Healthcare Systems 9

1.3.3 Federal Policy and Regional Coordination in Hospital Disaster Preparedness 12

1.3.4 Disaster Management as a Sociotechnical Learning Health System 16

1.3.5 Implementation Science Opportunity to Enhance Disaster Management 21

1.3.6 Identified Literary Gaps and Study Opportunity 22

1.4 Conceptual Framework 23

1.5 Study Purpose, Overview, and Design 29

1.5.1 Specific Study Aims and Research Questions 31

1.5.2 Philosophical Positioning, Reflexivity, and Research Orientation 33

1.5.3 Study Design/ Methodological Overview 36
Chapter 2 Characterizing Federal Design and Implementation Domains of the MRSE 40
2.1 Abstract 40
2.2 Introduction 41
2.3 Literature Review 43
2.4 Methods 51
2.4.1 Data Collection 53
2.4.2 Data Analysis 53
2.5 Results 57
2.5.1 MRSE Situation Manual 64
2.5.2 MRSE Evaluation Plan 66
2.5.3 MRSE Exercise Planning and Evaluation Tool 67
2.6 Discussion 69
2.6.1 Limitations 76
2.6.2 Future Research 77
2.7 Conclusion 77
Chapter 3 Local Implementation of the MRSE: Participant Perceptions, Barriers, and Enablers 79
3.1 Abstract 79
3.2 Introduction 81
3.3 Literature Review 83
3.4 Methods 91
3.4.1 Sampling 94
3.4.2 Quantitative Data Collection and Analysis 97
3.4.3 Qualitative Data Collection and Analysis 102
3.4.4 Integration of Quantitative and Qualitative Data 107

3.5 Results 107
3.5.1 Quantitative 108
3.5.2 Qualitative 117
3.5.3 Integration of Quantitative and Qualitative Data 127
3.6 Discussion 133
3.6.1 Limitations 136
3.6.2 Future Research 138
3.7 Conclusion 139
Chapter 4 Participant-Identified Strategies and Mechanisms to Support MRSE Implementation 140
4.1 Abstract 140
4.2 Introduction 142
4.3 Literature Review 145
4.4 Methods 152
4.4.1 Data Collection 154
4.4.2 Data Cleaning 164
4.4.3 Data Analysis 166
4.4.4 Data Integration and Synthesis 168
4.5 Results 169
4.6 Discussion 184
4.6.1 Limitations 190
4.6.2 Future Research 191
4.7 Conclusion 192
Chapter 5 Discussion, Implications, and Conclusion 194
5.1 Discussion 194
5.1.1 Integration Across the Three Aims 198

5.1.2 Framing Disaster Management as a Learning (Health) System 204
5.1.3 Federal Preparedness Infrastructure, Resilience, and Equity 208
5.2 Methodological Contributions 211
5.3 Implications 213
5.3.1 Implications for Disaster Practice 214
5.3.2 Implications for Disaster Policy 214
5.3.3 Implications for Learning Health System Model and Implementation Science 215
5.3.4 Implications for Applying Implementation Science to Disaster Management 215
5.3.5 Implications for Disaster Science and Research 216
5.4 Limitations 217
5.5 Future Research 218
5.6 Conclusion 221
Appendices 225
Bibliography 281

List of Tables

Table 1.1 Study Aims Conceptual Analytic Inputs and Outputs 31

Table 2.1 Defined CFIR Domain Boundaries for MRSE 55

Table 2.2 Overview of MRSE Documents and Coding Segments 58

Table 2.3 Top 10 Most Frequently Occurring Words Across MRSE Guidance Documents 59

Table 2.4 Top 10 Three-Word Combinations Identified Across MRSE Guidance Documents ... 60

Table 2.5 Proportion of Coded Text and Coverage of CFIR Across MRSE Documents 61

Table 2.6 Percent of Coded Text by CFIR Construct Across MRSE Planning and Evaluation Documents 62

Table 2.7 Distribution of MRSE Exercise Outcomes Across Outcome Domains and Subconstructs (N = 7) 63

Table 3.1 Participant Characteristics (N = 15)..... 109

Table 3.2 Summary of Respondent Participation Across 2024 MRSE Phases 111

Table 3.3 Estimated Hours Spent on Each Phase of the 2024 MRSE by Respondents..... 112

Table 3.4 Respondent Familiarity with MRSE Objectives and Outcomes..... 113

Table 3.5 Perceived Most Effective Disaster Preparedness Exercise Type..... 113

Table 3.6 Participant Agreement with MRSE Foundational Principles (n = 15) 115

Table 3.7 Evaluation of Organizational Performance for 2024 MRSE Objectives 116

Table 3.8 MRSE Implementation Outcomes Assessment using RE-AIM (n = 15) 117

Table 3.9 MRSE Implementation RADAR Thematic Determinants..... 118

Table 3.10 Distribution of Barriers and Enablers by CFIR Domain and Construct (Column Percentages, N=22)..... 119

Table 3.11 Thematic Determinants by Type and Resilience Classification (N=22) 120

Table 3.12 Ranked RADaR MRSE Thematic Barriers 122

Table 3.13 High-Frequency Implementation Barriers and Select Representative Quotes 122

Table 3.14 Ranked MRSE Thematic Enablers 124

Table 3.15 High-Frequency Implementation Enablers and Select Representative Quotes 125

Table 3.16 Joint Display of MRSE Determinants 128

Table 4.1 Comparison of Preliminary and Final Qualitative Theme Rankings for Enablers 161

Table 4.2 Comparison of Preliminary and Final Qualitative Theme Rankings for Barriers 161

Table 4.3 ERIC Strategy Groupings Used for Summarization 168

Table 4.4 Count of Strategies and Mechanisms by Thematic Determinant 171

Table 4.5 Selected Strategies and Mechanisms Identified Through Aim 3 RADaR Analysis ... 172

Table 4.6 RADaR Thematic Strategies and Grouped Strategy Counts 173

Table 4.7 ERIC Implementation Strategies Frequently Mapped to MRSE RADaR Strategy–Mechanism Pairs 175

Table 4.8 Distribution of ERIC Strategy Clusters Across MRSE Strategy–Mechanism Pairs .. 176

Table 4.9 Enabler Determinants Mapped to RADaR Thematic Strategies by Strategy-Mechanism Pairs..... 178

Table 4.10 Enabler Determinants Mapping to ERIC Strategy Clusters by Strategy-Mechanism Pairs..... 179

Table 4.11 Barrier Determinants Mapped to RADaR Thematic Strategies by Strategy-Mechanism Pairs 180

Table 4.12 Enabler Determinants Mapping to ERIC Strategy Clusters by Strategy-Mechanism Pairs..... 181

List of Figures

Figure 1.1 Conceptual alignment of Disaster Management and Learning Health System cycles 26

Figure 1.2 Overview of Study Aims, Data Collection, Data Analysis, and Integration 36

Figure 1.3 Overview of Study Aims, Design, and Implementation Science Frameworks for the MRSE Evaluation 39

Figure 2.1 Word Cloud of MRSE Document Content generated by MAXQDA 59

Figure 2.2 Disaster Exercises as a Learning System 73

Figure 3.1 Convergent Parallel Design 91

Figure 3.2 Recruitment and Participation Flow Diagram 96

Figure 3.3 Overview of Qualitative Data Methods and Process to Determine Determinants Related to MRSE Implementation 103

Figure 3.4 Estimated Hours Spent by Organizations Across MRSE Phases 112

Figure 3.5 Frequency of RADaR Thematic Barriers Identified in MRSE Interviews 121

Figure 3.6 Frequency of Thematic Enablers Identified in MRSE Interviews 124

Figure 4.1 Aim 3 Methods Analytic Workflow Overview 152

Figure 4.2 Enabler Rank List Interview Visual used for Member Checking 158

Figure 4.3 Abbreviated Implementation Research Logic Model (IRLM) Visual Used for Think-Aloud Activity 158

Figure 4.4 Enabler Rank List Interview Visual used for Member Checking 159

Figure 4.5 Example of Completed Think-aloud Interview Analytic Field Notes 163

Figure 4.6 Example of Analytic Field Note Transfer and Vertical Structuring in Excel for Enabler 1 (Strong Collaboration and Coalition Engagement) 163

Figure 4.7 Qualitative Methodological Approach and Data Cleaning Sub-Procedures 164

Figure 4.8 Example of RADaR Data Cleaning and Tracker Development in Excel 165

Figure 4.9 Horizontal and Vertical Analysis Overview 166

Figure 4.10 Graphic Representation of Parallel Thematic and ERIC Mapping Analysis 177

Figure 4.11 MRSE Mechanism Synthesis for Determinant Enabler Strong Collaboration and Coalition Engagement 182

Figure 4.12 MRSE Mechanism Synthesis for Determinant Barrier Competing Priorities & Time Constraints 183

Figure 4.13 MRSE Mechanism Synthesis for Determinant Barrier Administrative Burden & Complex Tools 184

Figure 5.1 Implementation Research Logic Model (IRLM) for the execution of the MRSE 203

Figure 5.2 Disaster Management as a Continuous Learning System 204

Figure 5.3 Multi-Level Disaster Preparedness as a Learning System Across the Disaster Management Cycle Continuum 207

List of Appendices

Appendix A IRB Exemption Determination Letter 225

Appendix B Summary of Study Procedures and Analytic Workflow 226

Appendix C MAXQDA Codebook Report and Overview of Analytic Application 228

Appendix D Federal MRSE Guidance Documents Reviewed in Aim 1(Chapter 2) 239

Appendix E Aim 1 Complete MAXQDA Output 241

Appendix F Aim 2 Survey Instrument (Chapter 3) 244

Appendix G Aim 2 Interview Guide (Chapter 3) 265

Appendix H Aim 3 Interview Guide and Activity (Chapter 4) 270

List of Abbreviations

AAR – After-Action Review or After-Action Report
AI – Artificial Intelligence
CA – Cooperative Agreement
D2K – Data to Knowledge
DHA – Defense Health Agency
DHS – Department of Homeland Security
DM – Disaster Management
EMS – Emergency Medical Services
FY – Fiscal Year
GAO – Government Accountability Office
HCC – Healthcare Coalition
HPP – Hospital Preparedness Program
HSDL – Homeland Security Digital Library
IoM – Institute of Medicine
iPRISM – Iterative, Practical, Robust Implementation and Sustainability Model
IRBMED –Institutional Review Board for Medicine
IRLM – Implementation Research Logic Model
IP – Improvement Plans
IT – Information Technology
K2P – Knowledge to Practice
KMS – Knowledge Management System
LHS – Learning Health System
MM – Mixed Methods
MRSE – Medical Response Surge Exercise
P2D – Practice to Data
PHE – Public Health Emergency
PHE – Public Health Emergency Preparedness
QUAL – Qualitative
QUANT – Quantitative
SOP – Standard Operating Procedure
SRQR – Standards for Reporting Qualitative Research
TMF – Theory, Models, Framework
TTX – Table-Top Exercise

List of Acronyms

ASPR – Administration for Strategic Preparedness and Response
CFIR – Consolidated Framework for Implementation Research
CITAP – Continuous Improvement Guidance, Continuous Improvement Technical Assistance Program
DoGE – Department of Government Efficiency
ERIC – Expert Recommendations for Implementing Change
FEMA – Federal Emergency Management Agency
HSEEP – Homeland Security Exercise and Evaluation Program
MAXQDA – Max Qualitative Data Analysis
NIMS – National Incident Management System
pCAT – Pragmatic Context Assessment Tool
PCORI – Patient-Centered Outcomes Research Institute
RADaR – Rapid and Rigorous Qualitative Data Analysis Technique
RE-AIM – Reach, Effectiveness, Adoption, Implementation, and Maintenance
TRACIE – Technical Resources, Assistance Center, and Information Exchange

Abstract

Healthcare organizations operate within a highly regulated environment that includes multiple mandates related to disaster preparedness. While written plans and manuals are necessary, disaster drills and exercises serve as critical mechanisms for generating knowledge and assessing both organizational capacity and capability. Existing disaster exercise guidance largely focuses on design, execution, and evaluation. Consequently, current literature provides limited guidance to help practitioners account for sociotechnical context during implementation. As a result, less is understood about how disaster preparedness exercises are carried out in practice or how contextual factors influence learning and readiness outcomes.

This gap is reflected in the broader disaster management literature, which demonstrates minimal application of implementation science approaches. Implementation science examines how evidence-based interventions—such as disaster preparedness exercises—work in real-world settings, emphasizing the importance of context in shaping implementation processes. This dissertation applies implementation science theories, models, and frameworks as evaluative tools to examine disaster preparedness exercises as knowledge-generating activities that inform response readiness.

Disaster management in the United States operates within a tiered structure that is federally supported, state managed and locally executed. The federally designed preparedness exercise known as the Medical Response Surge Exercise is intended to strengthen coordination, medical surge capacity, and overall system readiness across healthcare systems. This study

examines implementation of the MRSE, a mandated exercise for Healthcare Coalitions (HCCs) under the Hospital Preparedness Program (HPP), administered by the Administration for Strategic Preparedness and Response (ASPR). All study activities involving human participants were conducted virtually with individuals affiliated with HCCs in a single anonymized Midwestern state participating in the HPP through a cooperative agreement (CA).

This multiphase study used a convergent mixed-methods approach guided by the Implementation Research Logic Model (IRLM), an implementation science process framework; data sources included document analysis, surveys, and participatory interviews. Aim 1 applied the Consolidated Framework for Implementation Research (CFIR) implementation science determinants framework, along with RE-AIM and Proctor Implementation Outcomes evaluation frameworks, to analyze federal MRSE guidance document's structure and intended goals. Aim 2 used CFIR-informed surveys and semi-structured interviews to assess HCC leaders and members perceptions of past MRSE implementation and identify barriers and facilitators influencing planning, execution, and learning at local-level. Aim 3 used guided think-aloud interviews to identify implementation strategies and their associated mechanisms to strengthen implementation facilitators and address implementation barriers.

The findings across the aims were integrated using the IRLM to illustrate how the MRSE is federally supported, state managed and locally executed. Results highlight how sociotechnical factors, leadership engagement, organizational readiness, and resource availability shape implementation. Findings further demonstrate how implementation science frameworks, when applied as evaluative tools, can complement traditional After-Action processes by offering a more systematic approach to translating lessons learned into sustained preparedness improvement.

Overall, this dissertation contributes empirical evidence on the implementation of a federally designed disaster preparedness exercise and demonstrates the value of integrating implementation science and disaster science to strengthen learning and readiness across healthcare systems.

Chapter 1 Introduction

1.1 Background and Significance

The growing frequency and impact of disasters has amplified the stress on interconnected healthcare and public health systems, highlighting the importance of preparedness as a core component of system resilience. Disaster preparedness exercises are a critical but underexamined mechanism through which organizations attempt to translate knowledge (planning) into practice (action). Preparing for the complex and high-stakes environments in which a disaster occurs means that preparedness should not only depend on the design of the exercises but on how exercises are implemented within local contexts.

This dissertation adopts an implementation-focused perspective to examine how federally designed disaster preparedness activities are implemented locally. It conceptualizes disaster management as a macro-system that can be modeled as a Learning Health System (LHS), composed of interconnected sub-systems or phases that can also function as LHSs— including the disaster preparedness phase. Within this framing, disaster preparedness exercises, such as the Medical Response Surge Exercise (MRSE), are conceptualized as interventions; while groups of disaster practitioners, such as Healthcare Coalitions (HCCs), are conceptualized as learning communities. (Friedman, 2022a). Ultimately, this work seeks to provide empirical research on disaster preparedness exercises while offering a methodological implementation science approach that demonstrates the utility of accounting for sociotechnical factors influencing implementation to improve disaster exercises and strengthen overall disaster preparedness.

> *"There is a time for everything and a season for every activity under the heavens: a time to tear down and a time to build, a time to weep and a time to laugh… a time to search and a time to give up… a time to be silent and a time to speak… a time for war and a time for peace."*
>
> — Ecclesiastes 3:1–8

In disaster management and research, the question is not if the next disaster will strike, but when. The passage from Ecclesiastes rings true when overlaid with disaster management: there is a time to mitigate and a time to prepare; there is a time to respond and a time to recover— these times may often overlap due to poly-crises also known as compounding disasters. Thoroughly defined later, disasters are the result of a *hazard* plus the *impact* it has on human life.

While disasters are complex experiences, they can also become life-changing events, often altering the course of history—whether for individuals directly impacted or for society. Paradoxically, disasters can create moments for both "a time to mourn" the lives lost and "a time to dance" in celebration of survival (Ecclesiastes 3:1–8).

Disasters are rarely the result of a single hazard; they are the cumulative outcome of intersecting systems, policies, infrastructures, and inequities that shape who is exposed, who is protected, and who can recover. Reflecting on the experiences of a Jim Crow–segregated America on the precipice of the civil rights movement, poet Audre Lorde articulated the interconnected nature of social struggle when she stated:

> *"There is no such thing as a single-issue struggle because we do not live single-issue lives… Our struggles are particular, but we are not alone. We are not perfect, but we are stronger and wiser than the sum of our errors."*
>
> — Audre Lorde, Learning from the 60's (1984)

Several years later, Lorde experienced another type of disaster firsthand in St. Croix— Hurricane Hugo. Hugo was a Category 5 hurricane that made landfall between September 17 and

21, 1989, affecting Guadeloupe, Saint Croix, Puerto Rico, and South Carolina. After years of turbulent colonial rule marked by seven different flags (Spain, England, Holland, France, the Knights of Malta, Denmark, and the United States), St. Croix was left struggling to recover. Lorde found healing through her journal writings. Notably reflecting:

> *"Those who do not learn from history are doomed to repeat their mistakes. It is necessary to remember the nightmare experience and extraordinary heroisms of the hurricane. But it is also important that we remember those lessons, both immediate and long term, learned in the bleak days afterward."*
>
> — Audre Lorde, Of Generators and Survival: Hugo Letter (1989)

As explored throughout this study, disasters generate opportunities to build both tacit knowledge gained through experience and practice, and explicit knowledge that can be formally documented, shared, and applied. In disaster response, both forms of knowledge are critical for survival. I argue that explicit knowledge for disaster response can primarily be generated through disaster preparedness activities. Activities may include, but are not limited to, the development and study of manuals and policies, as well as the implementation of trainings and exercises (Herstein et al., 2021). Through these activities, disaster responders learn to move beyond instinctual reactions such as fight, flight, freeze, or fawn and instead focus on coordinated response and decision-making (Zingela et al., 2022). This preparedness is evident in historical examples of extraordinary leadership and action.

Harriet Tubman's leadership during the Underground Railroad exemplifies deliberate long-term preparation and explicit knowledge applied under extreme conditions. Tubman freed approximately seventy enslaved Black people by leveraging skills developed during her enslavement in Maryland's marshes and timber fields. She learned to navigate the terrain using the stars, built trusted networks along the path, planned rescues strategically, and used disguises and coded songs—each an intentional preparedness strategy.

On September 11, 2001, Rick Rescorla rescued nearly 2,700 people from the World Trade Center. Mr. Rescorla was formally trained in both the British and American armies. He experienced the 1993 World Trade Center bombing and became convinced that another attack was inevitable so as vice president for corporate security at Dean Witter Morgan Stanley, he developed and relentlessly rehearsed a disaster contingency plan. His preparation directly contributed to the successful evacuation that saved thousands of lives.

Similarly, in 2009, Captain Chesley "Sully" Sullenberger demonstrated the power of combined explicit and tacit knowledge during US Airways Flight 1549. Following a bird strike that caused dual engine failure shortly after takeoff, Sullenberger had less than three minutes to act. His decision to glide the aircraft safely into the Hudson River was informed by decades of preparation: military training as a fighter pilot, nearly thirty years as a commercial airline pilot, and extensive experience analyzing aviation accidents for both the Air Force and the National Transportation Safety Board. His calm decision-making under pressure was enabled by a lifetime of preparation.

Preparedness exercises, such as the MRSE serve as critical interventions to support learning, coordination, and surge readiness across the healthcare system. Federally required for HCC under the ASPR HPP, the MRSE represents a strong use case for examining how national preparedness expectations are operationalized in local contexts. However, there is limited empirical evidence examining how preparedness exercises are implemented and used in real-world settings.

1.2 Dissertation Overview

By using the MRSE as a case analysis, this study addresses this implementation gap, generating practical insights to strengthen disaster preparedness practice while contributing to both implementation science and disaster science. The findings have direct relevance for HCCs and public health agencies seeking to improve the design and execution of preparedness exercises in support of public health emergency preparedness.

Viewing disaster preparedness as an opportunity to build explicit knowledge, this dissertation applies implementation science to examine preparedness exercises within their local contexts. Rather than focusing solely on organizational performance during exercises, it examines how exercises are implemented within complex sociotechnical systems. Applying implementation science approaches, this work identifies key barriers and facilitators and advances practical strategies and mechanisms to support the translation of knowledge into practice for disaster responders, while offering pragmatic approaches for moving beyond traditional After-Action Reviews (AARs) to strengthen disaster practice and inform improvements in disaster preparedness exercise design.

1.3 Literature Review

Reviews completed between 2007 and 2025 concluded that no universally accepted definition of disaster exists, and the terms “disasters,” “catastrophe,” and “emergencies” are often used interchangeably throughout the literature (Mohamed, 2007; Lettieri et al., 2009; Al-Jazairi, 2019; Shroff, 2021; Chmutina & Von Meding, 2025). Broadly, disasters are events that cause severe disturbances resulting in loss of life, harm to health, disruption of normal patterns of life, and the need for assistance beyond routine capabilities (Lynch & Berman, 2012, p.5). Another study proposed a Universal Disaster Severity Classification Scheme (UDSCS) to

standardize how disaster severity is measured and communicated across hazard types; arguing that current disaster classification systems are fragmented and inconsistent, and emphasized that disaster impacts are shaped not only by hazard intensity, but also by social vulnerability, preparedness, infrastructure, and contextual factors (Caldera & Wirasinghe, 2022).

Based on *War and Public Health: A Handbook*, disasters are comprised of three core components: hazards (risks), vulnerabilities, and impacts (Perrin,1996). In 2015, The United Nations Office for Disaster Risk Reduction (UNDRR) expanded this framework by including "exposure" as an additional component (United Nations International Strategy for Disaster Reduction Secretariat [UNISDRS]). Hazards tend to be categorized into two main group– natural or man-made (Mohamed, 2007; Severin & Jacobson, 2020). Natural hazards are incidents assumed to be caused by the Earth's regular processes. There are six natural hazards sub-categories: (1) Geophysical (e.g., earthquakes), (2) Hydrological (e.g., flood), (3) Meteorological (e.g., hurricane), (4) Climatological (e.g., wildfire), (5) Biological (e.g., epidemic/pandemic), (6) Extraterrestrial (e.g., space weather) (Chaudhary & Piracha, 2021). Man-made hazards result from human decisions - intent, negligence, or error and have two sub-categories– socio-technical and warfare (Mohamed, 2007). Sociotechnical disasters may be related to man-made systems such as Technology (e.g., chemical spill), Transportation (e.g., airplane crash), Public place failure (e.g., structural collapse), or Production failures (e.g., distribution of defective products); warfare can be described as National War (e.g., civil war, strikes, disorder), Conventional International War (e.g., sieges), and Non-conventional International War (e.g., nuclear attacks). Vulnerabilities may be ecological, economic (individual, local, national, and international), social (human, community, and institutional), political, or legal (Perrin, 1996).

When exposure is considered a component of vulnerability, hazards interacting with vulnerabilities lead to impacts that are categorized as disasters. These disasters have significant impacts on human life and frequently place extraordinary demands on already strained healthcare systems. These events disrupt normal operations and require rapid-coordinated responses to protect public health. Hospitals are a critical infrastructure with staff serving as the primary responders to medical surge. Therefore, to respond holistically, disaster preparedness must extend beyond individual organizations to include regional coordination among various healthcare partners. Healthcare preparedness is a national security priority because disaster-related mortality depends not only on the severity of events but also on the capacity of health systems to respond effectively and mitigate consequences (Toner, 2017).

This literature review examines how disaster preparedness within U.S. healthcare systems is conceptualized and implemented, focusing on to the persistent gap between preparedness guidance and real-world execution.

1.3.1 Disasters, Public Health Emergencies, and Health System Impacts

In today's rapidly evolving world, the occurrence of disasters has become increasingly common (National Oceanic and Atmospheric Administration National Centers for Environmental Information, 2020). Disasters pose significant challenges for individuals, communities, and the delivery of health care services. In the United States, disasters can be declared either as a Public Health Emergency (PHE) by HHS to activate health-specific authorities or as a Stafford Act emergency or major disaster by the President to mobilize FEMA resources (Federal Emergency Management Agency [FEMA], 2011). PHEs typically generate widespread health impacts that increase demand for medical services, resulting in a medical surge that can strain healthcare system capacity. Hospitals often bear the brunt of disaster

impacts and are tasked with providing timely and efficient medical care to those affected, while experiencing significant strain on infrastructure, staffing, and resources (Bell et al., 2018; Pollack, 2025).

Because disasters disrupt healthcare delivery and overwhelm local response capacity, effective and coordinated disaster management is essential to support hospitals and the broader healthcare system in maintaining operations and responding to medical surge demands. PHEs expose gaps in preparedness, surveillance, and capacity, resulting in service disruption and increased inequities; evidence shows that integrated multisectoral (public health and healthcare) coordination, digital tools, and community-based teams are key to effective response and resilience (Khatri et al., 2023).

The Institute of Medicine and National Research Council's (2005) workshop on public health risks of disasters highlighted the critical role of communication, infrastructure resilience, and coordinated preparedness in mitigating disaster-related health impacts. Summary takeaways of the workshop emphasized that failures in these domains can significantly impair public health and health care system responses, emphasizing the need for integrated planning and sustained investment across sectors. A World Bank supported report found that health systems are increasingly vulnerable to shocks from disasters, climate events, and PHE that threaten continuity of care and population health; concluding that health system resilience depends on coordinated preparedness across infrastructure, workforce, supply chains, governance, and information systems, with systematic assessments needed to identify gaps and guide targeted investments (Rentschler et al., 2021). These challenges demonstrate the critical importance of disaster preparedness within healthcare systems to maintain essential functions during disasters.

1.3.2 Disaster Preparedness, Exercises, and Evaluation in Healthcare Systems

Over time, disaster management has evolved from an experience-based practice into a discipline grounded in principles, theoretical frameworks, and evidence-based approaches. As a discipline, disaster science develops evidence-based practices essential to increase human capacity to prepare for, respond to, and recover from disasters. The field of disaster science aims to develop interventions that improve disaster management processes, inform decision-making, promote communication and cooperation at the local, state, national, and global levels, and use statistical methods and models to quantify aspects of disasters (Masterson et al., 2019). However, ensuring the successful implementation of these disaster practices within healthcare settings is a significant research gap (Øvretveit & Ohrling, 2021).

In the United States, disaster management is guided by an all-hazards, capabilities-based approach that promotes coordinated preparedness for diverse threats (FEMA, 1996; Health Human Services [HHS], 2015). This approach is structured around the Disaster Management Cycle, which defines disaster management as an ongoing process of mitigation, preparedness, response, and recovery (Sawalha, 2020). The mitigation phase "consists of the efforts and actions to minimize the degree of risk, prevent disasters and reduce the vulnerability to the physical environment and community" (Gougelet, 2006). According to the U.S. Department of Homeland Security (DHS) National Mitigation Framework the seven core mitigation capabilities include– threats and hazards identification, risk and disaster resilience assessment, planning, community resilience, public information and warning, long-term vulnerability reduction, and operational coordination (Department of Homeland Security [DHS], 2016). The preparedness phase includes planning, training, and educational activities for events that cannot be mitigated (Waugh, 2015). Examples of preparedness activities may include training programs for emergency responders,

drills and exercises, early warning systems, contingency planning, and equipment and supply stockpiles (FEMA, 2015; United Nations Office for Disaster Risk Reduction [UNDRR], 2017).

Disaster preparedness exercises play a central role within the preparedness cycle by providing structured opportunities to test assumptions, validate plans and capabilities, identify gaps, and generate information that informs improvement planning (FEMA, 2015). Guided by standardized frameworks such as the Homeland Security Exercise and Evaluation Program (HSEEP), exercises are implemented within an organized cycle of planning, execution, evaluation, and improvement that can be tailored to meet organizational needs (DHS, 2020). Therefore, exercises support continuous readiness by allowing organizations to assess performance in a low-risk environment and iteratively strengthen preparedness over time (FEMA, 2015).

Fortunately, because large-scale PHE are rare, collecting real-world evidence on health system responses are both methodologically and ethically challenging (Cuthbertson & Penney, 2023). Therefore, healthcare and public health agencies rely heavily on exercises (simulated emergencies) to test preparedness; however, evaluation of performance during these exercises have been inconsistent, and there is limited evidence showing how exercise data reliably reflect true emergency readiness (Savoia et al., 2014). Traditional training evaluation models, such as the Kirkpatrick framework, are commonly used to assess learning outcomes but are not well suited for evaluating preparedness exercises that function as system-level tests rather than individual training interventions (Rouse, 2011). Savoia and colleagues (2014) analyzed over 70 public health emergency exercises, resulting in a framework to measure how well exercises can be used to assess preparedness including: the purpose of measurement (accountability versus quality improvement), the exercise design and quality, the unit of analysis (individual versus

organizational/system), and the measurement instruments used. Another study found that emergency preparedness and response programs demonstrate strong workforce capability but limited organizational capacity, with structural barriers and poor integration of community engagement into routine practice (Gamboa-Maldonado et al., 2012). The study amplified a disconnect between what programs can do and what systems support highlights the need for targeted participatory training to strengthen capacity and fully leverage existing capabilities for sustained, community-centered emergency preparedness.

A recent review on the importance of disaster preparedness in hospital found that hospital disaster preparedness is essential to mitigating disaster impacts and requires a comprehensive approach encompassing risk assessment, staff training, communication systems, resource management, and collaboration with external partners (Khirekar et al., 2023). The review highlighted persistent challenges across disasters including resource constraints, interoperability issues, evacuation planning, and ethical decision-making; further detailing that essential hospital disaster preparedness strategies must include comprehensive emergency operations planning, hazard-specific risk assessment, clear command and control structures, protection of critical infrastructure, workforce training, effective communication and resource management, coordination with external partners, and continuous evaluation and improvement through exercises and after-action learning. Another study noted that preparedness within healthcare systems must be an ongoing process that requires continuous assessment, planning, training, exercising, and revision (Herstein et al., 2021).

Within this context, understanding hospital disaster preparedness in the United States requires examining the federal programs, governance structures, and regional coordination mechanisms that shape how preparedness is operationalized in practice.

1.3.3 Federal Policy and Regional Coordination in Hospital Disaster Preparedness

Disaster management in the United States involves a multi-agency and multi-level—national, state, county, and local municipal system (DHS, 2011). These efforts are more commonly assumed to be led by FEMA, which coordinates national disaster management, preparedness, response, recovery, and mitigation efforts through an all-hazards and whole-community approach. While traditionally ASPR focuses on healthcare system preparedness, hospital surge capacity, and HCCs and the Centers for Disease Control and Prevention (CDC) leads public health surveillance, disease control, epidemiology, and emergency public health response activities. Additionally, the Defense Health Agency (DHA) supports military medical readiness, national health security, and coordinated medical response capabilities during large-scale emergencies and public health crises. However, despite the potentially interconnected roles of these agencies within the national disaster preparedness and response infrastructure, no research known to this author has comprehensively synthesized or clearly delineated the federal-level roles, responsibilities, operational scopes, or degree of coordination across these entities.

A 2022 Government Accountability Office (GAO) report found that the federal disaster recovery system is highly fragmented across agencies and programs, creating challenges related to coordination, communication, technical assistance, inconsistent program requirements, and equitable access to recovery resources. The report concluded that there is no single federal entity that oversees disaster recovery comprehensively (Government Accountability Office [GAO], 2022). As a result, the report identified 11 major reform options to improve efficiency, coordination, resilience investment, and support. These reforms largely focused on strengthening coordination, simplifying and standardizing recovery processes, improving communication and technical assistance, and enhancing accountability across agencies. The recommendations also

emphasized increasing resilience investments, improving recovery outcome tracking, prioritizing vulnerable communities, and reconsidering the broader federal role in disaster recovery governance.

Under Presidential Policy Directive 21, the U.S. has 16 critical infrastructure sectors whose disruption would threaten national security, economic stability, or public health and safety—two of these sectors are directly related to healthcare: the Healthcare and Public Health Sector and the Emergency Services Sector (Obama, 2013). Given this, healthcare organizations (more specifically hospitals) and public health agencies are recognized as essential community anchors during disasters (Pollack, 2021). In addition to delivering medical care, hospitals may assume expanded roles during disasters, including sheltering, social services, and security (S. C. Morris, 2020). As a result, hospitals are required to maintain comprehensive disaster management plans governed by federal, state, and accrediting requirements, as they serve as central first receivers in disasters and must sustain surge capacity, infrastructure, workforce, and coordination to effectively save lives (Chaffee & Oster, 2006)

Hospitals and other healthcare organizations operate within a complex regulatory and governance environment involving multiple federal agencies, accrediting bodies, and funding mechanisms for disaster preparedness. Although national frameworks emphasize coordination across federal, state, regional, and local levels, studies have consistently identified challenges related to overlapping jurisdictions, unclear roles, and fragmented governance (Sauer et al., 2009; Blackstone et al., 2017). These challenges complicate the translation of federal preparedness guidance into locally executable disaster management practices.

Preparing hospitals and healthcare systems for disasters is a national priority as disasters become more frequent and complex. Federal programs such as the HPP have strengthened

hospital readiness and regional collaboration, but funding cuts and governance challenges threaten these improvements; continued federal investment and stronger coalition-based approaches is needed to sustain hospital and health system resilience (Toner, 2017).

To enhance healthcare system preparedness, ASPR an agency within HHS established the Hospital Preparedness Program (HPP). The HPP is a core initiative within ASPR's Office of Health Care Readiness, focused on supporting health care systems at the local, regional, and national levels to advance ASPR's vision of a nation equipped to prevent, respond to, recover from, and build resilience against public health emergencies and disasters (Administration for Strategic Preparedness and Response [ASPR], n.d.-a). The primary mechanism for the HPP to advance this vision is funding HCCs as regional mechanisms for preparedness and response coordination (ASPR, 2016). The HCCs bring together hospitals, public health agencies, emergency medical services, and emergency management organizations to coordinate training, exercises, resource sharing, and real-time response activities (ASPR, 2023). As of 2023, more than 47,000 organizations participate in 318 HCCs nationwide, reflecting broad engagement across the healthcare and emergency response sectors (ASPR, 2025).

The HPP is the only federal funding source dedicated to regional healthcare system preparedness (ASPR, 2020). As outlined by ASPR, the goal of HPP is to "establish the foundation for national health care readiness, promote a consistent national focus to improve patient outcomes during emergencies, and enable rapid health care service resilience and recovery" (ASPR, 2016). Key HCC activities include coordinating joint exercises, training healthcare personnel, developing communication systems, sharing real-time information, and managing the distribution of medical equipment and supplies to strengthen regional resilience during emergencies; one of the primary core annual requirements for HCCs is to conduct the

MRSE (ASPR, 2016).

For FY 2025, the President's Budget for ASPR proposed $3.77 billion in discretionary funding as well as $10.54 billion in proposed mandatory funding to support ASPR activities as part of a broader $20 billion biodefense investment across HHS (ASPR, 2025). The HPP and HCCs serve as critical components of national disaster preparedness infrastructure by strengthening regional coordination, communication, surge capacity, and cross-sector collaboration to support healthcare system resilience during emergencies and public health crises. Despite nearly two decades of HCCs operating under the current ASPR model, limited empirical evidence exists regarding the effectiveness of the HCC structure. Prior research has demonstrated substantial variability in coalition maturity, governance structures, participant engagement, and operational readiness across regions, while also identifying challenges related to unclear value propositions and limited incentives for sustained participation (Barnett et al., 2020; Koch et al., 2022). This limited evidence base may partially contribute to recent federal criticism of the program, with the current presidential administration stating that "The Budget eliminates funding for ASPR's HPP, which has been wasteful and unfocused. This proposal remedies those flaws by allowing States and Territories to properly scope and fund hospital preparedness" (Office of Management and Budget [OMB], 2025), In accordance with this rational, the FY 2026 and FY 2027 federal budgets subsequently proposed broader restructuring and potential reductions to disaster management funding, including the possible elimination of the HPP.

These findings, alongside broader national challenges related to coordination, communication, and implementation across disaster management systems, highlight the complexity of disaster preparedness in real-world settings. Disaster preparedness depends

heavily on local context and implementation being shaped by interactions among people, organizations, and technologies, which underscores the importance of a sociotechnical systems perspective.

1.3.4 Disaster Management as a Sociotechnical Learning Health System

A 2018 study, examined how disasters contribute to long-term health impacts and highlighted the importance of sociotechnical factors in shaping disaster resilience (Sandifer & Walker, 2018). The authors argued that current disaster preparedness and recovery systems often focus heavily on immediate emergency response while giving limited attention to coordination and broader system-level factors that influence recovery and resilience over time. There are numerous theories, models, and frameworks guide disaster management by providing conceptual approaches to understanding disaster complexity and shaping planning and response strategies (Drabek, 2005). Continuous improvement is a fundamental concept in disaster management and is supported through practices such as after-action reviews, reports, and improvement plans, which aim to evaluate performance and incorporate lessons learned into future preparedness efforts (FEMA, 2023).

While AARs are intended to support learning and improvement, they primarily document what occurred and what should change, offering limited insight into how identified recommendations are implemented, adapted, or sustained across organizational contexts (Stoto et al., 2019). As a result, continuous learning activities are often inconsistently applied, resulting in persistent gaps between intended and enacted disaster management practices (Morris, 2020). Although widely used models such as the all-hazards approach and the disaster management cycle offer normative guidance, recent research reinforces concerns about weak theoretical consensus in disaster management by showing that many commonly used frameworks persist

without systematic evaluation of their relevance, calling for explicit theory life cycle approaches to ensure adaptability and continued usefulness (Ha, 2025). Another author calls for a shift toward more contemporary, adaptive, and value-based approaches to disaster management (Sawalha, 2020). Therefore, framing disaster management as a sociotechnical system offers a contemporary approach for improving adaptation and performance in complex, ever-evolving disaster contexts.

An earlier doctoral dissertation entitled *A systems thinking approach to risk reduction and mitigation for improving disaster management* found that disaster management is often constrained by poor coordination, weak governance, unreliable communication, limited community engagement, and an overemphasis on short-term outcomes rather than long-term mitigation processes (Shroff, 2021). To address these systemic barriers, the author recommended adopting a systems thinking approach to disaster preparedness that emphasizes proactive social capital building, cross-sector coordination, equity, accessible and actionable guidance, and continuous learning to better anticipate indirect impacts and strengthen resilience across the disaster cycle. The proposed process for approaching the continuous learning across the disaster cycle closely resembled the LHS model, emphasizing an iterative process of using inclusive data to inform implementation, evaluation, and adaptation, with the population always at the center of decision-making (Shroff, 2021; Friedman, 2022a).

Initially concepted during an Institute of Medicine Roundtable, an LHS, envisions a reengineered health system where evidence is rapidly generated, shared, and seamlessly applied in care to improve effectiveness and efficiency (Institute of Medicine (US) Roundtable on Evidence-Based Medicine, 2007). This theory has continued to evolve and is often paired with the Learning Health System (LHS) model (Friedman, 2022a). According to Friedman (2022), in

the LHS model, a multi-participant learning community continuously improves care by capturing real-world practice as data (P2D), transforming that data into locally relevant evidence (D2K), and applying the resulting knowledge back into care delivery (K2P) through iterative learning cycles supported by shared sociotechnical infrastructure.

Within disaster management research, only a limited number of studies have explicitly applied a socio-technical infrastructure perspective, and to the author's knowledge, no prior studies have examined disaster management through the lens of a LHS. A systematic review showed that disaster management is fundamentally a sociotechnical system, where performance and resilience emerge from the interaction of people, organizational structures, processes, and interoperable technologies rather than from technical solutions alone; it concluded that while the literature emphasizes coordinated response, multi-actor collaboration, and information technologies (e.g., GIS and communication systems), it consistently under addresses organizational learning, performance measurement, and knowledge management— limiting continuous improvement over time (Lettieri et al., 2009). A 2020 (Sawalha) conceptual paper critiques the traditional disaster management cycle as overly procedural and poorly suited to the complexity and uniqueness of modern disasters, as highlighted by the COVID-19 pandemic. It proposes an evolved, socio-technical disaster management model that embeds learning, innovation, leadership, situation awareness, and resilience across all phases to support continuous adaptation, improved performance, and long-term organizational learning.

A 2022 scoping review examined how health care organizations achieve interoperability during multi-organizational disaster management, finding that both technological and personnel-related barriers such as poor system integration, lack of shared language, and coordination challenges limit effective collaboration (Gastaldi & Horlait, 2022). The study concluded that a

hybrid approach combining compatible technologies with joint, multidisciplinary training and a shared culture of interoperability is essential for effective disaster response. Another study examined organizational resilience during COVID-19 emergency management using a socio-technical complex systems model to show how response efforts evolve from early improvisation and uncertainty to more coordinated and structured practices. The study concluded that transparent reporting, crisis-driven learning, and a balance of centralized planning with decentralized execution are essential for building resilient organizations in novel, complex emergencies (Cantelmi et al., 2022).

The literature consistently demonstrates that knowledge is foundational to effective disaster management, guiding planning, coordination, and adaptive response; however, the mechanisms for systematically capturing, managing, and transferring disaster-related knowledge remain underdeveloped in healthcare settings (Alavi & Leidner, 2001; Koenig et al., 2017). Across major U.S. disasters such as: Hurricane Katrina, Hurricane Sandy, and COVID-19—studies document repeated challenges related to infrastructure failure, patient surge, resource scarcity, communication breakdowns, and inadequate preparedness, despite the availability of lessons from prior disaster responses (Brevard et al., 2008; Adalja et al., 2014; Aliyu et al., 2021; Brands et al., 2013; Coe et al., 2020; Cuschieri et al., 2021; Darsey et al., 2013; J. R. Davis et al., 2010; Gifford et al., 2021; Glotzbecker, 2022; Hannan et al., 2021; Hartnett et al., 2022; Joy & Kemp, 2007; Mattox, 2006; Orsini et al., 2020; Ricci et al., 2015; Rodríguez & Aguirre, 2006; Rosen & Yakubov, 2013; Sariego, 2007; Tran et al., 2014; Vick, 2021; Walczyszyn et al., 2019; Walker & Yarbrough, 2013; Zorn et al., 2021).

While hospitals generate substantial tacit knowledge through disaster response, this knowledge is often locally retained, inconsistently documented, and insufficiently translated into

organizational learning or sustained practice change, resulting in recurring gaps between lessons identified and lessons institutionalized (Mattox, 2006; Ricci et al., 2015). The COVID-19 pandemic further exposed deficiencies in real-time knowledge sharing, data availability, and coordinated learning across institutions and regions, underscoring the absence of robust knowledge management systems capable of supporting continuous learning across disaster contexts (Hannan et al., 2021; Zorn et al., 2021). Collectively, these articles highlight a persistent knowledge management gap in disaster management, characterized by fragmented learning, limited integration across organizational levels, and insufficient infrastructure to transform experiential knowledge into system-level improvement.

Framing disaster management as a LHS provides an opportunity to intentionally integrate sociotechnical components (data, technology, people, processes, and culture) into iterative learning cycles that enable systematic and continuous improvement across disaster management phases. As argued by Friedman and colleagues (2024), the defining feature of an LHS is its shared sociotechnical infrastructure, which enables multiple learning cycles to operate simultaneously and sustainably by organizing people, technologies, processes, and policies into interoperable services that support the full P2D–D2K–K2P cycle. Persistent recurrence of similar challenges and barriers across disasters suggests that lessons learned are not consistently implemented or sustained, highlighting an opportunity to apply an LHS framework to better understand how disaster management knowledge is translated into practice. According to Kilbourne and colleagues, implementation science is a core foundational method of LHSs, emphasizing its role in ensuring that evidence-based interventions are effectively adopted, adapted, and sustained in real-world health system settings (Kilbourne et al., 2024). Together, these findings highlight an opportunity to examine the utility of implementation science in

advancing disaster management practice.

1.3.5 Implementation Science Opportunity to Enhance Disaster Management

Implementation science is a multidisciplinary field focused on understanding how evidence-based practices, policies, and formal guidance are adopted, implemented, and sustained in real-world settings (Bauer & Kirchner, 2020a; Eccles & Mittman, 2006). Implementation science recognizes that adoption alone does not ensure execution as intended and emphasizes the importance of examining implementation determinants, contextual factors, and strategies to achieve meaningful impact in practice (Damschroder et al., 2009). Disaster management evidence-based practices are largely derived from descriptive and observational research, with limited use of experimental or implementation-focused approaches, leaving gaps in understanding how, why, and under what conditions these practices are effectively adopted, adapted, and sustained (Goodwin, 2018; Jillson et al., 2019; Koenig et al., 2017).

Although early work called for the application of implementation science to disaster management to improve knowledge translation and diffusion, only a small number of disaster management studies have explicitly used the term implementation science, most of which emerged during the COVID-19 pandemic (Bell et al., 2023; Binagwaho et al., 2022; Øvretveit & Ohrling, 2021; Phillips et al., 2008). The existing studies demonstrate the feasibility of using implementation science frameworks to examine disaster response efforts, identify barriers and facilitators, and assess implementation outcomes (Bell et al., 2023; Øvretveit & Ohrling, 2021). While Binagwaho and colleagues (2022) proposed embedding implementation science to enhance health system resilience. Together, this literature suggests that implementation science offers a promising but underutilized approach to disaster management by helping explain how disaster-related evidence is implemented in practice within complex sociotechnical systems.

1.3.6 Identified Literary Gaps and Study Opportunity

Collectively, the literature demonstrates that disaster management within U.S. healthcare systems continues to experience persistent gaps between preparedness guidance and real-world implementation and execution. Although disaster management is commonly conceptualized as a continuous learning process, learning mechanisms such as After-Action Reviews (AAR) and preparedness exercises primarily focus on documenting events and recommended improvements without systematically examining how lessons learned are implemented, adapted, or sustained across organizational contexts (S. C. Morris, 2020; Stoto et al., 2019). As a result, similar challenges related to coordination, communication, resource management, and preparedness recur across disasters despite the availability of prior lessons (Darsey et al., 2013; GAO, 2022; Hannan et al., 2021; Mattox, 2006; Zorn et al., 2021).

HCCs are one of the primary mechanisms in which federal disaster management policy is translated into local healthcare system practice, yet empirical research examining coalition-based implementation remains limited (Barnett et al., 2020; Medcalf et al., 2020; Koch et al., 2022). Prior studies have focused on describing HCC structures, governance, and variation in maturity and readiness, rather than on how preparedness activities are operationalized and embedded within routine practice (Barnett et al., 2020; Koch et al., 2022). Consequently, the processes through which coalitions support learning, coordination, and sustained system improvement remain insufficiently understood.

Disaster preparedness exercises are a central component of healthcare preparedness and are widely used to test capabilities, identify gaps, and support improvement planning (Toner, 2017; ASPR, 2023). However, the existing literature has largely emphasized exercise design, scenario development, and performance outcomes; paying minimal attention to the

implementation of exercises within real-world, multi-organizational healthcare settings (Savoia et al., 2014). There is limited empirical evidence examining how federally developed exercise guidance is interpreted, adapted, and implemented by local coalitions, leaving key sociotechnical and contextual factors influencing exercise implementation poorly understood.

Together, these literature gaps highlight that disaster preparedness research has paid limited attention to how disaster management activities are implemented in complex real-world settings. Existing evaluations, such as AARs, have also focused primarily on exercise performance and outcomes, with less attention given to how contextual factors may influence implementation. A meta-narrative systematic review of healthcare resilience highlighted a shift from disaster-specific and infrastructure-focused approaches toward more interdisciplinary, relational, and process-oriented understandings of resilience across healthcare systems (Tan et al., 2023). The review emphasized that healthcare resilience operates across multiple hierarchical levels and depends not only on physical capacities, but also on leadership, collaboration, adaptation, recovery, and continuous learning before, during, and after crises.

Implementation science approaches may be well suited to address these gaps by providing a more systematic understanding of how preparedness activities are implemented within complex sociotechnical systems. Additionally, these approaches may help explain how preparedness learning, coordination, and adaptation are sustained across disaster management phases and collaborative preparedness networks such as HCCs.

1.4 Conceptual Framework

In materials science and engineering, the behavior of a material under stress does not only reveal its strength, but its capacity to absorb external forces and return to equilibrium without permanent damage (Hicks, 1999). Concepts such as stress, strain, and elasticity are used

to understand how materials respond to applied loads, and at what point those loads exceed the material's ability to recover. This study adopts a similar systems-oriented perspective to examine how individuals, organizations, and communities prepare for disasters. Within this conceptual metaphor, stress reflects the internal activation of a system in response to a hazard (capability), while strain represents the damage and recovery processes that follow (capacity). Just as materials fracture when forces exceed their elastic limits, disasters occur when hazards overwhelm system capacity. Although drawing further correlations between materials science and disaster science is beyond the scope of this work, this lens provides a coherent way to frame disaster preparedness exercises as interventions that can strengthen system resilience by improving coordination, knowledge, and adaptive capacity before hazards occur.

In the United States, disaster management commonly guided by an all-hazards, capabilities-based approach that emphasizes coordinated preparedness across a wide range of potential threats (FEMA, 1996). Central to this approach is the Disaster Management Cycle, which conceptualizes disaster management as a continuous process encompassing mitigation, preparedness, response, and recovery phases (Sawalha, 2020). These phases fit into three periods— pre-crisis, crisis, and post-crisis, recognizing that communities are often engaged in multiple phases simultaneously (Lettieri et al., 2009). Mitigation and preparedness focus on reducing risk and strengthening readiness before disasters occur, while response and recovery address immediate impacts and longer-term restoration (DHS, 2015, 2016; Gougelet, 2006; Waugh, 2015). Importantly, the cycle emphasizes that recovery is not an endpoint; lessons learned during response and recovery inform future mitigation and preparedness efforts, reinforcing disaster management as an iterative process of learning and system improvement (Al-Jazairi, 2019).

Viewing disaster management as a continuous process, this study takes an exploratory approach to examining how knowledge generated across the phases of disaster management can be considered through the LHS cycle. While learning from previous disasters is often regarded as the most effective teacher in disaster management, resulting in the development of tacit knowledge; capturing and systematically studying such knowledge in real time presents significant practical and ethical challenges (Abeysinghe & Leppold, 2023). Accordingly, this study attempts to adopt a more pragmatic approach by examining how explicit knowledge is generated for disaster responders through the implementation of a disaster preparedness exercise. In this context, the LHS framework provides a structured way to pay attention to the implementation of disaster exercises and to conceptualize how knowledge can translate into practice, whether for future disaster preparedness activities or disaster response— to support continuous learning and improvement.

The LHS cycle is a continuous, multi-phase process that begins with the formation of a learning community and moves through the transformation of performance (or practice) into data (P2D), data into knowledge (D2K), and knowledge back into performance (K2P) (Friedman, 2022a). LHS is an approach to continuously improving healthcare by integrating research, practice, and data-driven insights (Easterling et al., 2021). Central to an LHS is the recognition and emphasis of sociotechnical infrastructure, which describes interactions among people, processes, governance, and technology to enable continuous learning across data-to-knowledge-to-practice cycles (Friedman et al., 2024). Within this model, implementation science helps explain how knowledge is put into practice, especially during the K2P phase of the LHS model (Kilbourne et al., 2024). Conceptualizing disaster management as an LHS, with a focus on K2P, provides an opportunity to explore the implementation of exercises as shown in Figure 1.1.

Figure 1.1 Conceptual alignment of Disaster Management and Learning Health System cycles



Note. Conceptual alignment of the Disaster Management Cycle and the Learning Health System (LHS) cycle, positioning disaster preparedness exercises such as the Medical Response Surge Exercise (MRSE) as a knowledge-to-practice (K2P) intervention that supports learning, coordination, and system improvement across disaster phases.

Implementation science is a multidisciplinary field that focuses on closing the gap between research and real-world practice (Eccles & Mittman, 2006). It does so by using a variety of approaches including interdisciplinary theories, models, conceptual frameworks, and implementation strategies such as participant engagement, adaptation, and leadership support. The core goal of implementation science is to promote the adoption, scaling, sustainment, and integration of evidence-based interventions such as programs, practices, principles, products, pills, or policies (Brown et al., 2017; Bauer & Kirchner, 2020a; Eccles & Mittman, 2006; Kilbourne et al., 2020). It seeks to bridge the gap between research and practice by effectively identifying ways to implement and sustain innovations in various contexts. There are three primary segments of implementation science: (1) define the problem and select the evidence-based practice/intervention; (2) assess the determinants (barriers/ facilitators) of implementation success; and (3) design a plan to evaluate the implementation plan (Handley et al., 2016). Implementation science encompasses five categories of theories, models, and frameworks: process models, determinant frameworks, classic theories, implementation theories, and evaluation frameworks— that are used to understand, guide, and evaluate how and why a researched intervention (innovation) is successfully or unsuccessfully translated into practice (Nilsen, 2015). Implementation science approaches, therefore, offer a way to methodologically examine the implementation of disaster preparedness exercises and to contextualize what worked and what did not in relation to intended outcomes within a specific context or environment.

This study takes an exploratory approach to examine how implementation science frameworks can be used to assess disaster preparedness exercises, focusing on contextual factors of the design, implementation processes, and outcomes. The Consolidated Framework for Implementation Research (CFIR) 2.0, an implementation science determinants framework, is

used as an analytic lens to characterize the domains and constructs included in implementation guidance documents and to contextualize determinants that influence implementation (Damschroder et al., 2009; Damschroder et al., 2022). The Proctor Implementation Outcomes framework, an implementation science evaluation framework, is used to categorize the intended outcomes of the disaster preparedness exercise as service, implementation, or clinical outcomes (Proctor et al., 2011). The RE-AIM framework, another evaluation framework, is used to further categorize implementation outcomes across the domains— reach, effectiveness, adoption, implementation, and maintenance (Glasgow et al., 1999). This framework is relevant to preparedness exercises aimed at supporting organizational learning and long-term system readiness. In addition to these frameworks, the Expert Recommendations for Implementing Change (ERIC) strategy taxonomy and associated meta-frameworks are used to identify and categorize implementation strategies and mechanisms proposed to address observed barriers and strengthen enablers (Powell et al., 2015; Waltz et al., 2015; Hero et al., 2023). Lastly, the Implementation Research Logic Model (IRLM), an implementation science process framework, will be used to integrate the perceived determinants, strategies, mechanisms, and outcomes (Smith et al., 2020).

Together, these implementation science frameworks provide a complementary and integrated approach for examining the MRSE. CFIR 2.0 is used to contextualize determinants influencing implementation, while Proctor and RE-AIM categorize intended outcomes clarify associated with the exercise design. ERIC frameworks inform the identification of strategies and mechanisms proposed to address observed barriers and enhance enablers. The IRLM provides a structured approach for organizing findings to support learning and sustained improvement in MRSE implementation and to synthesize results across the dissertation aims.

In this study, the IRLM is used to guide a structured review of MRSE design and implementation informed by After-Action Review (AAR) principles. AARs are conducted after exercises or events to assess performance and improve future response. Conceptually, AARs operate as feedback loops to support reflection, identify system-level drivers of performance, and define priority actions that improve preparedness when conducted in a collaborative, no-blame environment; AARs can translate experience into generalizable knowledge that strengthens future preparedness and response (Stoto et al., 2019). Consistent with this approach, the ASPR requires HCCs to conduct AARs following the MRSE to review exercise performance (ASPR, 2016). Building on this intent, the IRLM is applied in this study as a structured process model to support systematic reflection on MRSE design and implementation to guide actionable improvements for future exercises.

1.5 Study Purpose, Overview, and Design

This dissertation primarily focused on strengthening preparedness for public health emergency (PHE) hazards that directly impact healthcare systems by causing a sudden increase in medical surge capacity. The MRSE is an annual disaster preparedness exercise developed by the ASPR for HCC as a requirement of their Cooperative Agreements (CA) under the HPP (ASPR, 2023). Because most CA recipients are states, the MRSE provides a unique opportunity to examine how federally supported, state-managed, and locally executed disaster preparedness efforts are implemented in practice. According to ASPR, the MRSE is intended to strengthen coordination, surge capacity, and overall system readiness; as such, the MRSE provides an important case for examining how federal preparedness guidance translates from policy into local implementation (ASPR, 2023).

The overarching purpose of this dissertation was to explore the application of implementation science within disaster management through the analysis of disaster preparedness exercise implementation. This study uses implementation science approaches as evaluative frameworks rather than in their more traditional role as planning tools. Using the MRSE as a case analysis, this study applies a sociotechnical framing to explore contextual factors relevant to preparedness exercise implementation, with the goal of informing future implementation approaches related to preparedness practice and disaster resilience.

This dissertation is structured using a three-paper model, with each manuscript addressing an independent but interconnected aim. Collectively, the three aims address the primary research question: ***How can implementation science theories, models, and frameworks be leveraged to understand implementation determinants and inform improvements in disaster preparedness practice?*** The first paper (Aim 1) identifies the most prevalent sociotechnical factors reflected in the federally developed guidance documents that inform the design and intended implementation of the MRSE. The second paper (Aim 2) explores local participant perceptions of the MRSE and identifies perceived barriers and enablers influencing its implementation in practice. Building on these findings, the third paper (Aim 3) identifies potential implementation strategies and mechanisms, as described by participants, that may support MRSE implementation within a specific local context. Within this context the participants are HCC participants (leads or members) that participate in the MRSE.

The three papers are synthesized in the Discussion, Implications, and Conclusion Chapter (Chapter 5). The IRLM is used to integrate the identified exercise outcomes from Aim 1, key barriers and facilitators from Aim 2, and strategies and mechanisms developed in Aim 3, specific to the MRSE. The purpose of the IRLM is to visually demonstrate how the implementation of an

innovation (intervention) can be enhanced within a given context (Smith et al., 2020). Together, these papers build on one another to generate empirical research that contributes to disaster preparedness practice, particularly as it relates to HCCs.

1.5.1 Specific Study Aims and Research Questions

CFIR 2.0 and IRLM serve as the primary frameworks guiding the research study. Table 1.1 presents the study aims and corresponding analytic inputs and outputs used to examine the implementation of the MRSE.

Table 1.1 Study Aims Conceptual Analytic Inputs and Outputs

Aim	Analytic Inputs	Analytic Outputs
Aim 1: MRSE Sociotechnical Design & Intent	Federally developed MRSE guidance documents	Identified sociotechnical structures and assumptions; intended implementation outcomes conceptualized using CFIR, Proctor Outcomes, and RE-AIM
Aim 2: MRSE Implementation Barriers and Facilitators	Local implementation experiences of HCC participants conducting the MRSE	Participant perceptions of the MRSE assessed using pCAT and iPRISM; identified implementation barriers and facilitators analyzed using CFIR
Aim 3: MRSE Implementation Strategies & Mechanisms	Strategy and mechanism participatory identification by HCC participants (considered or employed)	Implementation strategies and mechanisms mapped to ERIC to address barriers and strengthen enablers

The specific aims for this study include:

Aim 1: Characterizing Sociotechnical and Implementation Domains in Federal MRSE Guidance

This aim focuses on identifying implementation-related sociotechnical factors included in the federally developed Medical Response Surge Exercise (MRSE) guidance documents. A deductive document analysis will be conducted to assess three primary MRSE guidance documents using established implementation science frameworks, including CFIR, RE-AIM, and Proctor implementation outcomes. This analysis will identify the implementation domains and

outcomes most frequently represented in federal guidance, providing insight into the sociotechnical factors emphasized at the federal level. This aim is guided by the following research question:

What implementation-related domains and outcomes are emphasized in federally developed MRSE guidance documents when coded using established frameworks?

Aim 2: Exploring Local MRSE Implementation and Participant Perceptions

This aim examines HCC leads and participants perceptions of the MRSE, identifying observed barriers and enablers influencing implementation at the local level using CFIR as an analytic lens. A convergent parallel mixed-methods approach will be employed integrating quantitative data collected through a survey and qualitative data collected through semi-structured interviews. This aim is guided by the following research question:

What barriers and facilitators influence the implementation of the MRSE at the local level, as perceived by HCC leads and members?

Aim 3: Identifying Potential Implementation Strategies and Mechanisms

This aim focuses on identifying implementation strategies and mechanisms that have been used, considered, or could be applied to address barriers and support enablers for MRSE. Using modified think-aloud interviews, HCC leads and participants, develop strategies and mechanisms they have used, considered, or would apply in practice. These participant-identified strategies will be categorized using the ERIC taxonomy to support synthesizing the findings. This aim is guided by the following research question:

What implementation strategies and mechanisms do HCC leads and members propose to address perceived barriers and support enablers for future MRSE implementation?

1.5.2 Philosophical Positioning, Reflexivity, and Research Orientation

This dissertation is grounded in a pragmatic and critically informed worldview that draws from post-positivist, constructivist, and social-justice paradigms. A post-positivist approach assumes that the real world exists and can be studied systematically through rigorous methods to identify patterns and relationships; while the constructivist approach acknowledges that people create meaning and perspectives of multiple realities exist depending on experiences, role, and context (Pretorius, 2024). The social-justice paradigm is grounded in the belief that power, inequity, and social structures have shaped the world we live in today which has led to unequitable outcomes and that research should contribute to positive change, not just description to equitably benefit society (Throne et al., 2021). Collectively, these paradigms reflect a commitment to systematically studying real-world systems, centering participant experiences, and producing knowledge that informs equitable and actionable change in disaster management. Epistemologically, this research assumes that multiple perspectives can coexist. Structural patterns within existing disaster management infrastructure (e.g., policies, processes, systems, and people) can be observed and analyzed, while subjective experiences of preparedness, response, and recovery provide equally valid and necessary insight. Experiential knowledge is contextual rather than absolute, therefore "creating knowledge" requires methodological pluralism and reflexivity to truly capture real-world complexity.

This dissertation applies a complex system lens, more specifically a LHS, as a conceptual model to integrate disaster science and implementation science (Friedman & Greene, 2025). Rooted in the social-justice paradigm, the underlying ethos of this research is to examine how disaster preparedness efforts are implemented and function within interconnected, real-world systems. I strongly believe that disasters are conceptualized not solely as the result of a single

hazard, but as outcomes shaped by long-standing vulnerabilities, inequitable systems, and policy decisions that influence exposure, response capacity, and recovery. From this perspective, disaster preparedness and management are sociotechnical processes with ethical implications, where decisions at organizational and policy levels can either exacerbate or mitigate harm.

Methodologically, this study uses a multi-aim mixed methods approach. Semi-structured interviews, document review, and framework-guided analysis are used to examine context and implementation processes. Implementation science frameworks were intentionally applied to support robust analysis to provide a methodological framework for bridging the gap between theory and practice in disaster preparedness research. This pragmatic approach to the research reflects a commitment to producing actionable and contextually grounded knowledge that can inform real-world systems (problems and solutions).

Positionality Statement

I am a Christian Black woman raised in a lower-middle-class family in Detroit. These intersecting identities shape my perspectives and inform my awareness of structural inequities, power dynamics, and the ways in which systems differentially affect communities. Formally trained in material science and engineering, public health, and health infrastructure and learning systems, I draw on an integration of these lenses in my approach to disaster management research. Pivotal professional experiences include working within a Hospital Incident Command System during the early stages of the COVID-19 pandemic and racial uprisings and working in and for a health department during a presidential administration that enacted drastic cuts to public benefit programs and public health. My lived, educational, and professional experiences have motivated a commitment to equity-focused, solutions-oriented research. These professional and lived experiences in disaster-related systems have shaped my attention to both formal

preparedness processes and the experiential knowledge held by responders, reinforcing the importance of examining how different forms of knowledge are developed and applied in practice. I acknowledge that my values and positionality influence the research questions posed, the frameworks selected, and the emphasis on applied outcomes. To address this, I engaged in deliberate reflexivity throughout the research process, using an audit trail, analytic memos, transparent methods, and framework-guided analysis to ensure findings remained grounded in participant experiences rather than researcher assumptions.

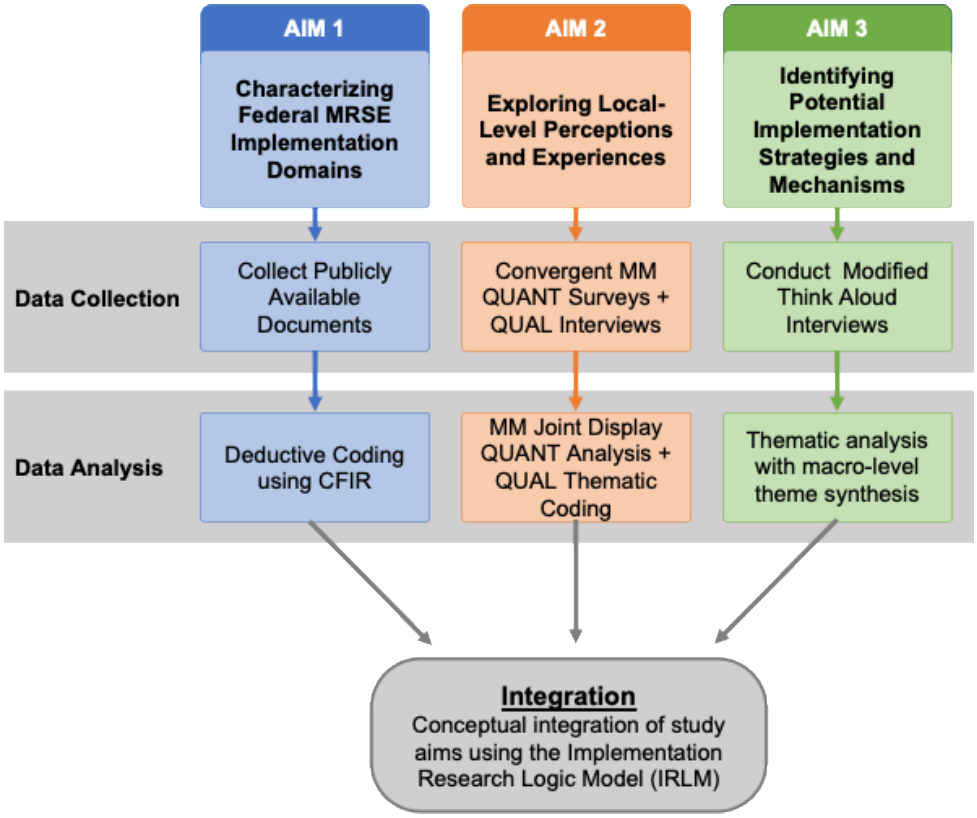
Rationale for Research Orientation

This research is guided by the assumption that disaster preparedness is an upstream privilege that can be translated into power and wealth (capital), reducing harm and strengthening resilience downstream during disaster response and recovery. Adapting Yosso's Cultural Wealth Model, this study conceptualizes disaster resilience as a form of community capital, framing inequities in disaster outcomes as rooted in systemic conditions rather than individual failure (Yosso, 2005). Guided by this belief, this dissertation applies a multi-aim, iterative mixed methods approach to examine disaster preparedness as a sociotechnical process shaped by context, power, and structure, and to identify barriers and facilitators to disaster preparedness within specific contexts. By integrating implementation science into disaster preparedness research, this work seeks to advance disaster preparedness practice by identifying strategies and mechanisms to improve the implementation of preparedness exercises— which ultimately aims to strengthen community resilience as well as collective capacity and capability.

1.5.3 Study Design/ Methodological Overview

This three-paper dissertation uses multimethod approach to comprehensively examine the implementation of the MRSE. Paper one (Aim 1 – Chapter 2) uses a document analysis approach; paper two (Aim 2 – Chapter 3) employs a convergent parallel mixed-methods design that disseminates a survey to collect quantitative data and conducts semi-structured interviews to collect qualitative data; and paper three (Aim 3 – Chapter 4) uses a participatory think-aloud interview approach. Figure 1.2 illustrates the three-aim study design, including data collection and analysis methods for each aim and the conceptual integration of findings using the IRLM. Each manuscript includes its own detailed methods section describing study design, data sources, analytic procedures, and reporting standards.

Figure 1.2 Overview of Study Aims, Data Collection, Data Analysis, and Integration



The study focused on MRSE activities implemented under the ASPR HPP CA during the 2024 MRSE (Federal FY 2023-2024). The study activities involving human participants (Aim 2 and Aim 3) were conducted fully virtually. All surveys and interviews were completed remotely using secure virtual platforms.

Participants were individuals affiliated with HCCs within a single, anonymized state in the United States Midwest that participates in the HPP through a CA with ASPR. Participants represented diverse roles within the health care preparedness system, including public health, emergency management, and health care organization partners. All study participants were leaders or members of various HCCs within the specified state. To protect confidentiality, the identities of the state, organizations, and participants have been withheld. This study was reviewed and determined to be exempt by the University of Michigan Institutional Review Board for Medicine (IRBMED; HUM#00246148).

Although one manuscript uses mixed methods, this dissertation is not inherently a mixed-methods study at the dissertation level. Results will not be integrated or interpreted through a single cross-paper mixed-methods analysis or meta-inference; integration will occur at a high-order methodological level to demonstrate the utility of using multiple implementation science tools to evaluate disaster preparedness exercises. This methodological decision was a result of the scope of the data collected and practical constraints associated with conducting and analyzing multiple datasets as a single researcher. Deeper cross-study integration and meta-inference development may be reserved for future research.

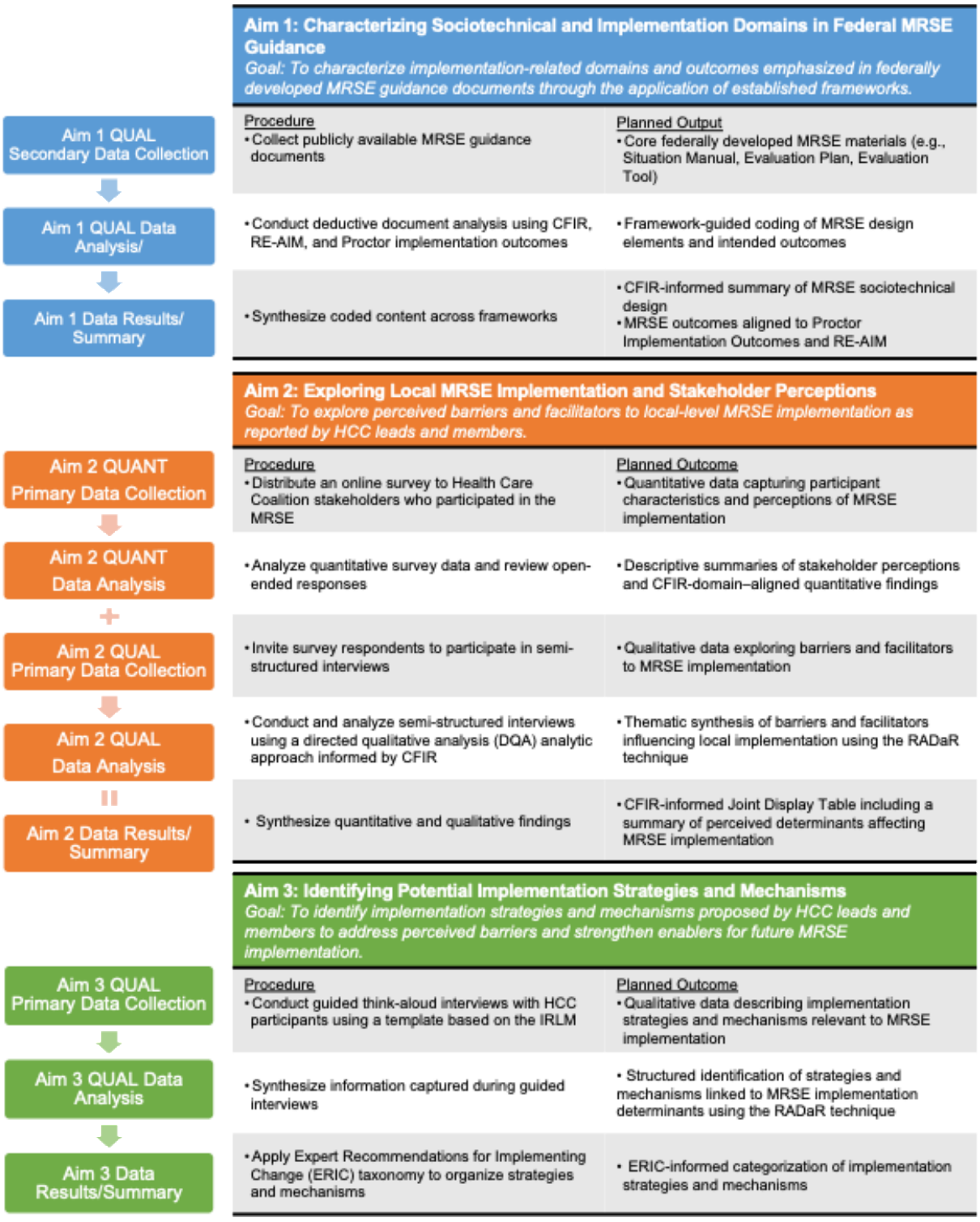
Across the dissertation, several implementation science frameworks are used, including: CFIR, RE-AIM, Proctor Implementation Outcomes, ERIC, and the IRLM. While these frameworks are commonly used for planning purposes, throughout this study they are primarily

applied as evaluative frameworks. CFIR, an implementation science determinants framework, was used as deductive coding tool in the document analysis and as a mapping tool for inductive qualitative coding. RE-AIM and Proctor Implementation Outcomes were used as a deductive coding tool for document analysis to categorize outcomes. ERIC strategies are used to identify and align implementation strategies with identified barriers and facilitators. The IRLM serves as a unifying structure to summarize and synthesize findings across aims.

Together, this methodological approach provides a pragmatic and practical evaluation of MRSE implementation as summarized in Figure 1.3. This study aims to demonstrate how implementation science frameworks can complement traditional AAR processes to support the more systematic translation of lessons learned into improvements in future preparedness exercises.

This research was funded by the University of Michigan Rackham Graduate Student Research Grant, and the author has no conflicts of interest to report.

Figure 1.3 Overview of Study Aims, Design, and Implementation Science Frameworks for the MRSE Evaluation



Chapter 2 Characterizing Federal Design and Implementation Domains of the MRSE

2.1 Abstract

Objective: Disaster preparedness exercises are critical for strengthening coordination and response capacity. However, there is limited research has examining how implementation and sociotechnical context influence their real-world effectiveness. This study used the Medical Response Surge Exercise (MRSE), a federally mandated preparedness exercise for Healthcare Coalitions (HCCs) under the Hospital Preparedness Program (HPP) Cooperative Agreement (CA). The MRSE us used as a case analysis to demonstrate how implementation science frameworks can characterize disaster preparedness exercises as sociotechnical interventions. The Consolidated Framework for Implementation Research (CFIR) 2.0, Proctor's Implementation Outcomes, and RE-AIM were applied to examine contextual determinants and intended outcomes represented within federal MRSE guidance documents.

Methods: A deductive qualitative document analysis was conducted using three core MRSE guidance documents: the Situation Manual, Evaluation Plan, and Exercise Planning and Evaluation Tool. An a priori codebook was developed from CFIR 2.0, Proctor's Implementation Outcomes, and RE-AIM constructs. MAXQDA was used to systematically code, summarize the sociotechnical context, and intended outcomes represented within the documents.

Results: The findings showed that MRSE guidance documents primarily emphasized the CFIR 2.0 Innovation and Implementation Process domains, particularly exercise design, adaptability, execution, and reflection and evaluation constructs. In contrast, there was limited focus on the Inner Setting domain focused on organizational context; the Individuals domain

focused on participant roles and characteristics; and the Outer Setting domain focused on broader external system influences. The intended exercise outcomes predominantly focused on service-level and implementation outcomes such as efficiency, safety, and adoption. There was limited emphasis on patient-centered or long-term system outcomes. Overall, the findings suggest that federal MRSE guidance prioritizes procedural standardization and operational implementation over guidance for contextual adaptation across diverse local settings.

Conclusion: Applying CFIR 2.0, Proctor's Implementation Outcomes, and RE-AIM demonstrated the utility of implementation science frameworks for characterizing disaster preparedness exercises as sociotechnical systems. These frameworks provided a structured approach for identifying implementation priorities and contextual gaps within federal preparedness guidance. The findings suggest that implementation science can complement existing disaster preparedness frameworks by helping exercise designers and practitioners better assess contextual factors that shape preparedness capacity and real-world implementation.

2.2 Introduction

This study is the first of three interconnected studies exploring the utility of implementation science frameworks in disaster research, with a focus on how implementation science theories, models, and frameworks can be leveraged to understand implementation determinants and inform improvements in disaster preparedness practice. More specifically, this first aim of the dissertation frames disaster preparedness exercises as sociotechnical systems used as a mechanism to build knowledge that can translate to practice for future disaster preparedness exercises and disaster response. Using existing implementation science frameworks, the aim of this study is to characterize the federally designed MRSE to better understand which sociotechnical components are prioritized by the federal government and how intended outcomes

are categorized based on guidance documents.

To address this aim, a deductive document analysis was conducted on the three primary MRSE guidance documents using the CFIR 2.0, Proctor's Implementation Outcomes, and RE-AIM as coding frameworks. These frameworks are used as an analytical lens. This aim is centered on the question: *What implementation-related domains and outcomes are emphasized in federally developed MRSE guidance documents when coded using established implementation science frameworks?*

The MRSE is an annually required exercise administered by the HHS ASPR as part of the Hospital Preparedness Program (HPP) Cooperative Agreements (CA), which are implemented by states in coordination with their respective HCCs (ASPR, 2023). The implementation of the MRSE offers an important opportunity to analyze how Federal Emergency Management Agency's (FEMA) disaster management theoretical model, *"Federally Supported, State Managed, and Locally Executed,"* is translated into practice during the disaster preparedness phase (Federal Emergency Management Agency [FEMA], 2024).

Understanding the sociotechnical infrastructure of disaster preparedness exercises is important for successful implementation, as interactions between social and technological elements can facilitate or constrain the execution of intended exercise outcomes. The complex context in which disaster preparedness exercises are designed at the federal level and implemented across diverse state and local settings underscores the need for structured frameworks to identify what is prioritized, what may be missing, and how exercises are designed to function in practice.

There has been limited research examining implementation and contextual factors embedded within disaster preparedness exercise design beyond traditional evaluations, such as

After-Action Reviews (AARs), that are primarily focused on exercise performance and outcomes. This research addresses this gap by examining disaster preparedness exercise design using implementation science frameworks. By applying these approaches, this study seeks to better understand how federally developed preparedness exercises operationalize implementation expectations within complex sociotechnical systems. The following literature review examines disaster preparedness exercises as sociotechnical systems, the role of context in disaster management and preparedness implementation, and the application of implementation science frameworks within disaster preparedness research.

2.3 Literature Review

A 2023 study argued that disaster response must be framed as a sociotechnical system, demonstrating that effectiveness hinges on the alignment of teams, organizational structures, technologies, and task environments rather than technical solutions alone (Hale-Lopez et al., 2023). The authors identified barriers and facilitators to team performance and thematically grouped these determinants into eight sociotechnical domains and 21 dimensions, resulting in eight design principles for disaster intervention development teams and reinforcing that intentional sociotechnical alignment is critical to improving disaster intervention performance. This indicates that understanding the sociotechnical infrastructure of disaster preparedness exercise design is likely critical for successful implementation, as disaster exercises inherently operate at the intersection of social and technological systems.

Sociotechnical systems theory emphasizes that the design and performance of complex systems can only be understood by considering social elements such as people, organizations, norms, and governance structures; as well as technical elements, including tools, infrastructure, and information systems (Clegg, 2000). Sociotechnical theory emerged in the mid-20th century,

proposing that organizational effectiveness depends on the joint optimization of social and technical subsystems rather than privileging technology alone (Abbas & Michael, 2025; Trist & Bamforth, 1951). Rooted in open systems theory, sociotechnical design prioritizes human-centered values including democratic participation and equity, while viewing organizations and work systems as dynamic, environmentally embedded systems in which people, technologies, tasks, and structures continuously interact and shape one another (Mumford, 2006). Over time, sociotechnical theory has evolved beyond its industrial origins and has been widely applied across information systems, organizational design, engineering, and other complex sociotechnical domains (Clegg, 2000; M. C. Davis et al., 2014).

Disasters are increasingly understood as sociotechnical experiences, shaped by interactions among individuals, organizations, technologies, policies, and environments (Bowker et al., 2009; Drabek, 2005; Lettieri et al., 2009). Challenger and Clegg (2011) framed crowd disasters as sociotechnical systems failures from interacting breakdowns in organizational culture, decision-making, communication, infrastructure, and emergency response rather than single technical or human causes. Their analysis demonstrated recurring errors tied to sociotechnical design principles including complacent safety mindsets, fragmented responsibility for system oversight, failure to learn from prior incidents, and limited frontline empowerment—framing disasters as emergent outcomes of misaligned social and technical system elements. Conceptualizing disasters as sociotechnical systems highlights how social and technological context shape outcomes; there is an opportunity to shift attention upstream in the disaster management cycle by framing preparedness as a sociotechnical system to reduce response failures.

Within the United States, disaster management is often fragmented in practice but is broadly guided by federal frameworks that emphasize coordination across multiple levels of government and phases of disaster management (GAO, 2022). A few of these frameworks include: the Disaster Management Cycle, the all-hazards approach, the Whole Community concept, and the principle of *"Federally Supported, State Managed, and Locally Executed"* (DHS, 2015; FEMA, 2020). The Disaster Management Cycle includes four primary phases – (1) mitigation, (2) preparedness, (3) response, and (4) recovery (FEMA, 2021). The preparedness phase includes planning, training, and educational activities for events that cannot be mitigated (Waugh, 2015). The *Whole Community* strategy approaches disaster management as a shared responsibility that calls for the involvement of everyone (individuals, businesses, faith-based, nonprofit groups, and government) in preparedness efforts (FEMA, 2020). Examples of preparedness activities may include training programs for emergency responders, drills and exercises, early warning systems, contingency planning, and equipment and supply stockpiles (UNDRR, 2017).

In 2007, a Institute of Medicine (IoM) committee convened to evaluate the U.S. emergency care system determined that hospitals were inadequately prepared for disasters (Institute of Medicine Committee on the Future of Emergency Care in the U.S. Health System, 2007). Exercises and drills are essential for training and evaluating public health emergency preparedness; developing standardized criteria and documentation methods to assess and improve response capacity as part of an ongoing preparedness process (Gebbie et al., 2006). Emergency preparedness exercises range from discussion-based formats (seminars, workshops, and tabletops) that build knowledge and plans, to increasingly complex operations-based activities (drills, functional exercises, and full-scale exercises) that progressively test specific

functions, coordination, and full system response under realistic conditions (FEMA, 2013).

Exercises enhance coordination and system capability by testing roles, resources, and interagency assumptions (Toner, 2017). Benefits of exercises include improved plan adherence, increased role confidence, real-time response adjustments, and better staff support, particularly when exercises are conducted recently (Skryabina et al., 2020). A 2010 study found that rigorously evaluated public health emergency preparedness exercises educate the workforce by clarifying roles, strengthening coordination, and facilitating knowledge transfer across agencies (Biddinger et al., 2010). However, the study concluded that these exercises also identify persistent systems-level challenges such as gaps in leadership, communication, surveillance, and surge capacity that guide targeted improvements in large-scale emergency response.

In 2025, Chambers and colleagues conducted a rapid review of 15 studies (2013-2024) to identify evidence-informed practices that enhance the design, delivery, and evaluation of all-hazards emergency preparedness exercises within public health agencies. The findings highlighted the importance of clearly defined exercise objectives, realistic and context-specific scenario design, diverse and representative participant selection, well-trained facilitators, alignment of evaluation methods with exercise aims, and the integration of structured post-exercise activities to support continuous improvement (Chambers et al., 2025). The review also identified persistent gaps, including: limited public health–specific evidence, variability in evaluation rigor, and the need for standardized frameworks and innovative approaches to strengthen exercise effectiveness and resilience outcomes. Another study found that although disaster exercises are widely conducted, their evaluation is under-researched and conceptually fragmented, with a clear need for stronger empirical evidence and clearer alignment between evaluation purpose, methods, and outcomes (Beerens & Tehler, 2016).

In response to the need for more structure, DHS and FEMA developed Homeland Security Exercise and Evaluation Program (HSEEP) is a standardized framework for designing, conducting, and evaluating preparedness exercises (DHS, 2020). However, relying solely on HSEEP's capability-focused evaluations can reinforce silos and overlook system-wide challenges, underscoring the need for evaluation approaches that better assess sociotechnical factors (Renger et al., 2021). Existing literature on disaster preparedness exercises has primarily focused on exercise design processes, participant performance, and outcome assessment (Savoia et al., 2014). Far less attention has been given to examining the implementation assumptions embedded within exercise design guidance documents themselves (Gebbie et al., 2006).

In 2007, ASPR was established within HHS to manage public health emergencies (PHE), piloted a regionalized disaster management approach through the Hospital Preparedness Program (HPP) by funding Healthcare Coalitions (HCCs) (ASPR, 2018). As defined in the *ASPR 2017-2022 Health Care Preparedness and Response Capabilities*, HCC is a group of individual healthcare and response organizations (e.g., hospitals, emergency medical services, emergency management organizations, and public health agencies) in a defined geographic location that plays a critical role in developing healthcare system preparedness and response capabilities (ASPR, 2016). Identifying HCCs as a critical mechanism for how the healthcare system prepares for disasters, a 2020 study by Barnett et al. used a SWOT analysis to summarize the internal strengths and weaknesses and external opportunities and threats related to the HCC model. Their study ended with four concrete recommendations – (1) evaluate the role of HCCs and their members, (2) reconsider the existing framework for HCC administration, (3) increase incentives for meaningful community participation in HCC preparedness, and (4) support next-generation development of health-care preparedness systems for future pandemics (Barnett et al., 2020).

One mechanism HCCs use to prepare is the annually mandated MRSE, a federally developed preparedness exercise designed to assess healthcare system surge capacity and coordination among HCCs, hospitals, and public health partners (ASPR, 2023). The MRSE is distinct from smaller or locally developed exercises because it is designed for repeated use across jurisdictions under standardized federal guidance, making it well suited for examining how federal preparedness goals and assumptions are embedded in exercise design before local adaptation and implementation.

Therefore, there is an opportunity to apply implementation science to assess the implementation of the MRSE by framing it as a disaster preparedness exercise grounded in sociotechnical systems theory. A 2023 study concluded that public health policy effectiveness is frequently misjudged when policy adoption is conflated with successful implementation, underscoring the need for stronger implementation science approaches to evaluate how policies function in practice (Chriqui et al., 2023). Reviewing how the MRSE has been implemented can help identify where the policy works, where it falls short in practice, and what factors influence its use during real-world preparedness and response, starting with an examination of the federal guidance.

Implementation science offers a structured approach for examining how interventions, programs, and practices are adopted, implemented, and sustained within real-world systems, with explicit attention to context (Bauer & Kirchner, 2020b; Eccles & Mittman, 2006). Rather than focusing solely on outcomes, implementation science emphasizes the determinants and processes that shape whether intended practices can be effectively carried out across settings (Kilbourne et al., 2020). Implementation science uses theories, models, and frameworks to explain what drives successful adoption of evidence-based interventions and to guide how they are implemented in

real-world settings (Damschroder, 2020). However, two reviews found many are hard to use, limited in scope, and not well tested (Wang et al., 2023; Weight et al., 2025). Theoretical approaches in implementation science serve three main purposes: to describe or guide how research is put into practice (process models), to explain factors that influence implementation success (determinant frameworks), and to evaluate implementation efforts (evaluation frameworks) (Nilsen, 2015).

One study combines implementation science and disaster research in a mixed-methods, participatory case study to examine how implementation science determinant frameworks can be applied during disaster response, improving emergency management practice while contributing to scientific knowledge (Øvretveit & Ohrling, 2021). One of the most popular determinants frameworks based on number of citations is the CFIR. Grounded in sociotechnical theory, first published in 2009 and updated in 2022 (CFIR 2.0), CFIR is a meta-framework composed of five domains (intervention characteristics, outer setting, inner setting, characteristics of individuals, and implementation process) used to identify multilevel factors influencing implementation across interventions, organizations, people, and processes (Damschroder et al., 2009; Damschroder et al., 2022). Evaluation frameworks such as Proctor's Implementation Outcomes and RE-AIM provide complementary structures for examining intended implementation and service outcomes, such as feasibility, adoption, and fidelity (Glasgow et al., 1999; Proctor et al., 2011). Together, these frameworks help systematically assess how well an intervention's design fits the real-world context in which it is implemented.

Building on the idea that disaster preparedness exercises support continuous improvement, a foundational principle of learning health systems is their cyclical process of moving from practice to data (P2D), data to knowledge (D2K), and knowledge back to practice

(K2P) (Chambers et al., 2025; Kilbourne et al., 2024). Effective LHS depend on sociotechnical infrastructure that enable continuous, multi-participant improvement cycles leading to better health outcomes (Friedman et al., 2024). Frameworks for developing and evaluating complex interventions, such as disaster preparedness exercises, support the application of implementation science by examining context, program theory, participant engagement, key uncertainties, intervention refinement, and economic considerations within real-world systems (Skivington et al., 2021). This study addresses a critical gap in disaster preparedness research by examining how federally developed exercise guidance shapes implementation prior to local execution.

Preparedness exercises are not just training activities; they also reflect policy expectations and assumptions about how systems are supposed to work in practice (Koenig et al., 2017). Despite widespread use, little is known about how this federal guidance is implemented in real-world preparedness contexts; there is also limited empirical research available using implementation science approaches to contextualize disaster preparedness exercises. To address these gaps, this study applies implementation science frameworks to federal exercise guidance to identify embedded sociotechnical determinants and intended outcomes by using CFIR 2.0 alongside outcome-focused frameworks including RE-AIM and Proctor's Implementation Outcomes, to characterize how implementation expectations are articulated within federally developed MRSE guidance documents prior to local execution.

Informed by this literature, the methods described below use implementation science frameworks to evaluate how federally developed MRSE guidance operationalizes sociotechnical assumptions and implementation expectations before adaptation and execution at the local level.

2.4 Methods

Guided by implementation science approaches, this study employed a deductive qualitative document analysis of MRSE guidance to examine how sociotechnical factors and implementation expectations are communicated in federal disaster preparedness policy prior to local adaptation. CFIR 2.0 was used as an analytical and evaluative framework, with a deductive (a priori) codebook developed to contextualize the content of the exercise documents across the five CFIR domains (Innovation, Outer Setting, Inner Setting, Individuals, and Implementation Process) and their associated constructs and sub-constructs, in order to identify which implementation-related factors are emphasized within federally developed MRSE exercise documents (Damschroder et al., 2022). Additionally, the implementation science evaluation frameworks Proctor's Implementation Outcomes and RE-AIM were used to categorize the intended outcomes established at the federal level for the MRSE (Glasgow et al., 1999; Proctor et al., 2011). The documents included in the analysis were the (1) the MRSE Situation Manual, (2) the MRSE Exercise Evaluation Plan, and (3) the MRSE Exercise Planning and Evaluation Tool (ASPR, 2023).

Document analysis is a qualitative method that systematically examines existing documents (e.g., books, news articles, journal articles, reports, and even visual materials like photos or videos) as data to generate descriptive and/or interpretive insights (Bowen, 2009). Although it is less commonly used than interviews, partly due to limited guidance in the literature, it is an important approach because it enables rigorous inquiry using pre-existing sources when fieldwork is impractical and can reveal both explicit content and underlying meanings in texts (H. Morgan, 2022). As described by Bowen (2009), document analysis enables researchers to extract relevant information, identify key themes, and interpret data within a meaningful research context. Deductive (a priori) analysis is a top-down approach in which

researchers use predefined codes from theory, literature, or research questions to organize and analyze data in a focused, systematic way (Bingham, 2021). A deductive document content analysis approach was selected as the primary method for this study because it enables the systematic examination of existing federal guidance documents to generate empirical insights and understanding (Watkins, 2023, pp. 37-46).

Following the standard three phases of deductive qualitative analysis (preparation, organization, and reporting), the preparation phase focused on collecting the documents and developing the codebook using implementation science frameworks. The codebook was developed in an Excel template and uploaded to MAXQDA Analytics Pro (Release 26.0.0). During the organization phase, the documents were reviewed in MAXQDA and mapped to the predefined codes. The final phase of the deductive analysis (reporting) is presented in the Results and Discussion sections of this chapter summarizing the coded text using descriptive percentages.

To support rigor, transparency, completeness, and reproducibility, the Standards for Reporting Qualitative Research (SRQR) checklist was referenced in the preparation of this manuscript (O'Brien et al., 2014; Poduthase, 2015). Because this study analyzed publicly available documents, it did not require its own IRB review. It was conducted as part of a broader research project that received an IRB exemption from the University of Michigan Medical School Institutional Review Board (IRBMED; HUM00246148) and therefore posed minimal ethical concerns. This research was funded by the University of Michigan Rackham Graduate Student Research Grant, and the author reports no conflicts of interest.

2.4.1 Data Collection

In preparation for the qualitative analysis, relevant documents were first collected. According to the Situation Manual, the three core MRSE guidance documents are the (1) Situation Manual, (2) Evaluation Plan, and (3) Exercise Planning and Evaluation Tool. The MRSE Situation Manual and Evaluation Plan, published in July 2023, were obtained from the ASPR website in November 2023 (ASPR, n.d.). Because the Exercise Planning and Evaluation Tool was not publicly available, ASPR was contacted via email in January 2024 to request access to additional MRSE resources relevant to the analysis. In February 2024, a representative from the Office of Health Care Readiness provided Word versions of the Situation Manual and Evaluation Plan, as well as the Excel version of the Exercise Planning and Evaluation Tool, demonstrating that these documents are publicly accessible although not readily available online (K. Sheehan, personal communication, February 21, 2024). All electronic versions of the documents were saved in a secure Dropbox folder.

Via the email communication with ASPR, the representative indicated that updated documents were anticipated prior to July 1, 2024 (K. Sheehan, personal communication, February 21, 2024). As of June 2025, updated versions had not been posted online; therefore, analysis proceeded using the three documents obtained.

2.4.2 Data Analysis

Following document collection, all materials were uploaded to MAXQDA; the priori codebook was developed in Excel and imported into MAXQDA to begin analysis. The analysis began by completing a full read-through of each of the three MRSE documents. During this initial review, reflections, emerging questions, and analytic decisions were recorded in an electronic audit trail using Microsoft OneNote (Rodgers & Cowles, 1993). The MRSE Situation

Plan and MRSE Evaluation Plan were imported into MAXQDA as PDF files from Dropbox. For ease of analysis, the MRSE Exercise Planning and Evaluation Tool, originally an Excel file with 11 worksheets, was converted into a single PDF document. MAXQDA was then used to organize codes, manage analytic memos, and support systematic comparison across the documents.

A priori deductive coding (also referred to as directed content analysis) approach was used as the primary document analysis method. This qualitative method applies a pre-existing framework, theory, or body of research to guide analysis, beginning with established categories to examine, validate, and extend specific concepts within the data (Kleinheksel et al., 2020). The deductive codebook was developed using the constructs and sub-contracts as codes and definitions as memos from CFIR 2.0, Proctor Implementation Outcomes, and RE-AIM frameworks (Damschroder et al., 2022; Glasgow et al., 1999; Proctor et al., 2011). The codebook and corresponding memos were formatted in an Excel template and then imported into MAXQDA to generate the coding framework labeled "CFIR" and "Outcomes," a complete codebook is included in Appendix C for reference purposes.

Prior to coding, all CFIR domains, constructs, and subconstructs were reviewed to ensure conceptual clarity of the coder. Consistent with guidance from *The Consolidated Framework for Implementation Research (CFIR) User Guide: A Five-Step Guide for Conducting Implementation Research Using the Framework*, this analysis established clear operational boundaries for each CFIR domain prior to coding by defining CFIR domains and their boundaries within a study context is essential for accurately linking findings to implementation determinants and identifying targets for intervention (Damschroder et al., 2022; Reardon et al., 2025). In accordance with this direction, Table 2.1 outlines the domain-level boundaries and definitions developed to be used as reference to guide coding decisions. As described by Curran

(2020), the *innovation* is the being the 'thing' being implemented such as a new clinical treatment, educational program, or city service; so within this context the innovation is the disaster preparedness exercise— the MRSE.

Table 2.1 Defined CFIR Domain Boundaries for MRSE

CFIR Domain	Defined Boundary for MRSE	Adapted Definition for MRSE
Innovation	The Medical Response Surge Exercise (MRSE)	The MRSE itself, conceptualized as the intervention being implemented, including its design, objectives, scenario, and exercise structure
Outer Setting	State and National Context (outside the HCC)	External policy environment, funding structures, regulatory guidance, and preparedness expectations influencing MRSE design and implementation
Inner Setting	Healthcare Coalition (HCC) and partner organizations	The organizational context of the HCC, including structure, culture, communication networks, and readiness for implementing the MRSE
Individuals	HCC members participating in the 2024 MRSE	Individuals involved in the MRSE, including HCC staff and partners, whose knowledge, roles, experiences, and perceptions influence exercise implementation
Implementation Process	Implementation of the 2024 MRSE	The processes used to plan, execute, and evaluate the MRSE, including pre-exercise planning, exercise conduct, and post-exercise activities (e.g., After-Action Review) as outlined in HSEEP

While coding was primarily deductive, iterative analytic memoing helped refine interpretations and make sure coding aligned with framework definitions (Braun & Clarke, 2022). Coding decisions were reviewed regularly, and any uncertainties were resolved using Table 2.1; audit trail notes were used to maintain consistency and reliability. The MRSE Situation Manual and Evaluation Plan were coded at the section and subsection level, with each section assigned to the CFIR 2.0 domain and construct that best fit its main purpose. This approach captured the content systematically while keeping the coding clear and manageable. To maintain clarity and prevent redundancy, each section of the documents was coded only once, focusing on its primary purpose. This approach ensured that each segment of text was interpreted according to its main intent, rather than being assigned multiple codes that could complicate the

analysis or inflate the frequency of themes.

The decision to apply CFIR alongside Proctor's Implementation Outcomes and RE-AIM was intentional to distinguish between implementation determinants and intended outcomes within the MRSE guidance documents. CFIR was used to characterize multilevel sociotechnical factors related to implementation context and process, while Proctor's framework and RE-AIM were applied only to explicitly stated exercise outcomes. To maintain analytic clarity and avoid inflating construct frequency, document sections were coded according to their primary purpose rather than applying multiple overlapping codes to the same segment. This approach prioritizes transparency and interpretability of distribution patterns across domains.

While coding segments under the *Doing* construct within the Implementation Process domain, additional sub-constructs were added to provide more context. The sub-constructs "*Innovation Deliverers*" and "*Innovation Recipients,"* matching the sub-constructs under the *Engaging* construct. They were added to indicate who was responsible for carrying out activities: HCC Leaders were categorized as *Innovation Deliverers*, and HCC Partner Representatives were categorized as *Innovation Recipients*.

The MRSE Exercise Tool was mainly coded under the *Implementation Process* domain to cover the exercise lifecycle: planning, action, and reflection. Sections of the document like Concepts and Objectives, Planning and Coordination, and the Health Care Surge Capacity Calculator, were coded under the *Planning* construct. Sections describing real-time actions, like Exercise Initial Actions, Information Sharing, Resource Coordination, and the Patient Surge Summary Table, were coded under *Executing.* Post-exercise evaluation sections, including Improvement Planning and HPP Performance Measures (PMs 14–21), were coded under *Reflecting & Evaluating*. A limited number of sections were broken out into sub-sections, like

the Patient Surge Summary Table, and coded with two constructs since sections within the table corresponded best with *Execution* and *Evaluation* constructs. Glossaries included in the appendix of the Situation Manual and Evaluation Plan were coded under the *Access to Knowledge & Information* construct within the Inner Setting Domain.

After coding, analytic outputs were generated in MAXQDA and exported to Excel. These included document characteristics (pages, paragraphs, words, sentences), word frequency and combinations, word clouds, CFIR coding counts and percentages, and Outcomes coding counts and percentages. These outputs helped show which sociotechnical and implementation elements were emphasized, missing, or underrepresented in MRSE guidance.

2.5 Results

The three core MRSE guidance documents analyzed in this study, all developed by ASPR, include the MRSE Situation Manual, the MRSE Evaluation Plan, and the MRSE Exercise Planning and Evaluation Tool. The Situation Manual, 70 pages in length, provides detailed instructions for planning and conducting the exercise intended to be base knowledge for all participants and facilitators. The Evaluation Plan, 38 pages in length, outlines exercise goals and guides evaluators in collecting information and facilitating the AAR with the exercise facilitators and evaluators being the primary audience. The Exercise Planning and Evaluation Tool, originally 11 sheets in Excel converted into a 41-page PDF, supports HCCs in conducting the exercise and collecting required data related to performance measures for HPP cooperative agreements. The tool is intended to be used by HCC leaders to consolidate data from exercise participants and send the results back to ASPR. Collectively these documents may be referred to as “the policies.” Each document was systematically coded using deductive document analysis, Table 2.2 provides a summary overview of the content of the documents and coded segments.

Table 2.2 Overview of MRSE Documents and Coding Segments

Document Name	Coded Segments	PDF Pages	Paragraphs	Sentences	Words	Characters
MRSE Situation Manual	367	70	1315	3019	20190	142449
MRSE Evaluation Plan	152	38	797	1745	10155	70768
MRSE Exercise Planning and Evaluation Tool	240	41	1107	2151	12784	85305

Prior to analyzing the results of the deductive coding, an initial analysis of the document contents was conducted using word frequency outputs. These results are presented in the figure and two tables below. Figure 2.1 displays a word cloud of the three core MRSE guidance documents generated in MAXQDA. The size of each term reflects its frequency across the documents, highlighting key concepts, participants, and operational elements. As displayed in the figure, the primary goal of the exercise is to "manage patient surge." Other important words pertain to the overarching policy that mandates the exercise – "hpp cooperative agreement and mrse performance measures" and various potential exercise participant groups such as "non-core hcc members," "skilled nurse facility," "poison control center," "public health agency," and "community care organization."

Table 2.3 presents the top 10 most frequently occurring words across all documents. This table represents a redacted version of the complete MAXQDA frequency list of nearly 1,300 words. The mention of the word "exercise" accounts for over 4% of the content in the document followed by HCC at 2.5%. In the frequency list, 'hospital' ranked 59 (≈80 mentions), whereas terms such as 'HCC,' 'bed,' and 'patient' ranked in the top 10.

Figure 2.1 Word Cloud of MRSE Document Content generated by MAXQDA



Table 2.3 Top 10 Most Frequently Occurring Words Across MRSE Guidance Documents

Word	Frequency	%	Situation Manual	Evaluation Plan	Evaluation Tool
exercise	1118	4.36	538	232	348
HCC	648	2.53	245	148	255
Care	430	1.68	269	79	82
Plan	427	1.67	151	160	116
patient	415	1.62	182	68	165
MRSE	410	1.60	245	85	80
surge	365	1.42	182	67	116
member	357	1.39	157	87	113
bed	334	1.30	163	49	122
Response	297	1.16	136	75	86

The top 10 three-word combinations identified across all documents are summarized in Table 2.4. The word combination “non-core hcc member” which refers to healthcare and community organizations outside of the core four organization (acute care hospitals, public health agencies, emergency medical services (EMS), and emergency management agencies) is mentioned over 49 times across each of the documents.

Table 2.4 Top 10 Three-Word Combinations Identified Across MRSE Guidance Documents

Word Combination	Frequency	%	Rank	Situation Manual	Evaluation Plan	Evaluation Tool
non-core hcc member	49	3.90	1	19	12	18
mrse performance measure	37	2.94	4	29	6	2
public health agency	31	2.46	9	13	7	11
homeland security exercise	27	2.15	14	12	10	5
acute care hospital	20	1.59	22	8	6	6
initial emergency notification	17	1.35	34	8	6	3
Healthcare Coalition	15	1.19	47	5	6	4
emergency management agency	13	1.03	59	7	2	4
hazard vulnerability analysis	13	1.03	59	8	2	3
hcc response plan	13	1.03	59	2	8	3

Note. Word combinations not mentioned across all three documents have been eliminated from this table.

The CFIR 2.0 deductive codebook was comprised five domains, 48 constructs, and 21 sub-constructs, resulting in a total of 69 unique codes. Codes at the domain level were aggregated from both second- and third-level constructs. Although the Individuals domain is divided into two components (Roles and Characteristics), although they are not counted as separate domains.

To assess the applicability of CFIR to contextualize the MRSE guidance documents, Table 2.5 was created. This table summarizes the ratio of constructs coded relative to the total possible constructs within each CFIR domain. Of the 69 unique codes 44.9% (n=31) were used. The Implementation Process domain had the highest coverage (88%), indicating that nearly all constructs were addressed across the documents. The Innovation and Individuals domains had moderate coverage (50% and 54%, respectively), while the Outer Setting domain was less represented, with 3 of 10 codes applied. The Inner Setting domain had the lowest construct coverage (9.5%), indicating that relatively few constructs were applied, despite accounting for 19.9% of the coded text. Within this domain, the MRSE guidance documents primarily addressed inner setting factors related to training, access to information, and resourcing.

Table 2.5 Proportion of Coded Text and Coverage of CFIR Across MRSE Documents

CFIR Domain	Total # of Constructs	# of Constructs Coded	% of Codes Used
Innovation	8	4	50%
Outer Setting	10	3	30%
Inner Setting	21	2	9.5%
Individuals	13	7	53.8%
Implementation Process	17	15	88.2%
Total	69	31	44.9%

Note. This table reflects the spread of coding across the domain categories and does not account for the frequency of code use or weighting.

While the Situation Manual emphasizes adaptability, participant engagement, and planning guidance; the Evaluation Plan focuses more heavily on implementation ("doing") alongside structured reflection and evaluation. The Exercise Planning and Evaluation Tool centers on noting the innovation design, clarifying team roles and responsibilities, and tracking performance metrics.

Each of the MRSE guidance documents included some representation of the CFIR domains, the extent and emphasis of coding varied across documents. The results, as shown on Table 2.6, demonstrate that most of the content across the MRSE guidance documents were concentrated within the Implementation Process (39.1%) and Innovation (27.0%) and domains, with limited codes within the Inner Setting (19.9%), Individuals (4.9%), and Outer Setting (4.6%) domains. The Evaluation Plan has over half of its content (58.7%) coded to the Implementation Process domain.

Table 2.6 Percent of Coded Text by CFIR Construct Across MRSE Planning and Evaluation Documents

CFIR Code System	MRSE Situation Manual	MRSE Evaluation Plan	MRSE Exercise Planning and Evaluation Tool	TOTAL
I. INNOVATION DOMAIN	**32.6%**	**6.5%**	**51.7%**	**27.0%**
A. Innovation Source	2.9%	2.3%	-	2.4%
B. Innovation Evidence-Base	1.6%	1.0%	-	1.2%
D. Innovation Adaptability	21.0%	-	-	12.6%
G. Innovation Design	14.2%	3.1%	51.7%	15.0%
II. OUTER SETTING DOMAIN	**2.8%**	**9.2%**	**2.0%**	**4.6%**
A. Critical Incidents	1.6%	3.6%	-	2.0%
E. Policies & Laws	1.0%	5.1%	2.0%	2.3%
F. Financing	0.2%	0.4%	-	0.3%
III. INNER SETTING DOMAIN	**21.1%**	**23.0%**	**5.5%**	**19.9%**
J. Available Resources	5.5%	-	5.5%	3.9%
K. Access to Knowledge & Information	15.6%	23.0%	-	16.0%
IV. INDIVIDUALS DOMAIN	**3.7%**	**1.9%**	**19.6%**	**4.9%**
IV. INDIVIDUALS DOMAIN (Roles)				
D. Implementation Facilitators	0.9%	-	-	0.6%
E. Implementation Leads	1.0%	-	-	0.6%
F. Implementation Team Members	0.2%	-	14.2%	1.6%
G. Other Implementation Support	0.3%	0.6%	2.1%	0.6%
H. Innovation Delivers	0.8%	0.3%	-	0.6%
I. Innovation Recipients	0.2%	-	3.3%	0.5%
IV. INDIVIDUALS DOMAIN (Characteristics)				
B. Capability	0.6%	1.9%	-	0.9%
V. IMPLEMENTATION PROCESS DOMAIN	**32.7%**	**58.7%**	**21.2%**	**39.1%**
B. Assessing Needs	0.8%	-	6.9%	1.2%
2. Innovation Recipients	0.8%	-	-	0.5%
C. Assessing Context	3.4%	-	2.9%	2.4%
D. Planning	5.1%	4.0%	2.3%	4.5%
E. Tailoring Strategies	0.7%	-	-	0.4%
F. Engaging	10.7%	-	5.2%	7.0%
1. Innovation Deliverers	1.0%	-	-	0.6%
2. Innovation Recipients	10.7%	-	5.2%	7.0%
G. Doing	5.2%	36.9%	3.9%	14.3%
1. Innovation Delivers	0.7%	36.9%	-	11.2%
2. Innovation Recipients	0.7%	-	-	0.4%
H. Reflecting & Evaluating	5.8%	17.8%	-	8.7%
1. Implementation	4.0%	9.6%	-	5.2%
2. Innovation	1.3%	8.2%	-	3.2%
I. Adapting	0.4%	-	-	0.3%

Note. Constructs with no coded content were omitted; dashes indicate no coding within a document. Percentages may not total exactly due to rounding. Full coding results are provided in Appendix E.

The intended outcomes of the exercise were deductively coded using Proctor's Implementation Outcomes Framework and RE-AIM. The exercise outcomes were explicitly stated in the Situation Manual and Evaluation Plan. It is important to note that for this analysis, exercise objectives were not treated as outcomes and were coded under CFIR rather than Outcomes. A total of seven outcomes were identified; five were categorized as Service outcomes (71%) and two as Implementation outcomes (29%), mapping to three of the thirteen associated subconstructs. The complete summary and analysis of the outcomes are presented in Table 2.7.

Table 2.7 Distribution of MRSE Exercise Outcomes Across Outcome Domains and Subconstructs (N = 7)

Outcome Domain	Construct	Frequency	Column%	Outcome Statement
Service (n=5; 71%)	Efficiency	3	43%	3. Strengthened processes to coordinate and share information during a community-wide emergency or disaster. 4. Improved HCC capacity to assess availability of and secure access to critical resources (staffed beds, personnel, supplies, equipment, and transport). 5. Improved HCC capacity to assess and secure EMS personnel and resource needs.
	Safety	2	29%	6. Strengthened HCC preparedness to support appropriate patient placement during large surge events. 7. Improved and/or validated response plans and corrective actions to reduce patient morbidity and mortality.
	Effectiveness	0	0%	—
	Patient-Centeredness	0	0%	—
	Timeliness	0	0%	—
Implementation (n=2; 29%)	Adoption	2	29%	1. Improved HCC member engagement in preparedness and response planning. 2. Strengthened executive engagement through participation in the MRSE and/or After-Action Review.
	Reach	0	0%	—
	Effectiveness	0	0%	—
	Implementation	0	0%	—
	Maintenance	0	0%	—
Clinical/Patient (n=0; 0%)	Satisfaction	0	0%	—
	Function	0	0%	—
	Symptomatology	0	0%	—
TOTAL		**7**	**100%**	

There was a total of five *Service* outcomes, three within the *Efficiency* construct and two within *Safety*. The other two outcomes were categorized under the Implementation domain, both under Adoption— emphasizing HCC members and partner organizations executive engagement.

The deductive coding results from using CFIR, Proctor Implementation Outcomes, and RE-AIM analysis of the three core MRSE guidance documents reveal that federally developed disaster preparedness exercise materials are primarily focused on the procedural implementation (Implementation Process), exercise design (Innovation), and service outcomes. There is a moderate amount of content in the documents related to organizational context (Inner Setting); however, the depth of context is limited given the relatively small number of sub-constructs applied. Comparatively, there is significantly less content on Individual roles and characteristics as well as and broader external factors (Outer Setting).

2.5.1 MRSE Situation Manual

The MRSE Situation Manual provides a comprehensive overview of the exercise, including objectives, intended outcomes, structure, phases, and conduct guidelines. It includes detailed instructions for planning, scheduling, implementation, and post-exercise review, as well as clearly defined exercise roles with descriptions. The appendices include supplemental materials such as tools for calculating surge capacity, a comprehensive glossary, guidance on using real-world incidents as exercise scenarios, suggestions for engaging non-core HCC, and documentation of alignment with HSEEP exercise design standards. The manual also includes various templates, such as email communications and optional exercise outcomes, to support implementation.

Although the manual is publicly available and intended for use by all MRSE participants, it is dense and primarily useful for the exercise implementation committee. While it includes an

extensive exercise overview and implementation instructions, there are notable gaps. For example, it provides limited guidance on using hazard vulnerability assessments to tailor exercises to specific scenarios. Also, although it suggests adapting the MRSE for other organizational requirements, it does not include a dedicated appendix referencing additional relevant regulations or standards that could assist HCC leaders in planning exercises year over year.

Based on the analysis, the MRSE Situation Manual contained the greatest number of CFIR codes, drawing from 31 of the 69 possible constructs. This is expected given the document's purpose and length, the Situation Manual is designed to be the most comprehensive overview. Across CFIR domains, 32.6% of codes were within the Innovation Domain, 32.7% within the Implementation Process Domain, 21.1% within the Inner Setting, 3.7% within the Individuals Domain, and 2.8% within the Outer Setting.

Within the Innovation Domain, most coding concentrated in Innovation Adaptability and Innovation Design, reflecting the manual's strong emphasis on outlining the exercise and providing flexibility for HCCs to tailor implementation. The Implementation Process Domain included nearly all subconstructs, demonstrating that the Situation Manual offers guidance across the full exercise implementation from assessing needs and planning, to engaging participants, executing the exercise, and reviewing outcomes. These align directly with the three primary MRSE phases: Plan & Scope, Exercise, and Review. Notably, a large proportion of codes centered on Engaging, particularly Innovation Recipients, reinforcing that the manual is designed to prepare and support those expected to participate. Collectively, these findings suggest that the Situation Manual functions as the primary operational guide for implementing the MRSE.

Codes within the Inner Setting Domain were concentrated around Available Resources and Access to Knowledge and Information, suggesting that the manual serves primarily as a resource and instructional guide for the HCC. The relatively limited representation of other Inner Setting constructs as well as constructs within the Outer Setting and Individuals domains is not unexpected given the document was developed at the federal level. However, it raises important questions about the extent to which state- and local-level specific context is addressed in HCC-developed materials.

2.5.2 MRSE Evaluation Plan

The MRSE Evaluation Plan provides an overview of the MRSE evaluation approach and outlines procedures for assessing implementation of the exercise. It details evaluation components, defines evaluation products, and provides instructions and guidelines for the assessment process. Importantly, it links evaluation processes directly to HPP performance measures aligned with the seven intended MRSE outcomes. The appendices include extensive guidance for conducting after-action reviews, including structured discussion questions and a glossary of terms.

The MRSE Evaluation Plan provides an overview of the MRSE evaluation approach and outlines procedures for assessing exercise implementation. It details evaluation components, defines evaluation products, and provides instructions and guidance for the assessment process. One of the most important takeaways, is that it links evaluation processes directly to HPP performance measures aligned with the seven intended MRSE outcomes. The appendices further strengthen this guidance by offering structured after-action review tools, discussion questions, and a glossary of key terms.

Nearly 60% of the Evaluation Plan's content was coded to the Implementation Process

Domain, with the majority concentrated in Doing subconstruct particularly for Innovation Delivers (36.9%). This emphasis demonstrates the Evaluation Plan's role in directing execution as it pertains to what needs to happen during and after the exercise and the specific responsibilities of exercise evaluators.

The next largest proportion of coding was within the Inner Setting Domain, particularly Access to Knowledge & Information (23.0%) subconstruct. This shows that the plan functions as a practical "how-to" guide. In contrast to the Situation Manual, only 6.5% of the Evaluation Plan mapped to the Innovation Domain, which is expected given its focus on operationalization rather than details on the innovation design. Similar to the Situation Manual, there was limited coding within the Inner Setting (beyond Access to Knowledge & Information), Outer Setting, and Individual Characteristics domains. However, the Outer Setting domain had a slightly higher proportion of content (9.2%), particularly within the "policies and laws" construct. This increase is from the inclusion of performance measures explicitly mapped to the exercise objectives, as well as references to critical incidents that provided guidance for supplementing the MRSE scenario with real-world applications.

2.5.3 MRSE Exercise Planning and Evaluation Tool

Lastly, the MRSE Exercise Planning and Evaluation Tool is an Excel-based resource, developed by a federally contracted consulting firm, intended primarily for Exercise Facilitators and Evaluators. It supports documentation and decision-making across the full exercise lifecycle, spanning Phase I: Plan & Scope through Phase III: Review. The tool includes 11 sequentially organized worksheets and, consistent with guidance provided in the Evaluation Plan, is designed to capture required exercise implementation data, including information relevant to HPP cooperative agreement performance measures. While the Excel version is clearly structured, it is

also extremely lengthy.

Similar to the Situation Manual, the top two domains represented in the tool were the Innovation Domain (51.7%) and the Implementation Process Domain (21.2%). However, in contrast to the Situation Manual, there was less variation across subconstructs within these domains. The Innovation Domain was comprised solely of the Innovation Design subconstruct (51.7%), while the Implementation Process Domain reflected five subconstructs (Assessing Needs, Assessing Context, Planning, Engaging, and Doing). Unlike the other MRSE documents, the Individuals Domain had a higher presence in this tool (19.6%), primarily because a key function of the tool is to document who participated in the MRSE and the roles of the implementation team. Consistent with the other MRSE documents, the Outer Setting and Inner Setting domains contained relatively limited content.

Across the three documents, the emphasis is on how to plan, execute, and evaluate the exercise with detailed instructions on scenario design, participant roles, and required documentation. When mapped to CFIR, most of the content falls within constructs related to implementation activities and exercise design, particularly planning, doing, reflecting and evaluating, and adaptability. Organizational context was primarily addressed through guidance on access to information and available resources, indicating that the documents prioritize ensuring coalitions have the knowledge and tools needed to carry out the exercise. The stated outcomes mainly focus on operational performance during surge events such as coordination, information sharing, resource access, and appropriate patient placement. Additional implementation outcomes focused on engagement and participation of HCC members and leadership in preparedness efforts.

2.6 Discussion

As outlined in the literature review, there remains a significant gap in consistent evaluation methodologies and metrics for disaster preparedness exercise implementation, limiting broader understanding of training effectiveness. This study applied implementation science determinants and evaluation frameworks including CFIR 2.0, Proctor's Implementation Outcomes, and RE-AIM as a priori deductive coding tools to analyze federally developed MRSE guidance documents. The three documents analyzed referred to as the MRSE policy package (the MRSE Situation Manual, MRSE Evaluation Plan, and MRSE Exercise Planning and Evaluation Tool) function together within FEMA's "Federally Supported, State Managed, and Locally Executed" disaster management structure. The application of CFIR 2.0 as an implementation science determinants framework enabled a structured examination of sociotechnical components across the Innovation, Outer Setting, Inner Setting, Individuals, and Implementation Process domains, highlighting how intervention characteristics, contextual influences, individual roles, and implementation processes are represented in federal guidance (Damschroder et al., 2022).

The findings show that MRSE guidance documents can be systematically mapped onto CFIR constructs, confirming that disaster preparedness exercises can be analyzed as sociotechnical implementation systems. However, the distribution of coded content reveals that the documents prioritize exercise design and procedural implementation processes, with more limited emphasis on organizational context, individual-level determinants, and broader external influences. This pattern suggests that while federal guidance provides strong direction on how to plan, execute, and evaluate the exercise, it offers less support for navigating the more complex contextual factors that influence how implementation unfolds in diverse real-world settings.

Disaster exercises are often treated as structured procedural activities, but exercises like the MRSE are implemented within complex sociotechnical environments. The MRSE is

designed to test HCC capacity to manage patient surge across a range of scenarios from acute disruptions such as hospital evacuation to longer-duration public health emergencies. Because HCCs include a various healthcare agencies including but not limited to hospitals, EMS, public health agencies, long-term care facilities, dialysis centers, and emergency management agencies successful implementation requires coordination across multiple organizational boundaries. This inherently requires multi-organizational leadership engagement, communication processes, resource distribution, organizational culture, and external pressures which are all sociotechnical factors that extend beyond procedural guidance alone.

The MRSE documents consistently frame the exercise as a structured and repeatable innovation supported by standardized tools and clearly defined objectives as revealed by the high coding density within the Innovation and Implementation Process domains. The documents provide detailed instructions for planning, conducting, engaging participants, documenting activities, and evaluating performance. This demonstrates a strong focus on operational clarity and reliability, consistent with HSEEP standards (DHS, 2020).

At the same time, the use of implementation science frameworks revealed important gaps. Although the Inner Setting domain was moderately represented, most content mapped to access to knowledge and available resources, indicating that organizational context is addressed primarily in terms of information availability and logistical support. Broader organizational constructs such as culture, implementation climate, leadership engagement beyond attendance, and structural characteristics were minimally represented. This suggests that within the federal MRSE policy documents organizational determinants are mainly those that pertain to supporting exercise execution, rather than those that may be complex drivers of implementation variability— which is to be expected.

Similarly, the Individuals domain was limited overall, although the Exercise Planning and Evaluation Tool documented implementation team roles and participant responsibilities. While roles are defined, guidance on individual motivation, opportunity, behavioral capability, and decision-making processes is not a dominant focus of the federal documentation. Given that public health leaders often serve in incident management roles outside their routine job functions, limited emphasis on individual-level determinants may represent an area for future refinement in preparedness guidance.

The Outer Setting domain was minimally represented across documents. Policies and laws were referenced, primarily in relation to performance measures and alignment requirements, but broader contextual factors such as financing pressures, interorganizational dependencies, and external environmental variability were less emphasized. Because MRSE implementation occurs across highly diverse state and local environments, this limited representation suggests that federal guidance prioritizes standardization and consistency over contextual adaptation at the outer-system level. Because disasters do not occur in vacuums, giving greater attention to this domain provides an opportunity for practitioners to better understand the complex systems that shape disaster response and to practice navigating those systems during preparedness activities, with the goal of strengthening overall response resilience.

Analysis of the seven intended outcomes, using Proctor Implementation Outcomes and RE-AIM, showed that the MRSE policy package emphasizes service-level operational outcomes and measurable implementation engagement. Most outcomes were categorized within the Service domain, particularly focusing on coordination, safety, efficiency, and appropriate patient placement during surge. Two outcomes aligned with Implementation outcomes under adoption. Together these findings indicate that success, according to the federal guidance documents, is

primarily defined in terms of improved system coordination and operational capacity. There is less emphasis on patient-centered or broader population-level outcomes. While these operational outcomes are essential, implementation science suggests that sustainable improvements require attention to contextual determinants that influence whether these operational gains translate into long-term capacity building (Flynn et al., 2021).

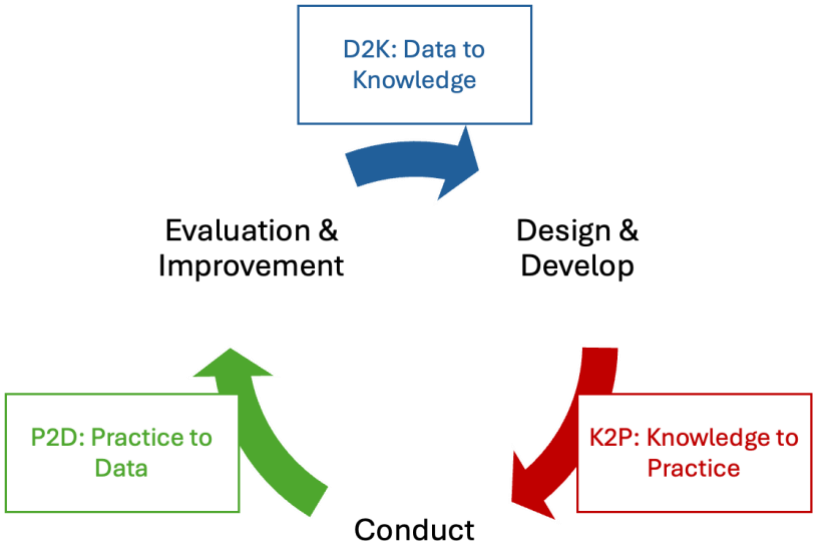
According to the MRSE Situation Manual, the MRSE was developed in alignment with the HSEEP guidelines. HSEEP, developed by DHS and FEMA, is considered the gold standard framework in the U.S. for designing, conducting, and evaluating emergency preparedness exercises. It establishes national best practices for capability-based exercise planning, performance evaluation, and continuous improvement through standardized after-action reporting. However, prior research has highlighted the need to organize shared learnings through standardized training programs, realistic practice exercises, and technology when helpful; along with consistent ways to measure results so that knowledge is not lost and can clearly improve future emergency responses and leadership (Koenig et al., 2017; Li et al., 2022). Both studies emphasize that disaster and public health emergency preparedness should be grounded in rigorous, evidence-based science focused on improving population outcomes to strengthen disaster preparedness capabilities and response capacity.

The purpose of this research is not to contradict or combat HSEEP guidelines. Instead, it is intended to show how implementation science frameworks can be used in complement to HSEEP to help local practitioners, those who are implementing and executing the exercise, more intentionally account for the sociotechnical factors that shape their local context. By doing so, these frameworks can support stronger implementation, improve knowledge transfer, and make exercises more practical and locally meaningful. Ultimately, this helps exercise participants

better understand how the exercise applies to their own setting and real-world disaster response responsibilities. In this way, implementation science does not replace HSEEP; it provides an additional lens for examining how exercises function within the federal–state–local implementation model.

Although this study focuses on applying implementation science determinant and evaluation frameworks to analyze existing federal disaster preparedness exercise documents, demonstrating preliminary utility of implementation science approaches in disaster management, it also highlights additional ways these frameworks can be integrated across the broader three-stage exercise cycle: (1) Design and Development (referred to as Plan and Scope in MRSE), (2) Conduct (referred to as Execute in the MRSE), and (3) Evaluation and Improvement Planning (referred to as Review in the MRSE) as indicated in the HSEEP (DHS, 2020). The stages of these cycles can conceptually fit within the LHS model as indicated in Figure 2.2 below.

Figure 2.2 Disaster Exercises as a Learning System



Note. This cycle is an adaptation of the Friedman Learning Cycle (Friedman, 2022) and HSEEP exercise cycle (DHS, 2020).

For the Design and Development stage, determinant frameworks can be used similar to how they were applied in this study by codifying the sociotechnical components emphasized in federal (state or other) guidance and identify those that may be underrepresented. This provides local practitioners a structured way to think through what additional contextual or organizational considerations may need to be incorporated into their local supplemental exercise materials. The intent of using these implementation science approaches is not to change the exercise, to maintain fidelity to the original design, but rather to reveal areas where practitioners can adapt the exercise to better fit the implementation context of their environment. Therefore, an implementation science evaluation framework could be applied to measure exercise fidelity based on HSEEP standards and ensure that the intended outcomes are achieved, rather than being used solely to evaluate the guidance documents themselves (Carroll et al., 2007). As displayed in Figure 2.2, greater understanding (knowledge) of the preparedness exercise structure can help inform and improve practice.

In the Conduct stage of the exercise, implementation science frameworks can be shared with exercise participants as structured lenses for thinking about implementation in real time. Using the framing of the Johari Window, distinguishing between what is known and unknown, implementation science frameworks can surface "blind spots" in how participants approach exercise implementation as it pertains to accounting for sociotechnical components (Frey, 2018).

Early exposure to these frameworks can provide practitioners with a shared structure and language that can strengthen the execution of various disaster preparedness activities while also serving as a training tool that can encourage more deliberate consideration of downstream disaster response components that might otherwise be overlooked. As presented in Figure 2.2, conducting the exercise generates data for practitioners and participants.

Combining the Evaluation and Improvement Planning stages, implementation science frameworks can be applied in two complementary ways. As highlighted in prior literature, clearly defining the boundary of the implementation setting is essential to strengthen the practical utility of findings (Reardon et al., 2025). When the boundary is defined at the level of implementation of the exercise, frameworks such as CFIR can be used to assess broader barriers and enablers related to exercise design, structure, and intended objectives. Conversely, when the boundary is defined at the level of the organization, the framework can be used to examine organization-specific barriers and facilitators that influenced how exercise play unfolded. The latter boundary approach allows for systematic identification of sociotechnical components such as leadership engagement, communication processes, resource capacity, and organizational culture that require strengthening to build sustainable disaster response capabilities. The data generated from conducting the exercise can be reviewed and translated into knowledge to guide future preparedness exercises and disaster response activities.

To the best of the author's knowledge, this is the first application of CFIR in this manner to characterize the sociotechnical and implementation domains embedded within federally developed disaster preparedness exercise guidance. Applying implementation science frameworks in this way provides a structured approach to analyzing disaster preparedness exercises as sociotechnical systems. Overall, these findings demonstrate that MRSE guidance documents (policy package) strongly support exercise design clarity and procedural implementation activities, with more limited attention to organizational and external contextual determinants. Applying implementation science frameworks in this way helps clarify how preparedness exercises are designed and carried out and supports translating exercise knowledge into sustainable disaster response capability. The next aim focuses on examining exercise

implementation, where frameworks such as CFIR can be used to assess broader barriers and enablers related to exercise design, structure, and intended objectives.

2.6.1 Limitations

One significant limitation of this study is that there was only one coder, which may introduce subjectivity and limits the ability to assess interrater reliability. Although efforts were made to apply the coding framework consistently, the absence of multiple coders means that alternative interpretations of the data cannot be fully ruled out. The most significant limitation of this study is that coding was conducted by a single researcher, which limited the ability to assess inter-rater reliability (O'Connor & Joffe, 2020). Despite these limitations, rigor was maintained through systematic documentation of coding decisions, maintenance of audit trails, and clear analytic procedures to support transparency and replicability. Future research would benefit from the use of a coding team to strengthen coding agreement and increase confidence in the application of CFIR constructs.

Another limitation was the conversion of the MRSE Exercise Planning and Evaluation Tool from Excel to PDF for deductive coding, which created formatting challenges that limited coding precision and reduced the reliability of code weighting and frequency-based analyses. Additionally, the CFIR 2.0 framework codebook was not heavily modified to specifically fit the disaster management context. While this was intentional to preserve fidelity to the established framework, it may have limited the extent to which disaster-specific nuances were captured. Related to the results, coding percentages reflect the distribution of contextual content within the documents and may not fully capture the relative importance of specific constructs in practice.

2.6.2 Future Research

Future research can build upon this research by examining state and locally developed exercise materials to determine whether contextual determinants underrepresented in federal guidance are already being addressed elsewhere. There is also an opportunity to explore barriers and facilitators to using MRSE guidance in real-world implementation and to assess whether contextual gaps identified in guidance correspond with implementation challenges experienced by HCCs. Related to the applicability of existing implementation tools such as the CFIR Codebook, future research could strengthen the credibility and trustworthiness of these findings through additional validation strategies, such as member checking with subject matter experts, including ASPR MRSE administrators.

2.7 Conclusion

This study demonstrates the utility of implementation science determinants and evaluation frameworks (CFIR, Proctor's Implementation Outcomes, and RE-AIM) as tools for systematically assessing the sociotechnical factors embedded within disaster preparedness exercise guidance documents such as the MRSE implemented by HCCs. Applying these frameworks revealed both strengths and gaps in the federal guidance: while the documents strongly emphasize exercise design (Innovation domain) and procedural implementation guidance (Implementation Process domain), they underrepresent critical elements related to individuals and roles, organizational context (Inner Setting), and broader external system factors (Outer Setting) that influence successful implementation in complex sociotechnical environments.

These findings have important implications for preparedness practice and health system resilience. Exercises like the MRSE are intended to strengthen capacity and capabilities of

disaster practitioners throughout the preparedness cycle. Using implementation science frameworks in this context provides a structured way to identify gaps, inform improvements, and support the development of complementary state- and local-level materials.

Future research should examine whether the sociotechnical factors underrepresented in federal guidance correspond to barriers or facilitators encountered during actual exercise implementation. Doing so would deepen understanding of how preparedness exercises move from policy to practice and further strengthen the design of exercises.

Chapter 3 Local Implementation of the MRSE: Participant Perceptions, Barriers, and Enablers

3.1 Abstract

Objective: The literature shows that disaster preparedness exercises strengthen coordination, communication, and response capacity. However, recurring challenges related to fragmented coordination, unclear roles, communication breakdowns, and weak follow-through continue to persist across disaster preparedness exercises and real-world disaster response. There is also limited research on how improvements identified through preparedness activities are operationalized and sustained in practice. This study used implementation science approaches to examine local implementation of the Medical Response Surge Exercise (MRSE) by exploring Healthcare Coalition (HCC) participant perceptions of barriers and enablers influencing exercise implementation.

Methods: A convergent parallel mixed-methods design was used to collect and analyze quantitative and qualitative data concurrently. The quantitative data strand included 15 HCC members from a single ASPR cooperative agreement state. The respondents completed a structured survey assessing participant engagement, organizational roles, resource investment, preparedness alignment, performance outcomes, lessons learned, and perceptions of MRSE implementation. Subsequently, the qualitative data was collected through semi-structured Zoom interviews with 10 of those participants to more indepthly understand participant experiences and identify implementation barriers and enablers related to CFIR domains. Quantitative data was primarily analyzed using descriptive statistics, while the qualitative data using interview

transcripts was analyzed using directed qualitative analysis and the Rapid and Rigorous Qualitative Data Analysis (RADaR) technique to identify major determinants. Identified determinants were mapped to CFIR 2.0 domains and constructs.

Results: Quantitative findings showed generally positive perceptions of MRSE implementation particularly as it pertains to— leadership guidance, capability-based design, and implementation processes. Relatedly, perceptions of long-term effectiveness and sustainability were more mixed. Qualitative findings identified 22 thematic implementation determinants (10 enablers and 12 barriers). Major barriers included low executive engagement, competing priorities, administrative burden, staffing shortages, inconsistent partner participation, and communication challenges. Key enablers included strong collaboration, communication and information sharing, realistic exercise design, and continuous improvement processes. Integrated findings validated that successful MRSE implementation is strongly shaped by organizational context, leadership engagement, coalition relationships, communication structures, and local implementation capacity across HCCs.

Conclusion: This study demonstrates that successful implementation of federally designed disaster preparedness exercises depends heavily on local organizational context, coalition relationships, leadership engagement, and operational capacity. Applying implementation science frameworks provides a structured way to identify determinants influencing preparedness implementation in real-world settings. The findings suggest that strengthening disaster preparedness requires moving beyond procedural exercise completion toward greater focus on inner setting contextual factors such as organizational readiness, collaboration, communication, and sustained implementation support.

3.2 Introduction

This study is the second of three papers examining how implementation science can be applied to disaster research, with a focus on how these approaches can inform the evaluation and improvement of preparedness exercises. More specifically, this paper applies implementation science approaches to examine the MRSE at the local level by investigating perceived barriers and enablers (collectively referred to as determinants) related to exercise design, structure, and intended objectives. These determinants are explored from the perspectives of HCC leaders and partners using the implementation science determinants framework, CFIR 2.0, as the guiding theoretical model within a convergent mixed-methods study design.

The ASPR HPP is the primary federal program dedicated to strengthening healthcare system preparedness and readiness in the U.S. (ASPR, n.d.). The primary mechanism of the HPP is supporting states and regions in building and sustaining HCCs through Cooperative Agreements (CAs); they are tasked with coordinating preparedness, response, and recovery across healthcare organizations that may otherwise compete under routine conditions (ASPR, 2023a). HCCs are networks of healthcare organizations within a defined region that collaborate to strengthen preparedness and response during emergencies. Each HCC must include four core partners: acute care hospitals, public health agencies, EMS, and emergency management agencies. While the organizations (specifically hospitals and EMS) typically compete under "normal" conditions, they become interdependent during disasters, relying on each other for resources, personnel, and information (ASPR, 2023a).

Nationally, approximately 326 HCCs with more than 42,000 members are supported through 62 state and territorial CA recipients (ASPR, 2020). HCCs play a critical role in disaster readiness by coordinating exercises, facilitating resource sharing, establishing communication systems, enabling real-time information exchange, and providing training and education. The

MRSE is the premier annual functional exercise federally required of HCCs to test their ability to manage medical surge (ASPR, 2023a). Designed as a functional exercise, the MRSE is intended to place realistic stress on healthcare systems to evaluate capabilities, identify preparedness gaps, and inform improvement planning (ASPR, 2023b).

Because the MRSE is federally designed but locally executed, it provides a unique opportunity to examine how FEMA's disaster management model "Federally Supported, State Managed, and Locally Executed," is translated into practice. Understanding HCC leaders and participants opinions and experience implementing the MRSE can reveal factors (determinants) that help (facilitators/enablers) or get in the way of (barriers) successfully implementing federally designed exercises.

This study explores the experiences of HCC leaders and members who participated in the 2024 MRSE to understand their perceptions of the exercise and identify key barriers and enablers influencing its implementation. Using CFIR 2.0 as the implementation science determinant framework, this research examines how federal guidance translates into real-world execution. A convergent mixed-methods approach was employed, combining a quantitative survey with qualitative semi-structured interviews. The survey captured participant engagement, perceptions of effectiveness, resource allocation, and organizational performance, while interviews provided deeper insight into contextual factors, organizational processes, and resilience outcomes. The guiding research question is: *What barriers and facilitators influence the implementation of the MRSE at the local level, as perceived by HCC leads and members?*

By integrating survey and interview data through an implementation science lens, this study clarifies how the MRSE is operationalized locally and identifies the sociotechnical factors that shape its implementation. These findings provide a foundation for strengthening disaster

preparedness exercises beyond the MRSE, supporting HCCs in implementation, and enhancing broader healthcare system resilience.

3.3 Literature Review

The literature demonstrates that strong disaster policy and well-designed exercises are critical components of effective public health emergency response. A qualitative multi-case study examined six natural hazard disasters found that disaster legislation and policy that clearly define roles, enable coordination, and engage cross-sector partners significantly strengthen emergency health responses; highlighting the need for disaster declarations to be earlier and more action-oriented (Finnigan, 2023). Another study noted that disaster exercises are essential for testing plans, strengthening coordination and communication, evaluating surge capacity, and identifying system gaps to improve real-world disaster response readiness. Simulation-based exercises ranging from tabletop to full-scale scenarios allow healthcare teams to practice clearly defined roles, improve interdisciplinary collaboration, and evaluate system-level readiness—highlighting the importance of repeated training, broad participant engagement, and continuous improvement in disaster management planning and preparedness (Gandra d'Almeida & Coopersmith, 2024).

The National Incident Management System (NIMS) provides a nationwide framework in the U.S. that establishes a common structure, terminology, and approach for how government agencies, healthcare systems, and emergency responders manage disasters (FEMA, 2017). NIMS conceptualizes preparedness as a continuous cycle of planning, organizing and equipping, training, exercising, and evaluating to strengthen coordinated emergency response across all levels of government. The National Preparedness Goal is a component of the NIMS framework that further defines preparedness as building a secure and resilient nation with the capabilities

needed across the whole community to prevent, protect against, mitigate, respond to, and recover from major threats (DHS, 2015). This goal is intended to be operationalized through 32 core capabilities that allow communities to set targets based on their local risk (FEMA, 2020). Exercises and real-world events are intended to validate these capabilities and identify areas for improvement, supported by national standardized guidance such as HSEEP and the National Exercise Program (FEMA, 2022).

Exercises provide an opportunity to address these issues prior to real-world events. A qualitative study of six functional exercises involving 83 command centers identified gaps in incident command activation, interagency coordination, backup communications, resource request processes, unified public messaging, and reimbursement documentation (Obaid et al., 2017). Similarly, a case study of 1,000 emergency responders found that information sharing was hindered by limited shared situational awareness and unclear communication, compounded by digital infrastructure constraints, time pressures, and coordination complexity (Waring et al., 2018). More recent evidence reinforces the importance of comprehensive planning, simulation-based exercises, continuous training, strong coordination, community engagement, technological support, and ongoing evaluation to strengthen response capacity (Genç & Genç, 2025).

Despite structured federal frameworks and a multitude of exercises, the literature consistently highlights recurring challenges such as fragmented coordination, unclear roles, and communication breakdowns; alongside conditions that support implementation, including stronger collaboration, enhanced training, and structured follow-up processes related to disaster preparedness exercises. Across the literature, studies consistently describe fragmented interagency coordination, unclear roles, communication breakdowns, inefficient workflows, and gaps in resource management and documentation processes (Aminafshar et al., 2026;

McCormick et al., 2014; Obaid et al., 2017; Renger et al., 2021). These issues are frequently identified through HSEEP-guided exercises, where limitations in incident command use, information sharing, and operational handoffs continue to surface (McCormick et al., 2014; Obaid et al., 2017; Renger et al., 2021).

The literature also highlights conditions that support improved preparedness, including stronger interagency collaboration, clearer role definition, enhanced training, improved communication strategies, more realistic exercise design, and structured follow-up processes (Aminafshar et al., 2026; Obaid et al., 2017; Renger et al., 2021). Another qualitative study found that disaster preparedness depends on many connected factors, including planning, training, communication systems, staffing, coordination, leadership, and the mental readiness of personnel (Shafiei et al., 2025). Major challenges included communication breakdowns, limited coordination between organizations, staffing shortages, lack of dispatch-focused training and exercises, and weak support systems for dispatch staff. The findings also emphasized that regular training, realistic exercises, strong communication systems, and clear emergency plans are important for improving disaster response and preparedness. However, most studies continue to emphasize gap identification and general recommendations, with limited attention to how improvements are operationalized or sustained in practice (Aminafshar et al., 2026; McCormick et al., 2014; Obaid et al., 2017; Renger et al., 2021). This reflects a continued disconnect between identifying challenges and translating findings into actionable, implementation-focused approaches.

Evaluation and improvement planning are core components of HSEEP; however, the literature raises concerns regarding the translation of lessons learned (knowledge) into sustained improvement (practice) (Borst et al., 2022). A structured content analysis of 91 AARs to identify

recurring public health system challenges during responses to the H1N1 pandemic and major hurricanes found recurring challenges in communication, information sharing, and incident command coordination (Savoia et al., 2012). The study also highlighted several limitations in the AAR structure and quality that hinder systematic organizational learning. Naik and colleagues (2023) conducted an inductive qualitative analysis of 14 Public Health Emergency Preparedness (PHEP) AARs from exercises and real-world incidents (2012–2018) revealed six overarching themes including: communications, coordination, resource distribution, unified planning, surveillance, and knowledge sharing. In contrast, in the study by Obaid and colleagues (2017), the functional exercise was followed by a regional AAR that produced coordinated AARs and Improvement Plans with assigned points of contact and follow-up mechanisms, resulting in measurable preparedness gains; this study demonstrates the utility of exercises and AARs when there is accountability and follow-up.

It is generally accepted that greater standardization in AAR structure and reporting is needed to strengthen continuous quality improvement and improve evaluation of public health preparedness capabilities (Naik et al., 2023). Since the early 2000s, the federal government has coordinated a central repository for AARs. Initially under the purview of FEMA, the Lessons Learned Information Sharing system (LLIS.gov) served as a centralized repository of lessons learned, best practices, AARs, and collaboration tools for emergency management professionals across all levels of government (DHS, 2005). In 2015, it ceased independent operations and merged its nearly 23,000 resources into the Homeland Security Digital Library (HSDL) to improve accessibility and consolidate information (Homeland Security Digital Library [HSDL], 2017). Despite annual completion of the MRSE by HCCs across the United States, there was no indexed literature within the HDSL. This raises questions about the extent of use and impact of

this repository, which remains unclear and warrants further investigation beyond the scope of this study. As a result, majority of the knowledge related to the implementation of the MRSE from HCC AARs remains embedded inaccessible federal documents rather than disseminated in peer-reviewed literature.

Other historical examples illustrate the gap between knowledge generation and implementation. The 700-page congressional report on Hurricane Katrina documented implementation challenges under NIMS including: insufficient and uneven training/exercises, confusing command/authority relationships, overlapping/ambiguous interagency responsibilities, lack of catastrophe-specific operational plans, and severely degraded communications and situational awareness (Select Bipartisan Committee to Investigate Preparation for and Response to Hurricane Katrina, 2006). The numerous challenges identified during the implementation of Hurricane Pam, the primary preparedness exercise preceding Hurricane Katrina, ultimately contributed to significant challenges during the actual disaster response, including disrupted information sharing, inefficient request processes, and limited coordination of resources across federal, state, and local systems (Beriwal, 2006; Dosen, 2025).

Based on the knowledge of this author, following the bipartisan congressional investigation into Hurricane Katrina, nearly 15 years passed before another large-scale congressional committee was convened to examine a major natural or biological hazard. Following the presidential proclamation declaring COVID-19 a national emergency in March 2020, the Select Subcommittee on the Coronavirus Pandemic was formed in April 2020 (Select Subcommittee on the Coronavirus Pandemic, 2024; Trump, 2020). Nearly a year and a half later, in October 2021, members of Congress introduced the National Disaster Safety Board Act of 2021 – H.R. 5532 (Congressional Research Service, 2021). This bipartisan proposal to seeks to

establish an independent National Disaster Safety Board, modeled after the National Transportation Safety Board, to investigate disaster-related fatalities and economic losses associated with major natural hazards and provide recommendations to improve disaster preparedness, response, and safety. However, as of this writing, the board has not been formally established.

The congressional 500-page After Action Review of the COVID-19 pandemic identified repeated challenges in federal-state-local coordination and surge management, and significant mismanagement in response efforts (Select Subcommittee on the Coronavirus Pandemic, 2024). The report also highlighted the importance of maintaining constitutional protections and public trust during public health crises. These federal findings are synonymous with those found in the literature that COVID underscored the need to strengthen health system surge capacity, expand testing and surveillance infrastructure, build public trust to support risk-mitigation behaviors, address social and economic inequities, enhance global cooperation and diversified supply chains, and recognize that recurring infectious disease threats require sustained investment in resilient preparedness systems (Nuzzo & Gostin, 2022).

Effective exercises followed by implemented AARs (Reviews and Reports) and Improvement Plans ensure that lessons learned are translated into sustained preparedness improvements. A 2006 article argued that “lessons learned” in disaster response are often a misnomer because the same recurring problems in command/unified command, communications, planning, resource management, and public messaging are repeatedly identified in after-action processes but rarely institutionalized due to weak reporting and dissemination, limited training and realistic exercising, lack of incentives and follow-through, and insufficient long-term commitment and resources (Donahue & Tuohy, 2006). These institutional gaps were most

notably revealed prior to Hurricane Katrina in 2005, the FEMA-sponsored Hurricane Pam exercise of 2024 simulated many of the anticipated impacts; however, incomplete planning, insufficient integration, and lack of fully operationalized training limited translation of lessons into practice (Beriwal, 2006). These examples demonstrate that conducting exercises and identifying lessons learned do not guarantee effective implementation.

HCCs developed under the HPP, serve as the primary regional mechanism for coordinating healthcare preparedness and implementing federally supported exercises related to medical surge. HCCs connect hospitals, public health agencies, emergency management, and other partners through planning, training, and exercises (Toner, 2017). Although research is limited, HCCs and their corresponding exercises have been shown to strengthen interorganizational coordination, medical surge planning, and information sharing, while also serving as critical mechanisms for identifying system-level gaps in logistics, communication, and patient tracking across institutions (Barnett et al., 2020; Toner, 2017). However, optimizing HCC performance requires moving beyond capability-based exercises toward system-level integration to identify vulnerabilities, improve tightly coupled information and resource systems, and strengthen leadership and resilience (Hupert et al., 2015). During Hurricane Harvey, a coalition functioned as a regional medical coordination entity, demonstrating how coalition capacity influences real-time operational response (Upton et al., 2017).

However, coalition performance across the nation varies substantially based on factors that remain under researched. A previous qualitative study comprised of interviews with 22 HCC leaders summarized “success” by five contributions: active member participation, diverse membership, measurable increases in members’ response/recovery capacity, information and resource sharing, and being recognized externally as a leader (Acosta et al., 2015). Subsequent

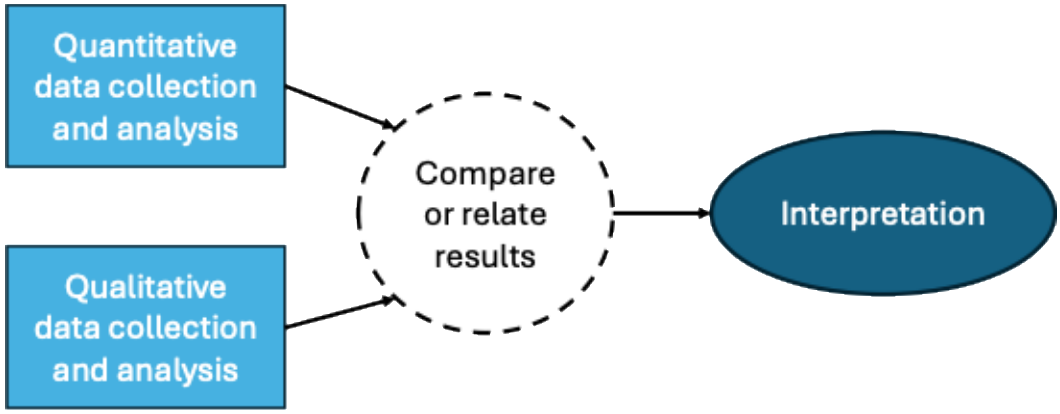
research highlighted differences in coalition maturity, governance structures, leadership engagement, funding stability, and operational readiness; implementation challenges include non-strategic growth, reduced engagement from core members, unclear federal guidance, and inconsistent prioritization of activities (Barnett et al., 2020; Grimm, 2020; Koch et al., 2022). These findings elucidate the importance of examining preparedness implementation at the local level, where contextual factors shape how federal guidance is interpreted and enacted.

In summary, the literature on disaster preparedness exercises consistently highlights recurring challenges, including unclear roles, communication breakdowns, infrastructure limitations, resource constraints, leadership misalignment, and weak follow-through as well as conditions that support implementation such as clearly defined roles, interdisciplinary training, participant engagement, structured improvement planning, and strong coalition governance. Despite these consistent findings, there is limited research on how to operationalize or sustain improvements, suggesting implementation is largely shaped by organizational readiness and local context. Additionally, despite the MRSE being implemented annually at the national level, limited empirical research, restricted access to AARs, and variability in coalition maturity leave key aspects of implementation underexplored. There is also limited consensus within the disaster preparedness community regarding how to define and measure a successful preparedness exercise (Biddinger et al., 2010). Together, these gaps create an opportunity to examine how implementation challenges emerge within the MRSE and how implementation science frameworks such as CFIR 2.0 can help identify factors that influence successful local exercise implementation (Reardon et al., 2025).

3.4 Methods

This study uses CFIR 2.0 to examine the barriers and facilitators influencing local implementation of the MRSE using a parallel mixed methods design (Damschroder, Reardon, Widerquist, et al., 2022; Katz-Buonincontro, 2024). In this design, qualitative and quantitative data are collected concurrently, analyzed independently, and subsequently integrated to provide a comprehensive understanding of the phenomenon, as depicted in Figure 3.1 ("Mixed Methods Designs - Convergent Parallel Design," 2015). This study applies that design to examine how the MRSE is implemented at the local level from participant perspectives, whether it meets intended objectives aligned with federal guidelines, and the factors that shape implementation.

Figure 3.1 Convergent Parallel Design



Note: Adapted from ("Mixed Methods Designs - Convergent Parallel Design," 2015)

The convergent parallel mixed methods design allows for triangulation and complementarity between data strands, enhancing the rigor and depth of insights (Katz-Buonincontro, 2024). The quantitative and qualitative components are described separately in subsequent sub-sections, including methods for data collection, analysis, and integration. A mixed methods approach was selected to investigate participant perceptions by quantifying factors across key domains and assessing alignment with MRSE objectives, while qualitatively

exploring implementation factors.

This study examined MRSE activities conducted under the ASPR HPP CA during the 2024 MRSE cycle (Federal FY 2023–2024). Study components involving human participants were conducted fully virtually, with surveys and semi-structured interviews completed remotely using secure online platforms.

Participants were individuals affiliated with HCCs within a single, anonymized United States Midwest state participating in the HPP CA with ASPR. The study participants represented diverse roles across the health care preparedness system, including public health, emergency management, and health care organization partners, and are collectively referred to as HCC members. The identities of the state, organizations, and participants are not disclosed to protect confidentiality. This study was conducted as part of a broader research project that received an IRB exemption from the University of Michigan Medical School Institutional Review Board (IRBMED; HUM00246148).

The quantitative strand of this study was collected via an electronic survey administered through Qualtrics XM to HCC members who either led or participated in the 2024 MRSE in HPP CA. The qualitative strand was collected through semi-structured interviews conducted via Zoom Workplace version 6.5.5 (59968) with survey respondents who opted in for a follow-up interview. A subset of qualitative survey responses and interview transcripts were analyzed in MAXQDA Analytics Pro (Release 26.0.0). Microsoft Excel was used as the primary tool for data management and analysis.

Participants provided informed consent through the Qualtrics survey, and those participating in interviews were sent their signed consent form from the survey prior to the interview. Participants were offered compensation of $25 for completing the survey and $50 for

participating in the semi-structured interview. This research was funded by the University of Michigan Rackham Graduate Student Research Grant, and the author reports no conflicts of interest.

The development of the study, from design through data collection, was guided by multiple resources, including foundational texts in mixed methods research and consultations with the University of Michigan Mixed Methods Program (Creswell et al., 2011; DeCuir-Gunby & Schutz, 2017; Mixed Methods Program at the University of Michigan, n.d.; D. Watkins & Gioia, 2015). The development of this manuscript used the reporting guidelines— *A Checklist of Mixed Methods Elements in a Submission for Advancing the Methodology of Mixed Methods Research* (Fetters & Molina-Azorin, 2019).

Guided by the pragmatic and equity-focused worldview of the author, this study applies implementation science frameworks to examine disaster preparedness as a sociotechnical process (Clegg et al., 2017; "Pragmatic Paradigm," 2018). This worldview emphasizes how context, power, and structural inequities shape preparedness, with a focus on producing actionable knowledge. The author believes that while some hazards may be natural, disasters are not. Disasters result from the interaction between hazards and human vulnerabilities, where the severity of impact depends on factors such as preparedness, resources, infrastructure, and the ability of communities to respond and recover. Therefore, disaster preparedness represents a form of power and/or capital; when implemented effectively, it can strengthen disaster response and protect the populations it is intended to serve, minimizing harm and saving lives. The author also believes that understanding and improving disaster preparedness requires an iterative mixed methods approach, using qualitative methods to explore current structures and possibilities, and quantitative methods to assess and measure change.

Rigor and Trustworthiness

The methodological approach was grounded in prior qualitative and mixed-methods research. Aligning with the *Checklist to Maximize Rigor in Qualitative Data Analysis*, rigor was demonstrated through— triangulation of quantitative and qualitative data related to MRSE implementation; providing a detailed description of data collection and analytic procedures; inclusion of the researcher's positionality in the introduction to this chapter; and documentation of negative cases across multiple phases of the study (Barbour, 2001). Respondent validation will be conducted in a subsequent study. Additionally, reflexivity was maintained throughout the research process through analytic memos and an audit trail, supporting ongoing reflection on positionality, assumptions, and analytic decisions.

The quantitative and qualitative data collection was guided by the CFIR 2.0 and accompanying guides (Damschroder, Reardon, Widerquist, et al., 2022; Reardon et al., 2025). While the quantitative analysis focused on descriptive statistics of Likert scale responses, the qualitative analysis was guided by directed qualitative analysis (DQA) and the Rapid and Rigorous Qualitative Data Analysis (RADaR) approach, both of which emphasize transparency and systematic analytic consistency (Bhandari, 2020; Fife & Gossner, 2024; D. C. Watkins, 2017).

3.4.1 Sampling

This study used a *convenience sampling approach***,** leveraging professional relationships the author established while attending the 2023 National Healthcare Coalition Preparedness Conference (Clark, 2017). Participants were initially recruited through an email endorsement from a state-level leader in the HPP CA state, which facilitated access to the HCCs. The participant eligibility is included below. This sampling approach was chosen for its practicality

in accessing a specialized population, although it may limit the generalizability of findings. Additionally, HCCs across the nation have varied organizational structures and oversight mechanisms. Therefore, sampling from a single ASPR CA state helped ensure that factors in MRSE implementation could be assessed without confounding effects from structural variation across ASPR CA recipients (states and territories).

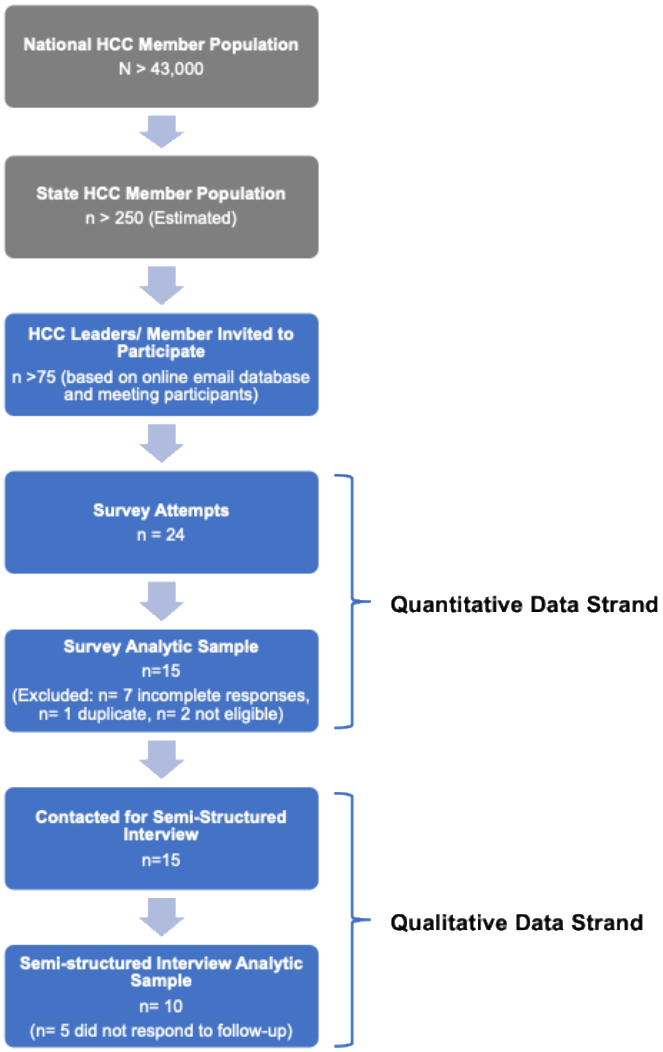
Participant Eligibility Criteria

To participate in the study, individuals had to meet the following criteria:

1. Be 18 years of age or older.
2. Be a Healthcare Coalition leader or a representative of a Coalition Partner organization in one of the HCCs within the selected ASPR CA state.
3. Have participated in at least one phase of the 2024 MRSE (Phase 1 – Planning, Phase 2 – Conducting, or Phase 3 – Evaluating and Reflecting)

An overview of recruitment and participation is provided in Figure 3.2, including the study inclusion and exclusion criteria and outlining the process used to identify eligible participants as well as the sample included in the analysis. A 2016 article, informed sampling and recruitment strategies to support participant engagement, minimize loss to follow-up between the survey and interview phases, and reduce potential bias (Norvell et al., 2016).

Figure 3.2 Recruitment and Participation Flow Diagram



Note. The national HCC membership was identified using publicly available ASPR website information last updated in June 2020 (ASPR, n.d.-a). The State HCC member population was identified from a calendar invitation for a statewide meeting to which the principal investigator was added.

Recruitment Process

The recruitment process primarily involved targeted email invitations to eligible participants. To increase the number of participants, snowball sampling was used to complement convenience sampling; participants were encouraged in the invitation email to share the study with additional colleagues who met eligibility criteria. In an effort to provide additional context for the research to a live audience, the author virtually joined a state-wide meeting in January

2025 to share more about the study. Additionally, a monetary incentive was offered to participants to compensate for their time: $25 for completing the survey and $50 for participating in the interview.

Following the surveys, all participants determined to be eligible to be included in the analytic survey sample were contacted via email as well as call or text based on the preference indicated on the survey to participate in a follow-up interview.

Sample

Approximately 80 potential participants were contacted through email invitations and meetings, using the convenience sampling strategy. Twenty-four participants initiated the electronic survey; 15 participants were included in the final analytic survey sample. For the semi-structured interviews, all eligible survey respondents (N=15) were invited to participate; ten respondents participated, as summarized on Figure 3.2.

The study sample included 15 participants representing Healthcare Coalition (HCC) leadership, government, and public health perspectives. Most participants served in regional HCC coordination or leadership roles, including Healthcare Coalition Leaders (60%) and Regional HCC Coordinators or Assistants (67%). The sample reflected a mix of urban, mostly urban, rural, and statewide representation. Participants also reported involvement in coalition governance and planning structures, including advisory committees, planning boards, executive committees, and regional workgroups, reflecting substantial experience in preparedness coordination and coalition operations.

3.4.2 Quantitative Data Collection and Analysis

To establish a baseline understanding of how HCC members who participated in the MRSE perceived its value and whether intended objectives and outcomes were met, an initial

survey was developed and administered using Qualtrics XM. The survey platform allowed respondents to save their progress and return to complete the survey later, aimed to increase flexibility for the respondents.

The survey evaluated how HCC members and their organizations experienced and implemented the 2024 MRSE. Data collected included participant demographics, organizational roles, level of engagement across each MRSE phase, estimated time and resources invested, familiarity with MRSE guidance materials, and alignment with preparedness and response goals. Additionally, respondents reported on organizational performance related to MRSE evaluation objectives, hazards of concern at the regional and national levels, integration of the MRSE with regulatory and accreditation requirements, and lessons learned to inform future disaster preparedness planning and execution.

The survey included 79 total questions across the following categories: eligibility and consent (4), demographics and coalition involvement (14), MRSE participation and engagement (9), participant feedback (38 Likert-scale items across seven domains), disaster preparedness insights and experiences (9), and compensation preferences (5). Informed consent was obtained electronically through the survey platform, with time and date stamps recorded to document participation. Additional details regarding the development of the study are provided below. As this study was determined to be exempt by the IRB, it posed minimal ethical risk to participants. Most questions utilized standardized Likert-scale response options to measure attitudes, perceptions, and levels of agreement (Bhandari, 2020; Likert, 1932). A copy of the survey is included in Appendix F.

The participant feedback section assessed organizational perceptions of the 2024 MRSE, including communication and understanding, alignment and compatibility with existing

structures, availability of time and resources, leadership commitment, and the perceived impact, adaptability, and sustainability of the exercise. Questions in this section were informed by the CFIR Pragmatic Context Assessment Tool (pCAT) to quantitatively measure barriers and facilitators influencing uptake of the MRSE and the Iterative, Practical, Robust Implementation and Sustainability Model (iPRISM) webtool was used to measure the uptake of the MRSE (Robinson & Damschroder, 2023; Trinkley et al., 2023).

The pCAT was selected as a foundation for this research due to its concise, accessible design and its ability to evaluate implementation barriers and facilitators in applied settings. The tool consists of 14 items developed through empirical research in collaboration with CFIR leadership and focuses on key contextual constructs associated with implementation outcomes (Robinson & Damschroder, 2023). For this study, the pCAT question phrasing was modified to reflect healthcare disaster preparedness exercises, with explicit reference to the MRSE as the innovation of interest. Proctor's implementation outcomes framework was used to categorize intended outcomes and objectives, with survey questions adapted from the 'RE-AIM Program Outcome Assessment' section of the iPRISM Web Tool to assess participant perceptions of whether MRSE objectives were met (Proctor et al., 2011; Trinkley et al., 2023). Several service and clinical outcome items were informed by the goals and metrics identified in Aim 1 of the study. The iPRISM Web Tool was selected because it aligns with the PRISM implementation science framework and supports assessment of reach, effectiveness, adoption, implementation, and maintenance (RE-AIM). Additional questions related to outcomes were based on the outcomes listed in the MRSE Situation Manual (ASPR, 2023).

Rigor was supported using established implementation science–informed frameworks and standardized Likert-scale measures, promoting measurement consistency across constructs and

supporting reliability and construct validity despite the exploratory nature of the study.

Additional Information on Survey Sampling and Selection

Eligibility criteria, sampling procedures, and the resulting analytic sample for the survey are described in detail in the Sampling section. As illustrated in Figure 3.2, a total of 24 initial survey responses were received. Of these, seven responses were excluded due to incomplete survey completion, one response was identified as a duplicate, and two respondents were deemed ineligible based on indicating that they had not participated in any phase of the MRSE.

Data Collection and Management Procedures

A structured online survey consisting of 79 questions was administered, including eligibility and consent items, demographic and coalition involvement questions, and closed-ended and Likert-scale items assessing MRSE participation, organizational context, implementation factors, and perceived outcomes, along with a limited number of open-ended questions capturing disaster preparedness experiences and insights. Given the length of the survey, duration was assessed using Qualtrics metadata. Because respondents were able to save progress and return later, unusually long completion times were observed. After excluding these outliers, the average survey completion time was approximately 24 minutes, aligning with recommended durations to maintain participant engagement (Sharma, 2022).

The survey was open from mid-December 2024 through late March 2025. Although the initial goal was to close the survey within 21 days, several external factors contributed to an extended data collection period including: the timing of major holidays, impacts related to federal ambiguity, and concurrent implementation of the 2025 MRSE. Following survey closure in mid-March 2025, all responses were exported from Qualtrics and stored in a secured Dropbox.

To adhere to a convergent parallel mixed-methods design, quantitative survey data were not analyzed until after completion of the semi-structured interviews. This approach was used to

minimize the risk of biasing interview questions based on preliminary quantitative findings, which would have shifted the study toward an exploratory sequential design rather than the intended convergent design.

A subset of survey data was extracted on a periodic basis to determine eligibility of respondents to be contacted for follow-up interviews. This process involved removing incomplete responses, duplicate entries, and respondents who indicated they had not participated in the 2024 MRSE. Identifiable information—including name, email address, phone number, mailing address, preferred gift card delivery method, and informed consent timestamp—was extracted into a separate "Participant Tracker" file for recruitment and compensation purposes. The primary survey dataset was then de-identified by removing all Personally Identifiable Information (PII). Identifiable data remained only on the Qualtrics server and were destroyed following submission of this dissertation to protect respondent confidentiality.

Data Analysis

The quantitative data from the survey was exported from Qualtrics into Microsoft Excel for analysis. Two short-answer qualitative items, one describing the 2024 MRSE scenario and one capturing open-ended comments, was imported into MAXQDA for supplemental coding and analysis. Respondent characteristics were summarized in a descriptive table.

The majority of survey data was analyzed using descriptive statistics, guided by established recommendations for analyzing Likert-type data (Sullivan & Artino, 2013). Frequencies and percentages were calculated for categorical variables to summarize respondent participation, organizational use of the 2024 MRSE, perceived effectiveness of disaster preparedness exercises, and assessments of organizational performance. Likert-scale items assessing familiarity, involvement, and agreement with foundational exercise principles were summarized using descriptive response distributions, including frequencies and percentages.

Time-related questions focusing on participants estimated hours spent across MRSE phases, were analyzed using grouped frequency distributions and summary statistics (mean, median, minimum, and maximum) to characterize variability in organizational effort. Open-ended responses identifying exercise types were reviewed and inductively categorized into thematic groupings, which were then quantified. Given the exploratory nature of the study and the small sample size, analyses were descriptive only, and no inferential statistical testing was conducted.

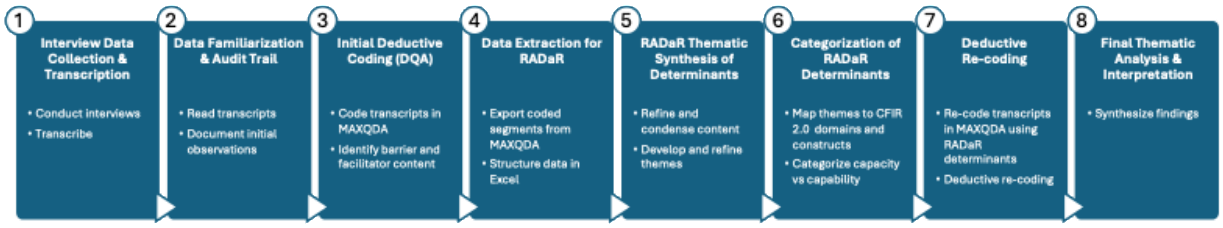
3.4.3 Qualitative Data Collection and Analysis

Following the standards of a convergent parallel design, the qualitative data for this study covered the same time period and phenomenon as the quantitative data so that the findings could be meaningfully compared and integrated ("Mixed Methods Designs - Convergent Parallel Design," 2015). The phenomenon for this study was considered to be the 2024 MRSE implemented by HCCs within a specific ASPR HPP CA recipient state. The interview guide was primarily designed to understand the experiences of HCC members who participated in the MRSE disaster preparedness exercise, to identify barriers and facilitators related to CFIR domains and better understand implementation outcomes.

To provide a clear overview of the qualitative analytic approach, Figure 3.3 illustrates the multi-step, iterative process used in this study. The process begins with interview data collection and transcription, followed by data familiarization and initial deductive coding using directed qualitative analysis (DQA). Coded data were then extracted and analyzed using the Rapid and Rigorous Qualitative Data Analysis (RADaR) technique to support iterative data reduction and thematic synthesis. Resulting determinants were mapped to CFIR 2.0 domains and constructs and categorized as organizational capacity or capability. These themes were then re-applied to

the transcripts through deductive re-coding to ensure consistency and depth of analysis. The figure also highlights the iterative nature of the process, where refinement occurred across coding, thematic development, and mapping to strengthen rigor and interpretation.

Figure 3.3 Overview of Qualitative Data Methods and Process to Determine Determinants Related to MRSE Implementation



Note. This figure summarizes the iterative qualitative analysis process, including DQA coding, RADaR-based data reduction and thematic synthesis, and mapping to CFIR 2.0. Themes were refined and re-applied to transcripts to support consistent interpretation of implementation determinants.

This structured and iterative approach supports transparency and provides a systematic foundation for identifying patterns and determinants influencing MRSE implementation at the local level.

Additional Information on Survey Sampling and Selection

Interview participants were pooled from the survey analytic sample, as illustrated in Figure 3.2. The final survey question included an "opt-in" option to assess participants' willingness to engage and to respect their choice to continue participation in the qualitative portion of the study. Respondents were asked, "*Would you be willing to participate in a follow-up 75-minute Zoom interview?"*, as included in the survey provided in Appendix F All 15 eligible survey respondents indicated either *"Yes"* or "*Maybe."* Beginning in mid-February 2025, eligible respondents were periodically contacted to schedule follow-up interviews via email and, when permitted, by text message or phone call based on their communication preferences. Interviews were conducted between late February 2025 and late April 2025. All

participants who complete the interview were offered a $50 incentive for completing the interview.

Data Collection and Management Procedures

The development of this interview guide was informed using unpublished versions of "CFIR User Guide Resources" publicly available on the CFIR website, these tools that were later included in a publication—*CFIR Construct Example Questions (Additional File 1)* (Reardon et al., 2025). The questions were modified and adapted to fit the MRSE context and the HCC member audience. A copy of the interview guide is provided in Appendix G In addition to CFIR-aligned questions, the guide included introductory rapport-building questions and closing reflections on disaster resilience, the role of HCCs, and the potential role of academia in disaster management.

For consistency, the author of this dissertation served as the sole interviewer. Invitation emails included a Calendly link that allowed participants to schedule an interview time that best fit their availability, with the goal of minimizing participation burden. The primary data source for this aim were interview transcripts. An audit trail was maintained to support reflexivity, including post-interview reflections and analytic memos (Rodgers & Cowles, 1993).

All interviews were audio-recorded using Otter.AI, which generated AI-assisted transcripts; Zoom's audio recording and transcription service was used as a backup. Within both Zoom and Otter.AI, transcript titles were replaced with participant pseudonyms to support confidentiality and incentive tracking. To improve data quality and transcription accuracy, each transcript was reviewed by a trained transcriptionist who listened to the audio recordings while reading the AI-generated text and corrected errors using OtterAI's editing tools. Following transcription verification, transcripts were uploaded to a secure Dropbox folder and deleted from OtterAI.

The finalized transcript folder was then uploaded from Dropbox into MAXQDA for qualitative analysis. Although participants were encouraged to avoid sharing names during interviews, identifying information was disclosed in some cases. To protect privacy, any names mentioned in the interviews will be redacted should the data be used for secondary analysis in the future.

Data Analysis

Multiple qualitative methods texts were referenced throughout the analysis process to support rigor and methodological consistency (Braun & Clarke, 2013, 2022; Taylor & Francis, 2013; Watkins & Gioia, 2015). The article *"Rapid versus traditional qualitative analysis using the Consolidated Framework for Implementation Research (CFIR)"* served as the methodological inspiration for the analysis (Nevedal et al., 2021). Data analysis used a blended approach, applying directed qualitative analysis (DQA) with content and thematic coding methods. DQA integrates deductive and inductive approaches to examine and refine a theoretical or conceptual model (Fife & Gossner, 2024). Deductive coding applies predefined codes drawn from an existing theory or framework to the data to examine how well the data align with those constructs; inductive coding allows new codes and themes to emerge from the data to capture concepts not fully represented in the existing framework (Bihu, 2023). Content analysis focuses on systematically categorizing and quantifying patterns in the data, while thematic analysis involves identifying, analyzing, and interpreting broader themes across the dataset (Vaismoradi et al., 2013).

Data analysis for the interview transcripts was a multi-step, iterative process. First, all transcripts were read in full, and any analytic observations were documented on the audit trail. Second, using MAXQDA as the coding software, a deductive coding strategy was applied to identify content related to MRSE implementation, with relevant text coded as either a barrier or a

facilitator. Following initial coding across interviews, the next step was to import the coded text segments into Excel and format the table to employ a rapid data analysis technique, "*Rapid and Rigorous Qualitative Data Analysis (RADaR)*" (Watkins, 2017). The RADaR technique was used as an iterative thematic synthesis approach to develop, refine, and consolidate thematic determinants, barriers and enablers were assessed separately. Following development of these determinant themes they were then systematically mapped to CFIR 2.0 domains and constructs to support further theory-informed analysis. Themes were also categorized as either an organizational capacity or capability, as a measure of resilience, to further support interpretation of how resources and implementation competencies influenced execution of the MRSE. Finally, all transcripts were re-coded in MAXQDA using the identified themes, also referred to as the RADaR determinants, as a deductive codebook.

In alignment with the need for transparency and rigor in mixed methods research, it is important to note that to prevent loss to follow-up between phases and encourage participation in the second interviews Aim 3 interviews were scheduled in parallel with data analysis for Aim 2. This decision was made given the already small sample size. At that time, data analysis was still in progress; therefore, preliminary results from the RADaR technique were used to move forward with Aim 3. Additional analysis, results, and implications are presented in the subsequent Aim 3 sections.

To provide additional contextual insight into the MRSE, a few supplemental content analyses were conducted using targeted word searches of coded segments on "2024 and 2025," "success," and "academia." These analyses further synthesized participants' perspectives on similarities and differences between the MRSE in 2024 and 2025, perceived effectiveness, and the role of academic engagement.

3.4.4 Integration of Quantitative and Qualitative Data

Following the convergent parallel design, the quantitative and qualitative data was analyzed separately and then merged to compare results using an joint display (Reardon et al., 2025). The joint display was developed in Excel using CFIR domains and constructs, corresponding pCAT survey questions, and mapped thematic barriers and facilitators to integrate quantitative survey results with qualitative interview findings. This approach enabled the development of meta-inferences by systematically examining where quantitative and qualitative findings converged, diverged, or complemented one another. CFIR domains that did not include more than one data strand (e.g., at least two qualitative thematic determinants or both qualitative and quantitative data) were excluded from further analysis. The integration of methods was categorized as confirmation, complementarity, or divergence. Confirmation indicates that quantitative and qualitative findings align and reinforce one another, complementarity (or expansion) occurs when the two data strands address different but related aspects of the same phenomenon, and divergence (discordance) arises when findings conflict or are inconsistent (Fetters et al., 2013).

The use of this joint-display approach strengthened methodological rigor through triangulation and supported the development of integrated, mixed-methods conclusions.

3.5 Results

This section presents findings from the quantitative and qualitative data strands, as well as the integrated results, following a convergent parallel mixed methods design. The focus is on understanding HCC member perceptions of determinants influencing MRSE implementation. Throughout the study, quotations were analyzed without attribution to individual participants; excerpts are presented as de-identified statements to support thematic findings. Full quotations

are not included in the results or appendices due to the presence of potentially identifiable information.

3.5.1 Quantitative

A structured survey consisting of with 79 items was administered through Qualtrics, to assess HCC members— (1) MRSE 2024 participation and engagement as well as disaster preparedness experiences and (2) participant perceptions of MRSE implementation, organizational context, implementation determinants, and perceived outcomes. Among respondents (n=17) who completed the survey, the average completion time was approximately 24 minutes after excluding outliers with unusually long durations, likely due to paused responses.

All participants who completed the survey in full were offered the $25 incentive, including those who were later determined to be ineligible for analysis (n = 17). Among the 17 respondents eligible for compensation, eight individuals selected, “No, I’m happy to participate without compensation,” based on the available survey response option. Two respondents were determined to be ineligible because they reported not participating in the 2024 MRSE. Therefore, based on the inclusion criteria, the final analytic sample consisted of 15 respondents.

Of the 15 participants determined to be eligible for inclusion in the analytic survey sample, most identified as White men (n = 9), with the entire sample identifying as White. Ages were diverse, ranging from 25 to 65+. Sixty percent of participants reported being HCC leaders, with the remaining 40% evenly split between government partners and public health department representatives. Eighty percent of the sample reported their HCC-related job titles as either Regional HCC Coordinator/Assistant or Regional HCC Medical Director. For the six participants who identified as government or public health department representatives, these titles reflect

their roles within the HCC and may not correspond to their formal job titles within their organizations. A couple of the respondents were members of multiple HCCs within the specified HPP CA state. Therefore, regional representation sum of the column percentage is greater than 100%. HCCs were grouped into urban and rural categories based on state data, with approximately 73% representing urban areas and 33% representing rural areas. In addition to their primary HCC role, several participants held multiple additional roles related to the HCCs.

Given the relatively small analytic sample size, further stratification across participants was not feasible. As a result, participant characteristics are presented in Table 3.1 to provide contextual information on the sample but were not used for additional statistical inferences or subgroup comparisons. These data are presented descriptively to situate the findings rather than support comparative analysis.

Table 3.1 Participant Characteristics (N = 15)

Characteristics	**N**	**%**
Gender		
Male	9	60%
Female	5	33%
Non-binary / third gender	1	7%
Age Range, year		
25-34 years old	2	13%
35-44 years old	4	27%
45-54 years old	4	27%
55-64 years old	1	7%
65+ years old	4	27%
Race		
White or Caucasian	15	100%
Healthcare Coalition Group		
Healthcare Coalition Leader	9	60%
Government Partner	3	20%
Public Health Department	3	20%
Job Title		
Regional HCC Coordinator/ Assistant	10	67%
Regional HCC Medical Director	2	13%

Characteristics	N	%
Other	3	20%
Regional Representation*		
Urban	6	40%
Mostly Urban	5	33%
Rural	3	20%
Mostly Rural	2	13%
State	1	7%
Other HCC Roles		
Regional Advisory Committee	11	73%
Regional Coalition Subcommittee Workgroup	8	53%
Regional Coalition Planning Board	8	53%
Healthcare Coalition Executive Committee	6	40%
Other	6	40%
None	4	27%
National ASPR Workgroup	1	7%
State Coordination Committee	1	7%

Note. Participants could select more than one option for Regional Representation and Other HCC Roles; therefore, percentages may exceed 100%.

Survey Questions Part 1 – MRSE 2024 Participation and Disaster Preparedness Experiences

Part one of the survey questions focused on participation and engagement in the 2024 MRSE. Questions in this part of the survey assessed whether respondents participated in the MRSE, their familiarity with the exercise objectives and intended outcomes, and their involvement across the planning, execution, and evaluation phases. Additional questions examined prior experience with ASPR exercises, engagement with MRSE materials, including the Situation Manual, and the extent of organizational participation, such as estimated time invested, and number of personnel involved.

As summarized in Table 3.2, all respondents reported participating in the exercise. Sixty-seven percent indicated that they participated in the Exercise Overview meeting, conducted at the state-level, to determine the approach to the exercise (HCC-specific or statewide). Sixty percent reported participating in the planning phase of the exercise, and 73% participated in the review

phase, including the AAR.

Table 3.2 Summary of Respondent Participation Across 2024 MRSE Phases

MRSE Phase	N	%
Exercise Overview	10	67%
Phase I: Plan & Scope	9	60%
Phase II: Exercise	15	100%
Phase III: Review	11	73%

Note. Participants were asked: "Which phases of the 2024 MRSE did you participate in? (Select all that apply)."

Relatedly, when asked to provide high-level estimates of time spent on the 2024 MRSE, respondents reported the greatest time investment during the exercise development and planning phases. Mean hours were highest for the Exercise Overview phase (10.13 hours) and the Plan and Scope phase (8.93 hours), collectively averaging almost 20 hours per participant. Time spent conducting or participating in the exercise was lower on average (mean = 4.73 hours), while review and improvement activities required a comparable level of effort to planning (mean = 8.4 hours). Median estimates across phases ranged from 2 to 4 hours, while the ranges varied widely indicating substantial differences in organizational engagement and roles across MRSE phases, as summarized in Table 3.3 and displayed in

Figure 3.4.

Additionally, 87% (n = 13) of respondents reported participating in previous ASPR exercises, such as the Coalition Surge Test and the Hospital Surge Test, which predated and were replaced by the MRSE. Focusing on the MRSE, 87% (n = 13) of respondents reported having read the MRSE Situation Manual, a document of more than 70 pages that outlines the exercise scenario, objectives, assumptions, and operational parameters used to guide planning and

execution (additional information about this document is provided in Aim 1). Although the MRSE outcomes and objectives are included in the Situation Manual, only 60% (n = 9) of respondents indicated that they were very or extremely familiar with the MRSE objectives and outcomes, as shown in Table 3.4.

Table 3.3 Estimated Hours Spent on Each Phase of the 2024 MRSE by Respondents

MRSE Phase	Mean Hours	Median Hours	Minimum Hours	Maximum Hours
Exercise Overview: Developing the exercise	10.13	2	0	50
Phase 1 - Plan & Scope: Planning the exercise implementation	8.93	4	0	40
Phase 2 - Exercise: Conducting or participating in the exercise	4.73	4	1	10
Phase 3 -Review: Reviewing the exercise and improving processes	8.4	3	0	60

Note. Participants were asked: "Estimate the number of hours you participated in the exercise."

Figure 3.4 Estimated Hours Spent by Organizations Across MRSE Phases

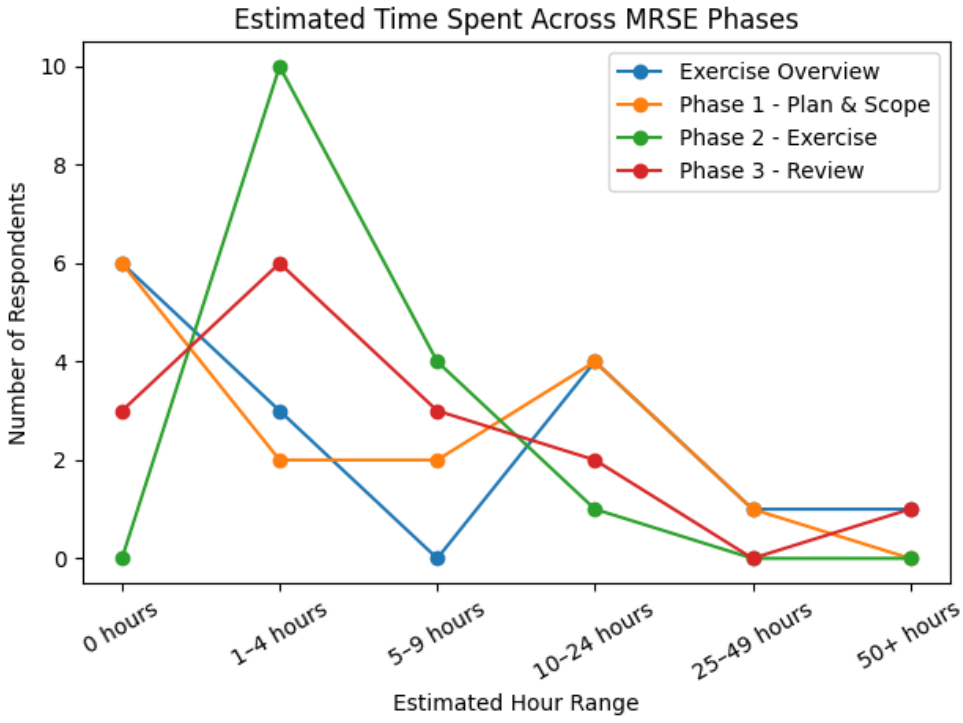


Table 3.4 Respondent Familiarity with MRSE Objectives and Outcomes

Degree of Familiarity	N	%
1 - Not familiar at all	1	7%
3 - Moderately familiar	5	33%
4 - Very familiar	2	13%
5 - Extremely familiar	7	47%

Note. Participants were asked: "On a scale from 1 to 5, how familiar are you with the objectives and intended outcomes of the MRSE?"

Per the MRSE Situation Manual, exercise planners are advised to account for other complementary disaster preparedness exercise requirements. When asked about using the MRSE exercise to fulfill additional requirements, 67% (n = 10) of respondents reported doing so successfully, while 33% (n = 5) reported they did not. When respondents were asked whether they applied lessons learned from the 2024 MRSE to strengthen emergency management strategies, 80% (n = 12) reported that they had. These findings provide a structured measure of how the exercise functioned as a knowledge-generating innovation across diverse HCC settings.

To gather respondents' insights on effective disaster preparedness exercises, they were asked to share their perceptions on preferred exercise type, frequency, and examples. Most respondents indicated that a functional exercise. These results are presented in Table 3.5.

Table 3.5 Perceived Most Effective Disaster Preparedness Exercise Type

Exercise Type	N	%
Full-Scale Exercise (FSE)	2	13%
Functional Exercise (FE)	9	60%
Tabletop Exercise (TTX)	4	27%

Note. Participants were asked: "Which type of exercise do you find most effective for preparing your organization for disasters?"

While the MRSE aligns with these criteria, only 33% (n = 5) of respondents identified the MRSE when asked to provide examples of effective disaster exercises. In contrast, 87% cited FEMA-designed exercises such as National Disaster Medical System (NDMS) and Strategic National Stockpile (SNS) or annual communication drills (73%, n=11). Respondents also indicated that the most effective type of disaster exercise is one conducted annually.

Survey Questions Part 2 – Participant Views on MRSE Implementation and Outcomes

Part two of the survey focused on participant perceptions of MRSE implementation, organizational context, implementation determinants, and perceived outcomes. There were seven sub-sections in this part. Sections 1, 2, and 7 were based on information found within the MRSE Situation Manual, including Exercise Foundational Principles (Section 1), Objectives (Section 2), and MRSE Outcomes and Evaluation Measures (Section 7).

Sections 3–5 were informed by the pCAT, focusing on Organization Understanding and Communication (Section 3), Alignment and Compatibility (Section 4), and Time, Resource, and Commitment (Section 5). The pCAT is a complementary tool informed by CFIR and is used to assess organizational context related to implementing an innovation. Sections 6 and 7 focused primarily on outcomes, with Section 6 questions adapted from the iPRISM web-based tool, which evaluates the perception that the MRSE achieved outcomes aligned with RE-AIM, an implementation science evaluation framework. The original questions from pCAT and iPRISM were modified only minimally to keep the fidelity and intent of the questions the same.

Participants were asked to select the option that best reflected their experience with the 2024 MRSE and the organization referenced earlier in the survey, based on their level of agreement using a Likert scale. Throughout this part, question types were kept as Likert-scale questions using Strongly Agree (5) to Strongly Disagree (0), including a Not Applicable option.

The results from Sections 3–5 will be further explored in the Quantitative and Qualitative

Integration Results section. After further review, Section 7 which focused on MRSE performance measures was determined to be a less accurate measure compared to Sections 2 and 6 and is therefore also included in the appendix. Accordingly, the tables included in this Results section reflect findings from Sections 1, 2, and 6.

Participant levels of agreement with core MRSE foundational principles, including senior leadership guidance, risk-informed development, capability-based and objective-driven design, consistent methodology, and whole community integration as summarized in

Table 3.6. Participants were asked to indicate their level of agreement to statements such as: (1) The 2024 MRSE was guided by senior leadership and (3) The 2024 MRSE was based on organizational capabilities and is driven by clear objectives. A copy of the full survey is included in Appendix F. Overall, responses indicate strong agreement across most foundational domains- Senior Leadership Guidance (80%, n=12), Risk-Informed Development (87%, n=13), Capability Based (93%, n=14), Consistent Methodology (93%, n=14). However, there was notability lower agreement regarding Whole Community Integration (60%, n=9).

Table 3.6 Participant Agreement with MRSE Foundational Principles (n = 15)

Response	Senior Leadership Guidance	Risk-Informed Development	Capability-Based, Objective-Driven Design	Consistent Methodology Used	Whole Community Integration
Strongly Agree	8 (53%)	10 (67%)	8 (53%)	8 (53%)	4 (27%)
Agree	4 (27%)	3 (20%)	6 (40%)	6 (40%)	5 (33%)
Neutral	3 (20%)	1 (7%)	1 (7%)	1 (7%)	5 (33%)
Disagree	0 (0%)	1 (7%)	0 (0%)	0 (0%)	0 (0%)
Strongly Disagree	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
N/A	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (7%)

Note. Part 4 of the Survey: MRSE Participant Feedback on Exercise Fundamental Principles. Participants indicated their level of agreement with statements regarding the 2024 MRSE within their organization.

The results of Section 2, which referenced the MRSE Objectives form the MRSE Situation Manual are shown in Table 3.7 (ASPR, 2023, p.8). For each objective, two to three respondents indicated disagreement with the statements, highlighting a potential trend among a subset of participants. Participants reported higher levels of agreement for MRSE objectives related to HCC engagement and response plan validation, with 74% and 67% of respondents, respectively, indicating agreement or strong agreement. In contrast, objectives related to incident notification, resource needs assessment, securing EMS resources, and reducing morbidity through patient placement yielded more mixed responses, with higher proportions of neutral and not applicable selections.

Table 3.7 Evaluation of Organizational Performance for 2024 MRSE Objectives

Response	Healthcare Coalition Engagement	Incident Notification & Coordination	Resource Needs Assessment	Securing EMS Resources	Reducing Morbidity Through Patient Placement	Response Plan Validation & Coordination
Strongly Agree	1 (7%)	5 (33%)	1 (7%)	0 (0%)	2 (13%)	1 (7%)
Agree	10 (67%)	1 (7%)	5 (33%)	6 (40%)	2 (13%)	9 (60%)
Neutral	0 (0%)	5 (33%)	5 (33%)	5 (33%)	6 (40%)	2 (13%)
Disagree	3 (20%)	2 (13%)	2 (13%)	2 (13%)	2 (13%)	2 (13%)
Strongly Disagree	1 (7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
N/A	0 (0%)	2 (13%)	2 (13%)	2 (13%)	3 (20%)	1 (7%)

Note: Part 4 of the Survey: Participant Agreement with MRSE Objectives. Participants indicated their level of agreement with statements related to the objectives of the 2024 MRSE. Columns reflect MRSE objectives adapted from the ASPR Situation Manual (2023), including engagement, communication and coordination, resource management, EMS capacity, patient outcomes, and response planning.

The summary of participant perceptions of MRSE implementation outcomes using the RE-AIM framework is displayed in Table 3.8. Overall, responses demonstrate moderate to high agreement across most domains, with greater variability observed in perceptions of reach, effectiveness, and long-term maintenance. Compared to Section 1, which had neutral responses, Section 6 included a greater number of disagreement responses across multiple domains.

Overall, the participant responses indicate relatively strong agreement regarding MRSE implementation, with 74% of respondents reporting agreement or strong agreement. Perceptions of adoption and reach moderate agreement, with 40% (n = 6) and 60% (n = 9) of respondents indicating agreement, respectively, alongside disagreement reported by 27% (n = 4) and 20% (n = 3). Perceptions of effectiveness and maintenance were more mixed, with a higher proportion of neutral and disagreement responses (61%, n = 9 and 54%, n = 8, respectively). Variation across RE-AIM domains suggests differences in MRSE implementation experiences across organizations and highlights areas that warrant further investigation.

Table 3.8 MRSE Implementation Outcomes Assessment using RE-AIM (n = 15)

Response	Adoption: Participation	Implementation: Staff Involvement	Reach: Equitable Reach	Effectiveness: Effective For Disadvantaged	Maintenance: Sustainability
Strongly Agree	3 (20%)	5 (33%)	3 (20%)	2 (13%)	1 (7%)
Agree	3 (20%)	6 (40%)	6 (40%)	4 (27%)	6 (40%)
Neutral	2 (13%)	1 (7%)	2 (13%)	4 (27%)	4 (27%)
Disagree	4 (27%)	1 (7%)	3 (20%)	4 (27%)	2 (13%)
Strongly Disagree	0 (0%)	0 (0%)	1 (7%)	1 (7%)	1 (7%)
N/A	3 (20%)	2 (13%)	0 (0%)	0 (0%)	1 (7%)

Note: Part 4 of the Survey: RE-AIM Domain Summary. Participants (n = 15) indicated their level of agreement with statements regarding the 2024 MRSE within their organization. Columns reflect RE-AIM outcome domains adapted from the iPRISM Web Tool (Trinkley et al., 2023), including adoption, implementation quality and adaptation, reach, effectiveness, and maintenance

3.5.2 Qualitative

The qualitative findings were generated through a structured, multi-step analytic process, beginning with interview transcription and familiarization, followed by deductive coding, RADaR-based data reduction and thematic synthesis, and mapping to CFIR 2.0 domains. Themes were iteratively refined and re-applied to the data to support consistent interpretation of determinants influencing MRSE implementation.

A total of 10 respondents participated in semi-structured interviews, representing a 67% survey-to-interview conversion rate and yielding over 750 minutes (12.5 hours) of recorded qualitative data. Across the 10 interviews, 463 coded segments were identified, including 184 barriers and 279 enablers. Through the RADaR technique process, these segments were synthesized into 22 thematic determinants (10 enablers and 12 barriers). The resulting determinants were further mapped to resilience measures (capacity vs. capability) and CFIR 2.0 domains and constructs. A full list of thematic determinants and an overview of this synthesis are presented in Table 3.9.

Table 3.9 MRSE Implementation RADAR Thematic Determinants

RADaR Thematic Determinants	Resilience	CFIR Domain	CFIR Construct
Barriers			
Low Executive / Leadership Engagement	Capacity	Individuals	High-level Leaders
Competing Priorities & Time Constraints	Capacity	Inner Setting	Relative Priority
Overly Complex / Simplistic Exercise Design	Capability	Innovation	Innovation Design
Limited Funding & Resources	Capacity	Outer Setting	Financing
Staffing Shortages & High Turnover	Capacity	Inner Setting	Workforce Infrastructure
Administrative Burden & Complex Tools	Capability	Innovation	Innovation Complexity
Low Perceived Value (“Check the Box”)	Capability	Process	Engaging
Low / Inconsistent Partner Participation	Capacity	Outer Setting	Partnerships & Connections
Lack of Jurisdictional Authority	Capability	Outer Setting	Policies & Laws
Communication Gaps & Breakdown	Capability	Inner Setting	Communications
Data Collection Challenges	Capacity	Inner Setting	Information Technology Infrastructure
Scheduling & Logistical Barriers	Capacity	Process	Engaging
Enablers			
Strong Collaboration & Coalition Engagement	Capability	Inner Setting	Relational Connections
Robust Communication & Information Sharing	Capability	Inner Setting	Communications
Inclusive Participant Involvement	Capacity	Outer Setting	Partnerships & Connections
Efficient Planning & Administrative Simplicity	Capability	Process	Planning
Continuous Improvement / AARs	Capability	Process	Reflecting & Evaluating
Supportive Leadership, Championing Culture	Capability	Inner Setting	Culture
Realistic, Clear, Manageable Exercise Design	Capability	Innovation	Innovation Design
Education, Training, Experience Sharing	Capability	Inner Setting	Access to Knowledge & Information
Regulatory / Accreditation / Funding Motivation	Capacity	Outer Setting	Policies & Laws
Flexibility / Local Adaptation	Capability	Process	Adapting

Note. RADaR thematic determinants identified from participant interviews and mapped to resilience dimensions, CFIR domains, and CFIR constructs.

The 22 thematic determinants were mapped across 17 unique CFIR domains and constructs, as displayed in Table 3.10. Most of the thematic determinants were mapped to the Inner Setting domain (36%, n=8); followed by the Implementation Process and Outer Setting domains, each accounting for 23% (n=5) of the determinants. The least number of determinants were mapped to Innovation Characteristics (14%, n=3). Among barriers, the majority were mapped to the Inner Setting (40%, n = 4), followed by the Outer Setting (25%, n = 3) and the Implementation Process (17%, n = 2). Among enablers, most were mapped to the Inner Setting (40%, n = 4) and the Implementation Process (30%, n = 3), followed by the Outer Setting (20%, n = 2).

Only one CFIR construct, Implementation Process (Engaging), had more than one thematic determinant (barriers) from the same determinant category mapped: (1) Scheduling & Logistical Barriers and (2) Low Perceived Value ("Check the Box"). Four CFIR constructs were coded as both barriers and enablers: Communications (Inner Setting), Innovation Design (Innovation Characteristics), Partnerships & Connections and Policies & Laws (Outer Setting).

Table 3.10 Distribution of Barriers and Enablers by CFIR Domain and Construct (Column Percentages, N=22)

CFIR Domain (Construct)	Barrier	Enabler	Total
Implementation Process	**2 (17%)**	**3 (30%)**	**5 (23%)**
Adapting	–	1 (10%)	1 (5%)
Engaging	2 (17%)	–	2 (9%)
Planning	–	1 (10%)	1 (5%)
Reflecting & Evaluating	–	1 (10%)	1 (5%)
Individuals	**1 (8%)**	**–**	**1 (5%)**
High-level Leaders	1 (8%)	–	1 (5%)
Inner Setting	**4 (33%)**	**4 (40%)**	**8 (36%)**
Access to Knowledge & Information	–	1 (10%)	1 (5%)
Communications	1 (8%)	1 (10%)	2 (9%)
Culture	–	1 (10%)	1 (5%)

Information Technology Infrastructure	1 (8%)	–	1 (5%)
Relational Connections	–	1 (10%)	1 (5%)
Relative Priority	1 (8%)	–	1 (5%)
Workforce Infrastructure	1 (8%)	–	1 (5%)
Innovation	**2 (17%)**	**1 (10%)**	**3 (14%)**
Innovation Complexity	1 (8%)	–	1 (5%)
Innovation Design	1 (8%)	1 (10%)	2 (9%)
Outer Setting	**3 (25%)**	**2 (20%)**	**5 (23%)**
Financing	1 (8%)	–	1 (5%)
Partnerships & Connections	1 (8%)	1 (10%)	2 (9%)
Policies & Laws	1 (8%)	1 (10%)	2 (9%)
TOTAL	12 (100%)	10 (100%)	22 (100%)

Note. Distribution of RADaR thematic determinants across CFIR domains and constructs, organized by identified barriers and enablers influencing MRSE implementation. Frequencies and percentages reflect the number of determinants mapped to each CFIR construct.

Further mapping of thematic determinants to resilience factors (capacity or capability), is shown in Table 3.11. Forty-two percent of barriers and 80% were mapped of enablers were mapped to capabilities. While 58% of barriers and 20% of enablers were classified as capacities.

Table 3.11 Thematic Determinants by Type and Resilience Classification (N=22)

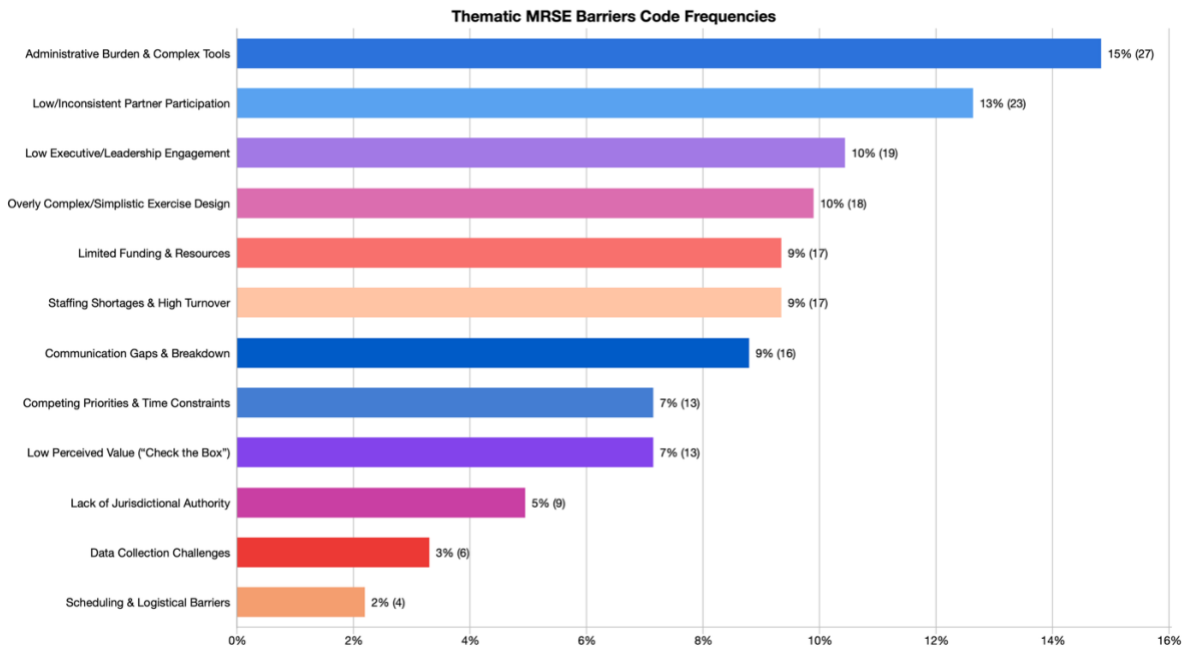
Determinant Category	Number of Thematic Determinants	% of Determinant
Barrier	**12**	**100%**
Capability	5	42%
Capacity	7	58%
Enabler	**10**	**100%**
Capability	8	80%
Capacity	2	20%
TOTAL	**22**	**100%**

Note. Distribution of thematic determinants by resilience category. Capability and capacity were used as measures of resilience to classify identified barriers and enablers influencing MRSE implementation. Frequencies and percentages reflect the proportion of determinants within each category.

Barriers

Of the 182 barrier-related coded segments, the most frequently coded barrier across documents were Administrative Burden & Complex Tools (15%, n=27) and Low/ Inconsistent Partner Participation (13%, n=23). Whereas Scheduling & Logistical Barriers (2%, n=4) and was among the least frequently coded. These results are displayed in Figure 3.5.

Figure 3.5 Frequency of RADaR Thematic Barriers Identified in MRSE Interviews



Note. Frequencies reflect the number of times thematic barriers were coded in MAXQDA during the deductive re-coding step using the RADaR-derived determinants as the codebook.

Of the 10 interviews analyzed, 10 of the 12 identified barriers (83%) appeared in six or more interviews, indicating broad consistency across participants. Three barriers appeared in fewer than five interviews. Barriers were ranked based on the number of interviews in which each theme appeared, with higher ranks indicating greater prevalence across participants, as summarized in Table 3.12. When themes were referenced in an equal number of interviews, rankings were further informed by the total number of coded segments. The most frequently

referenced barriers were Low Executive/Leadership (1) Engagement and Competing Priorities and Time Constraints (2), each appearing in nine interviews, highlighting the influence of leadership involvement and organizational capacity on MRSE implementation. In contrast, Data Collection Challenges (11) and Scheduling and Logistical Barriers (12) were less commonly cited, appearing in only three interviews each.

Table 3.12 Ranked RADaR MRSE Thematic Barriers

Rank	RADaR Thematic Barriers	Documents with codes	Segments with Codes	Coded segment (%)
1	Low Executive/Leadership Engagement	9	19	10.44
2	Competing Priorities & Time Constraints	9	13	7.14
3	Overly Complex/ Simplistic Exercise Design	8	18	9.89
4	Limited Funding & Resources	8	17	9.34
5	Administrative Burden & Complex Tools	7	27	14.84
6	Low/Inconsistent Partner Participation	7	23	12.64
7	Staffing Shortages & High Turnover	7	17	9.34
8	Low Perceived Value ("Check the Box")	7	13	7.14
9	Lack of Jurisdictional Authority	6	9	4.95
10	Communication Gaps & Breakdown	5	16	8.79
11	Data Collection Challenges	3	6	3.3
12	Scheduling & Logistical Barriers	3	4	2.2
	TOTAL	**10**	**182**	**100**

Note. Frequency of barrier-related RADaR thematic determinants identified across participant interviews. Rankings reflect the number of coded segments and documents associated with each barrier influencing MRSE implementation.

Table 3.13 summarizes the thematic results for the most frequently cited implementation thematic barriers, along with representative participant quotations illustrating each theme.

Table 3.13 High-Frequency Implementation Barriers and Select Representative Quotes

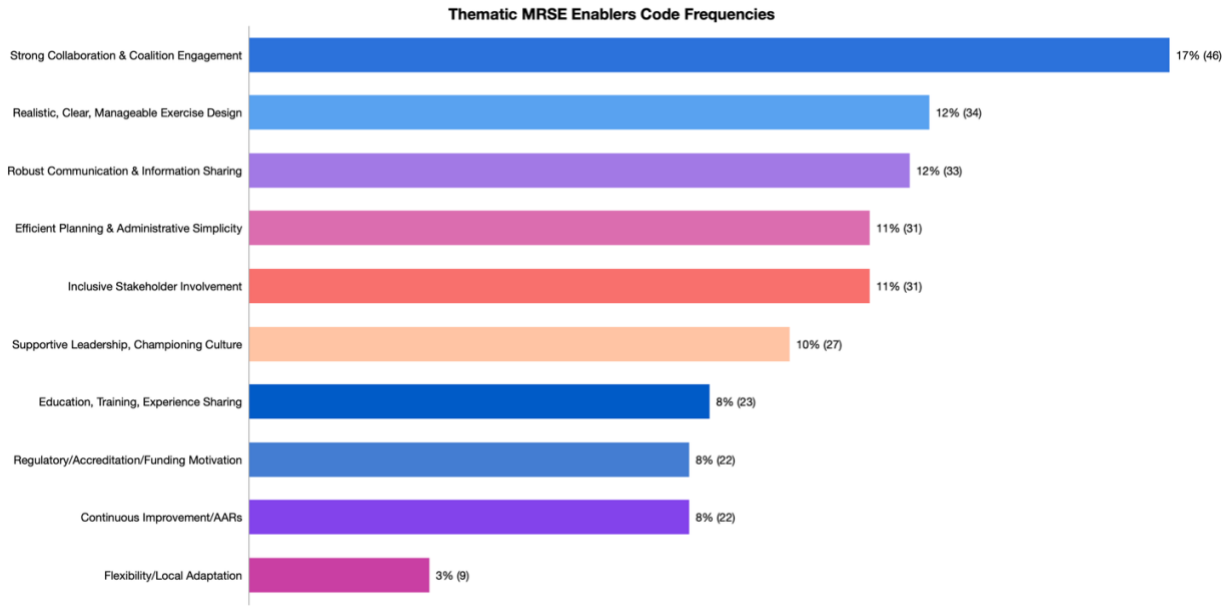
RADaR Thematic Barrier	Description	Selected Quotes
Low Executive / Leadership Engagement	Although executive participation is an MRSE objective and desired outcome, participants consistently described it as challenging to achieve. Executive and C-suite involvement in exercises and AAR was described as inconsistent, largely due to busy schedules and competing priorities.	*"The C suite is always a challenge… it's really a challenge to get the C suite to come to the table."(KA-30)*

RADaR Thematic Barrier	Description	Selected Quotes
Competing Priorities & Time Constraints	Many participants reported that real-world events, system-wide incidents, and daily operational responsibilities often interfered with organizations' ability to fully participate. Competing priorities frequently limited the amount of time staff could dedicate to the exercise, particularly for organizations managing multiple responsibilities or responding to concurrent incidents.	*"More responsibilities for our partners, which limits their time that they can spend on activities with the coalition or on emergency management in general. I wore three and a half hats, and it's only getting worse." (AT-14)* *"There has been times where we are not able to get full hospital participation because of a real live event that's going on at the hospital." (RC-31)*
Overly Complex / Simplistic Exercise Design	Participants described challenges balancing real-world realism with meeting multiple objectives without making the exercise too complex or too simple. This balance was described as particularly difficult across regions, with scenarios sometimes perceived as insufficiently challenging for some organizations and overly complex for others.	*"Some of the hospitals said doing that ten percent of the med surge beds. It wasn't much of an exercise, because that was the day before, you know, they were actually getting that at the time we did it."(RD-11)* *"You can't make them too complex. You got to keep them simple for everybody involved."(DF-20)*
Limited Funding & Resources	Participants reported that Healthcare Coalitions were limited in how funding could be used to increase participation, such as providing meals, marketing the exercise, or hiring additional staff. Many noted that preparedness funding had declined significantly since the beginning of HPP, constraining coalition infrastructure, innovation, and sustained engagement.	*"The ability to buy supplies and equipment has really been impacted. We just don't have that kind of additional funding." (DE-15)* *"We're very limited in what we can spend money on. We're not allowed to advertise, even down to name badges with our logo on it..." (RC-31)*

Enablers

Of the 278 enabler text segments, the most prominent enabler was Strong Collaboration and Coalition Engagement—representing 17% of all coded segments. Other frequently referenced enablers were Realistic, Clear, Manageable Exercise Design and Robust Communication & Information Sharing—each accounting for approximately 12% of coded segments. Whereas Flexibility/Local Adaptation was coded the least (3%, n=9). The complete results of thematic enablers most frequently coded are displayed in Figure 3.6 and in rank order based on prevalence across documents, similar to Table 3.14.

Figure 3.6 Frequency of Thematic Enablers Identified in MRSE Interviews



Note. Frequencies reflect the number of times thematic barriers were coded in MAXQDA during the deductive re-coding step using the RADaR-derived determinants as the codebook.

Table 3.14 Ranked MRSE Thematic Enablers

Rank	RADaR Thematic Enablers	Documents with codes	Segments with Codes	Coded segment (%)
1	Strong Collaboration & Coalition Engagement	10	46	16.55
2	Robust Communication & Information Sharing	10	33	11.87
3	Inclusive Participant Involvement	10	31	11.15
3	Efficient Planning & Administrative Simplicity	10	31	11.15
5	Realistic, Clear, Manageable Exercise Design	9	34	12.23
6	Supportive Leadership, Championing Culture	9	27	9.71
7	Continuous Improvement/AARs	9	22	7.91
8	Regulatory/Accreditation/Funding Motivation	8	22	7.91
9	Education, Training, Experience Sharing	7	23	8.27
10	Flexibility/Local Adaptation	4	9	3.24
	TOTAL	**10**	**278**	**100**

Note. Frequency of enabler-related RADaR thematic determinants identified across participant interviews. Rankings reflect the number of coded segments and documents associated with each enabler influencing MRSE implementation.

The thematic results for the most frequently cited implementation enablers, along with representative participant quotations illustrating each theme are summarized in Table 3.15.

Table 3.15 High-Frequency Implementation Enablers and Select Representative Quotes

RADaR Thematic Enabler	Description	Selected Quotes
Strong Collaboration & Coalition Engagement	Participants consistently described Healthcare Coalitions as central coordination hubs or networks that connect hospitals, EMS, public health, emergency management, and other partners. Coalitions were often described as creating a "family feeling" or trusted environment where non-competitive collaboration could occur.	*"So I was talking about being able to connect the infrastructure pieces. They [Healthcare Coalitions] help the community connect the lifeline. They're the tether between the lifeline pieces. So like, you know, here's our community, and then here's all the things that they need. They're the thing that connects it, the connective tissue." (JW-27)*
Robust Communication & Information Sharing	Communication ahead of the exercise was described as essential to ensure all partners could access and use statewide platforms for bed reporting, EMS coordination, and situational awareness. During the exercise, several Healthcare Coalitions intentionally used the MRSE as an opportunity to test communication systems, conduct communication drills, verify contacts, and identify gaps in messaging and information flow across partners.	*"communication is the most important thing… We're not always going to have all the resources, but you have to be able to communicate what's going on with who's nearby, and be able to shift around resources. You need good relationships, you need redundant systems, and you have to make sure people are actually reading what you're saying."(JW-27)*
Inclusive Participant Involvement	Participants noted that the MRSE has matured over time by expanding participation beyond hospitals to include core Healthcare Coalition partners such as public health, EMS, and emergency management, as well as auxiliary healthcare organizations such as long-term care.	*"Make it statewide, use the same scenario for everybody find out how to impact other members of the community. So we opened ours up to long term care, community health, dialysis centers, home health and hospice. And we sent the exercise out, invited them to play, and they could play in various ways."(RD-11)*
Efficient Planning & Administrative Simplicity	Although exercise leaders acknowledged that significant preparation time was required, participants frequently noted that ASPR-provided resources—such as the situation manual and planning guides—made planning and coordination easier. Having standardized materials reduced uncertainty and helped coalitions organize the exercise efficiently across diverse partners.	*"MRSE in particular is well organized. It's also pretty succinct. It's, it's not a hard lift… so I think it's well run, and I think there would be more of an affinity to participate in the MRSE, as opposed to other exercise that we've done in the past… it's not a heavy, heavy lift. It's not tremendous amount of time and effort from a partner standpoint" (KA-30)*

Summary of Supplemental Content Analyses

In addition to identifying barriers and facilitators, a few supplementary content analyses were conducted to provide a more comprehensive understanding of MRSE implementation. These topics emerged during the data familiarization and audit trail step, as transcripts were reviewed and initial observations and notes were documented. These analyses included summarizing (1) key differences between the 2024 and 2025 MRSEs conducted by HCCs within HPP CA State; (2) participants' perspectives on the potential role of academic partners in disaster management; and (3) description of a successful exercise.

Key Differences Between the 2024 and 2025 MRSE: A few (n=4) interviews mentioned the differences they noticed from the implementation of the 2024 MRSE and 2025 MRSE. Participants consistently described the 2025 MRSE as an improvement over 2024, reflecting greater realism, smoother implementation, and higher engagement. Changes included refining the scenario to better align with real-world capacity, streamlining (though not fully resolving) data collection tools, and adding communication mechanisms such as an open Zoom link, which increased real-time interaction and participation. Overall, experience gained from the 2024 exercise informed practical adjustments that enhanced engagement and functionality in 2025.

> *"So at one point, the 2024 MRSE is, well, it was, you sat in the office, waiting for somebody to call. The 2025 MRSE we had the radios going off, the phone behind me going off, my cell phone going off, and the Zoom link going off all the same time. And so we got a lot more engagement."*
>
> — RD-11

Successful MRSE Implementation: Participants described a successful MRSE as one that met clear, measurable objectives, demonstrated effective coordination, and allowed hospitals to manage surge without significant external support. Several participants emphasized that truly successful exercises should push participants beyond routine operations to identify gaps and

strengthen preparedness over time.

> *"Having those measurable objectives is what lets you know if you're being successful—if your tactics are working."*
> — TM-18

> *"A truly successful exercise is when you can really push the limits and either succeed or really learn from it."*
> — RC-31

Role of Academia in Disaster Management: Participants described academia as a potential valuable partner in disaster preparedness, uniquely positioned to ask critical questions, utilize research skills, and generate evidence that can inform practice and policy. Especially important for developing case studies, supporting education and workforce preparedness, and elevating the disaster management through data-driven insights that practitioners often lack the time or capacity to produce.

> *"I think it's only going to elevate the discipline. You need academia, you need research, and you need data not only to disseminate and educate, but also to affirm what's working and identify gaps. Without academia or research like what you're doing, the discipline risks becoming stagnant. It only progresses with research, data, and the dissemination of information, and that's invaluable."*
> — KA-30

3.5.3 Integration of Quantitative and Qualitative Data

Of the 61 CFIR constructs across the five domains (Innovation, Inner Setting, Outer Setting, Individuals, and Implementation Process), 26 constructs had either qualitative or quantitative data coded. This included 12 constructs with only qualitative data and 9 with only quantitative data. Five constructs included both qualitative and quantitative data and therefore met the criteria for inclusion in the joint display; an additional four constructs associated with more than one thematic determinant were also included to support deeper integration across data strands. This resulted in a joint display consisting of nine CFIR constructs. An abbreviated version of the joint display is presented in Table 3.16.

Table 3.16 Joint Display of MRSE Determinants

CFIR Domain (Construct) ***Data Integration Fit***	**Survey Question & Quantitative Survey Results (n=15)**	**Qualitative Interview Themes (Rank) & Example Quote (n=10)**	**Aim 2 - Integrated Interpretation**
Inner Setting (Work Infrastructure) ***Divergence***	*Section 4: 4. The structures and policies in place here enable us to conduct the MRSE.* 80% Agree/Strongly Agree (n=12); 20% Neutral (n=3)	**Barrier: Staffing Shortages & High Turnover (7)** *"Turnover is probably a bigger obstacle than getting the organizations to participate… as soon as you get somebody trained, you're starting all over again." (DE-15)*	Although most respondents perceived that the structures and policies in place create an adequate "work infrastructure" to conduct the MRSE within the HCC environment, interview findings revealed that staffing shortages and high turnover among HCC partners (hospitals, EMS, and long-term care) remain a barrier to implementation. This may suggest that while HCC partners feel they have the internal structures needed to facilitate the MRSE, they also face systemic barriers that limit consistent implementation. It is important to note that 80% of survey and interview respondents were HCC leaders whose roles explicitly include time to implement and focus on the MRSE, which differs from the roles and constraints of other partner organizations.
Inner Setting (Communications) ***Divergence (QUAN/QUAL)*** ***Complementarity (QUAL)***	*Section 3: 2. I have open lines of communication with everyone needed to execute the MRSE.* 87% Agree/Strongly Agree (n=13); 13% Neutral (n=2)	**Enabler: Robust Communication & Information Sharing (2)** *"... you have to be able to communicate what's going on with who's nearby, and be able to shift around resources. You need good relationships, you need redundant systems, and you have to make sure people are actually reading what you're saying." (JW-27)* **Barrier: Communication Gaps & Breakdown (10)** *"Generally, there's a communication breakdown from the top down... in the hospital setting...in the coalition" (AT-14)*	Survey findings suggest strong access to communication with pertinent participants to execute the MRSE; however, interview findings highlight communication breakdowns among various partners within the HCC, as well as across national, state, and HCC levels, that hinder implementation. Complementary to these challenges, robust communication and information sharing before, during, and after the exercise were identified as factors that support successful exercise implementation. This suggests that communication pathways may vary across HCCs and are often influenced by communication structures that exist outside the HCC, such as within partner organizations.

Inner Setting (Culture) ***Confirmation***	*Section 3: 1. People in my organization regularly seek to understand patients' needs and participate in the MRSE to meet those needs better.* 53% Agree/Strongly Agree (n=8); 13% Neutral (n=2); 7% Disagree (n=1); 27% N/A (n=4)	**Enabler: Supportive Leadership, Championing Culture (6)** *"organization's culture has a lot to do with their participation and how they participate. The more engaged, I think the more like a high reliability organization is going to put more into an exercise…" (AT-14)*	While only half of participants agreed that people within their organizations have a culture that supports effective MRSE implementation, this finding was reinforced by interview narratives emphasizing the importance of leadership-driven culture in implementing the MRSE. This suggests that a culture of disaster preparedness at the individual organizational level is essential for successfully engaging participants and developing sustained preparedness practices; however, such cultures are likely present but unevenly embedded across settings. It is important to note that a high proportion of respondents selected neutral or not applicable responses (40%, n = 6), which may further reflect variability in how organizational culture is experienced or interpreted across organizations.
Individuals (High-level Leaders) ***Divergence***	*Section 5: 3. Higher-level leaders are committed, involved, and accountable for conducting the MRSE.* 60% Agree/Strongly Agree (n=9); 40% Disagree/Strongly Disagree (n=6)	**Barrier: Low Executive/Leadership Engagement (1)** *"… it's really a challenge to get the C suite to come to the table [participate in the disaster exercise]." (KA-30)*	Although majority of respondents agreed, this survey question was one of the few that had polarized responses, with participants either agreeing or strongly disagreeing. These polarized responses aligned with interview concerns about executive disengagement, identifying leadership commitment as a key vulnerability to consistent MRSE implementation. A key limitation is that perspectives on "leadership" may differ, as some participants referenced highly supportive state-level leadership within the HCC structure, while others described a lack of engagement from executive leaders within HCC partner organizations who were expected to participate in the exercise. The major takeaway is that leadership engagement (in visible support and physical participation) is pivotal to the success of the MRSE.

Implementation Process (Reflecting & Evaluating) ***Confirmation***	*Section 3: 3. I have access to data to help track changes in outcomes related to conducting the MRSE.* 73% Agree/Strongly Agree (n=11); 7% Neutral (n=1); 13% Disagree (n=2); 7% N/A (n=1)	**Enabler: Continuous Improvement/AARs (7)** *"Those [After-Action Reviews] are absolutely a integral part of the success of the exercise. If you don't document it, it didn't happen… the after-action review is absolutely critical…Taking our lessons learned from the year before and making sure that we're applying them to the current year." (EU-26)*	This quantitative finding is strongly aligned with the qualitative results, which indicate that participants have access to mechanisms to track changes related to the MRSE. The qualitative data emphasize the importance of after-action reviews and reports (AARs), highlighting a shared learning orientation that supports iterative improvement and sustainment. A small number of respondents disagreed, which may relate to an additional thematic barrier associated with data collection challenges. There were also several complementary interview quotes noting that drafting an AAR alone is not sufficient; participants emphasized the need to develop improvement plans and actively operationalize them. As one participant stated, "When you write the after-action report, and the improvement plan, and you say who's going to do it, and then you put it in the drawer… then you just observed it. You didn't learn it. I am working on improving the improvement plan portion" (RD-11).
Implementation Process (Engaging) ***Confirmation***	N/A - no pCAT associated question	**Barrier: Low Perceived Value ("Check the Box") (8)** *"I'm not sure MRSE does as much of that as I think it's supposed to, because in some cases, I know the spirit quartered did, but we're checking the box. And that's what I don't like about MRSE, is a lot of it is checking the box. We did it. We checked the box. We did it. We checked the box." (RD-11)* **Barrier: Scheduling & Logistical Barriers (12)** *"It's always a challenge to get a lot of the people to participate, especially all on the same day" (DE-15)*	These two qualitative themes confirm that major barriers to increasing engagement in the MRSE are related to HCC participants not finding sufficient value in participating and facing scheduling and logistical challenges that make it difficult to engage partners and conduct the exercise.

Innovation (Design) ***Complementarity***	N/A - no pCAT associated question	**Barrier: Overly Complex / Simplistic Exercise Design (3)** *"Some of the hospitals said doing that ten percent of the med surge beds. It wasn't much of an exercise, because that was the day before, you know, they were actually getting that at the time we did it." (RD-11)* **Enabler: Realistic, Clear, Manageable Exercise Design (5)** *"when you hold exercises, you hope that you could make it as realistic as possible, and make people think about all the things they need to think about, so that when the real event happens, they just automatically go ahead and do it." (DF-20)*	Participants note that MRSE implementation is strengthened when exercise design is practical, understandable, and aligned with real-world conditions. Conversely, participants identified exercise design as a barrier when the MRSE was perceived as either overly complex (e.g., containing too many objectives or goals) or overly simplistic, testing processes that had become routine practice. Together, these perspectives highlight the importance of balancing exercise complexity: exercises must be sufficiently challenging to prompt critical thinking and learning, while remaining clear and manageable so that participants understand what is being tested.
Outer Setting (Partnerships & Connections) ***Complementarity***	N/A - no pCAT associated question	**Enabler: Inclusive Participant Involvement (3)** "Make it statewide, use the same scenario for everybody find out how to impact other members of the community. So we opened ours up to long term care, community health, dialysis centers, home health and hospice." (RD-11) **Barrier: Low/Inconsistent Partner Participation (6)** "Biggest thing was to get partners wanting to do the exercise… it's always like pulling new teeth." (EU-26)	Partnerships and connections are highlighted as a factor facilitating the MRSE. Designing an exercise that enables participation in the MRSE from various participants responsible for actual disaster response allows for networking and relationship building, not just among the four core HCC partners but also with other healthcare organization partners that are critical to the broader healthcare system. As one participant noted, "Emergency preparedness is even more so a relationship business, because if you don't know who to call in that disaster, you're SOL. You don't have to know it all. You just have to know who to call" (RC-31). Conversely, while partners are needed, it can often be difficult to get different sectors engaged, involved, and committed to participating in the exercise for a variety of reasons.

Outer Setting (Policies & Laws) ***Complementarity***	N/A - no pCAT associated question	**Enabler: Regulatory/Accreditation/Funding Motivation (8)** "our financial incentive is, is because it's tied to our work plan. So if I don't participate, I'm not fulfilling the grant funding requirements. So it puts it puts my entire program funding in jeopardy." (TM-18) **Barrier: Lack of Jurisdictional Authority (9)** "... it's really up to them. There's only so much we can't force them. We have no jurisdictional authority over them." (RC-31)	Given the MRSE is a regulated activity, the regulations tied to the HPP Cooperative Agreement (CA) provide a clear mandate that it must be implemented because it is required through grant funding. For public health departments, emergency management agencies, and hospitals, the MRSE can fulfill other regulatory requirements and is a relatively low lift for HCC partners to plan and coordinate. Other healthcare partners may also benefit if participation in the MRSE fulfills their own requirements. It is less clear whether EMS agencies have the same regulatory requirements, as many HCC leads reported ongoing challenges with securing their participation. On the flip side, while the MRSE is a federally mandated exercise through the HPP CA for Healthcare Coalitions, HCCs may still struggle to gain commitment from various partners because they do not have the authority to require participation.

Note. Quantitative survey findings and qualitative interview themes were integrated and mapped to CFIR domains to illustrate confirmation, divergence, and complementarity influencing MRSE implementation. Percentages reflect survey responses (n = 15), and qualitative themes reflect interview data from 10 participants.

3.6 Discussion

Despite several structured federal preparedness frameworks, the literature reveals persistent challenges in communication, coordination, and infrastructure during disaster preparedness exercises (Aminafshar et al., 2026; McCormick et al., 2014; Obaid et al., 2017; Renger et al., 2021). Highlighting the need to strengthen key sociotechnical components, including clearly defined roles, interoperable systems, continuous training, and ongoing evaluation (Sandifer & Walker, 2018). Findings from this study reinforce this gap, demonstrating that while frameworks like HSEEP and resources such as the MRSE guidance documents provide written structure, their usefulness is ultimately shaped by local implementation conditions.

Based on the MRSE semi-structured interviews, 22 thematic determinants emerged that together explain how MRSE implementation is experienced at the local level within this specific geographic context. At a high level, the most significant enablers were strong collaboration and coalition engagement; realistic and manageable exercise design; robust communication and information sharing; supportive leadership culture; inclusive participation; and continuous learning through AARs. These factors indicate that coordination, shared understanding, and engagement over time support MRSE implementation.

Conversely, the most significant barriers were—staffing shortages and turnover; competing priorities and time constraints; administrative burden; communication breakdowns; low executive engagement; inconsistent partner participation; logistical challenge; and low perceived value of the exercise. Additional barriers included structural and contextual challenges such as EMS coordination across jurisdictions, limited participation from long-term care, and constraints on outreach and engagement due to funding restrictions. Together, these barriers

directly reflect patterns identified in the broader literature.

It is also important to recognize that these determinants did not operate independently but as part of a broader implementation system. Improvements in one area (e.g., communication or leadership engagement) often helped address challenges in another (e.g., coordination or participation). This demonstrates that although the MRSE takes place on a single scheduled day, implementation itself is not a one-time (annual) event, but a dynamic system shaped by recurring organizational, relational, and structural conditions. These findings further support the conceptualization of MRSE as a mechanism for disaster preparedness. The federal requirements help to encourage participation in the exercise, coalition support and administrative capacity keep them engaged, and repeated exercises including evaluation build learning and improve preparedness.

The integration of quantitative and qualitative data (Table 3.16) provides a more nuanced understanding of these determinants by identifying areas of confirmation, divergence, and complementarity across CFIR domains based on quantitative and qualitative data. Divergence within the Inner Setting domain and Work Infrastructure construct between perceived readiness and staffing was one of the most important findings. While 80% of survey respondents agreed that structures and policies supported MRSE implementation, interview data revealed persistent barriers related to staffing shortages and high turnover. This suggests that although formal infrastructure may exist, the workforce capacity needed to operationalize that infrastructure remains unstable. A similar pattern emerged in the Inner Setting Communication construct, where survey results indicated strong communication access (87% agreement), however the interviews highlighted various communication breakdowns across organizations and within the HCC. At the same time, communication also emerged as a key enabler when relationships,

redundancy, and information-sharing practices were strong. This shows that strong communication supports successful implementation, while poor communication can significantly hinder it.

Leadership engagement, within the Individuals domain High-level Leaders construct, also demonstrated divergence. Survey responses were mixed, with 60% agreeing that higher-level leaders are engaged and accountable for the MRSE, while 40% disagreed, indicating inconsistent leadership involvement across organizations. Meanwhile, the qualitative findings consistently identified low executive engagement as a major barrier. This shows that leadership is key to successful implementation. The interviews highlighted that leadership may look different across settings, with stronger engagement often seen at the coalition or state level rather than within individual partner organizations.

In contrast, consistent findings were observed in the Inner Setting (culture) and Implementation Process (reflecting and evaluating) domains. Organizational culture especially as it pertains to leadership-driven culture was identified as an important factor in supporting MRSE participation and sustained preparedness. Similarly, both quantitative and qualitative data aligned in highlighting the importance of AARs. Participants described AARs as central to learning and improvement but also pointed out a key gap: documenting lessons does not mean they are put into practice. As a result, lessons are not truly learned until action is taken, reinforcing the need for accountability and follow-through. Exercise design emerged as both a barrier and enabler, depending on whether it was perceived as overly simplistic or overly complex. Partnerships and connections were seen as both a key strength that supports relationship-building and inclusive participation, and a challenge when it comes to consistently engaging a diverse range of partners to participate in the coalition.

Taken together, the thematic determinants and joint display findings highlight several important insights. The findings identified persistent barriers related to executive engagement, communication breakdowns, inconsistent partner participation, staffing shortages, and competing priorities, despite participants consistently emphasizing the importance of collaboration, communication, and coordination for successful MRSE implementation. However, similar to the findings of Shafiei and colleagues (2025), these challenges appeared to reflect difficulties translating preparedness principles into consistent practice rather than a lack of awareness.

To move beyond simply identifying barriers toward solving them, there is a need for stronger knowledge translation. While learning mechanisms like AARs are widely used, there are gaps in follow-through limit their impact, which reinforces a broader pattern where disaster preparedness is effective at identifying problems but less consistent at turning them into sustained solutions.

This study highlighted the value of integrating implementation science frameworks not just as evaluative tools, but as planning tools. While frameworks such as CFIR, pCAT, and RE-AIM required adaptation to fit the disaster context, they provided a structured approach for analyzing complex implementation environments. Continued work is needed to refine these tools for disaster research while maintaining their core intent and flexibility. Applying frameworks like CFIR and RE-AIM prospectively can help identify barriers and enablers upfront, improving both exercise design and execution.

3.6.1 Limitations

Several limitations should be considered when interpreting the findings of this study. First, the study focused on a single ASPR HPP CA recipient state and the relatively small sample size may limit the generalizability of the results for other HCCs. The use of convenience

sampling may have caused selection bias—individuals who chose to participate in the survey and interviews may have held particularly strong positive or negative views of the MRSE, potentially underrepresenting more neutral perceptions. Furthermore, while the primary focus of the study was the 2024 MRSE, most participants had also taken part in the 2025 MRSE by the time of data collection, introducing the potential for recall bias; however, because the MRSE guidance documents, objectives, and outcomes remained the same, additional stratification analyses were not conducted.

It is important to note that during the data collection phase for this research, the Department of Government Efficiency (DoGE), established through Presidential Executive Order 14158 introduced efforts aimed at reducing regulatory policies and streamlining government structures through reductions in the federal workforce and government spending. These reduction efforts contributed to delays in ASPR HPP CA renewals. The HPP CAs provide critical funding that state-level HCC leaders rely on to support staff salaries and program activities. As a result, many potential participants were likely overwhelmed by increased workloads and concerns related to while managing their day-to-day responsibilities. It is likely that these conditions also negatively affected research participation and participant recruitment.

Although the researcher did not reach the initial target sample size (n=50) despite several attempts to increase participation, it was determined that proceeding with the study was most appropriate. In order to conduct ethical research, particularly in the field of disaster management, the well-being and mental health of potential participants was prioritized over obtaining a specific sample size.

Of the estimated 250 HCC members within the specified HPP CA state, the survey and interview sample represented approximately 6% of the total population, which may limit the

transferability and broader generalizability of the findings across all HCCs (Faber & Fonseca, 2014). However, systematic reviews of qualitative research suggest that 9–17 interviews are typically sufficient to reach thematic saturation (Hennink & Kaiser, 2022). Therefore, despite the small sample size, the qualitative data components are considered adequate for generating meaningful insights.

Although this mixed methods study involved a relatively small sample within the specified state boundary, the results are still useful for understanding MRSE implementation at the local level. The combination of survey data and in-depth interviews provides complementary insights, allowing for meaningful analysis of patterns and factors influencing implementation within the targeted HCCs.

Limitations specific to the qualitative portion of this study included the use of a single coder for interview analysis, which prevented the assessment of interrater reliability. In addition, although several thematic determinants could be mapped to more than one CFIR domain, each theme was assigned to a single primary construct to maintain analytic clarity and reduce interpretive ambiguity.

Finally, the applicability of implementation science tools such as the pCAT and iPRISM Web Tool to disaster preparedness and response exercises is not yet well established in the literature. Although these tools were selected based on prior validation in health services research, their use in the context of disaster research and disaster preparedness exercises requires further evaluation.

3.6.2 Future Research

Future work should focus on translating these findings into practical tools and approaches that can be used by HCCs and partner organizations. This includes developing a standardized

disaster management ontology to improve consistency in terminology and strengthen knowledge sharing across systems. There is also an opportunity to refine and apply implementation science frameworks prospectively to guide exercise design, rather than only evaluating them after the fact. Additionally, future research should explore the development of sociotechnical assessment models to better measure preparedness across people, processes, and technology, as well as examine how these determinants vary across different regions, coalition maturity levels, and disaster contexts.

3.7 Conclusion

This dissertation contributes to disaster preparedness research by applying an implementation science lens to better understand how federally supported exercises are carried out at the local level. The findings show that while existing frameworks provide important structure, successful implementation depends on local capacity, leadership engagement, and the ability to translate lessons into sustained action. Many of the challenges identified are not new, they continue to persist due to gaps in how knowledge is captured, shared, and applied across systems. By using structured approaches to categorize and analyze these challenges, this research moves the field toward more practical and actionable solutions.

Overall, this work reinforces that disaster preparedness is not just about planning for events, but about strengthening the systems, relationships, and processes that support effective response, offering a foundation to advance both research and practice toward more resilient health systems.

Chapter 4 Participant-Identified Strategies and Mechanisms to Support MRSE Implementation

4.1 Abstract

Objective: The literature shows that disaster preparedness exercises are critical for strengthening coordination, communication, and system readiness. However, most of the existing research primarily focuses on identifying persistent gaps rather than providing an approach for translating lessons learned into sustained preparedness improvements. To the author's knowledge, there has been limited use of implementation science approaches to systematically connect identified barriers and facilitators into actionable implementation strategies within disaster preparedness exercises. This study explored participant-identified implementation strategies and mechanisms to support Medical Response Surge Exercise (MRSE) implementation within Healthcare Coalitions (HCCs). Building on prior findings related to MRSE implementation barriers and enablers, this study applied the Implementation Research Logic Model (IRLM) and additional implementation science frameworks to identify participant-informed strategies to strengthen disaster preparedness activities beyond traditional After-Action Reviews (AARs).

Methods: Participants from the previous study (Aim 2) were followed up with to participate in follow-up interviews, with nine of the original ten participants completing this study. A qualitative approach using modified think-aloud interview methods was used to confirm determinants identified in the previous study and explore how participants would address selected implementation barriers and enablers in real time. For the think-aloud activity, seven of

the 22 determinants identified in Aim 2 were used as discussion topics within an abbreviated Implementation Research Logic Model (IRLM). Data was collected through live analytic field notes during interviews and analyzed using the Rapid and Rigorous Qualitative Data Analysis (RADaR) technique. Analysis combined inductive thematic analysis with deductive mapping to Expert Recommendations for Implementing Change (ERIC) strategies and strategy clusters.

Results: Following a systematic data cleaning process, the interview analytic field notes generated 266 strategy–mechanism pairings across the seven selected determinants, including three enablers and four barriers related to MRSE implementation. Through inductive thematic analysis, 15 macro-level thematic strategies were identified, highlighting coalition collaboration, realistic and flexible exercise design, communication, training, leadership engagement, streamlined reporting, and reducing administrative burden. A deductive analysis approach mapped the strategy–mechanism pairs to 38 of the 73 ERIC implementation strategies across all eight ERIC strategy concept mapping clusters. Based on the combined inductive thematic analysis and deductive ERIC mapping, three determinants demonstrated the strongest alignment between thematic strategies and ERIC implementation strategies. The primary enabler was Strong Collaboration and Coalition Engagement, where participants emphasized building strong partner relationships, maintaining regular coordination, and adapting the exercise to local context. The two most prominent barriers were Competing Priorities and Time Constraints and Administrative Burden and Complex Tools, where participants emphasized designing streamlined and flexible exercises and simplifying MRSE reporting processes to reduce burden and improve usability. The key mechanisms included leveraging technology to simplify reporting and communication, strengthening coordination and relationships across partners, streamlining exercise processes, increasing leadership buy-in, and designing exercises that align

with real-world operational demands.

Conclusion: This study demonstrates the feasibility and value of using implementation science approaches in disaster preparedness research by generating context-specific strategies that address select sociotechnical determinants related to implementing the MRSE. Overall, the findings suggest that successful MRSE implementation depends on strong collaboration, communication, leadership engagement, flexibility, and streamlined processes to support participation and sustained disaster preparedness across HCCs. Going beyond the traditional AAR approach, this research highlights how implementation science frameworks can provide a structured approach for translating participant experiences and lessons learned from exercises into actionable implementation strategies and mechanisms that support sustained preparedness improvements.

4.2 Introduction

This study is the third in a series of three interconnected papers examining the application of implementation science frameworks within disaster preparedness research. Building on prior analyses that characterized the design of the MRSE through document analysis and identified major barriers and enablers to conducting the exercise through participant surveys and semi-structured interview. This paper continues to apply the IRLM to understand the strategies and mechanisms that can be developed to overcome the barriers and strengthen the enablers to achieve the intended outcomes. A modified think-aloud interview approach was used with eligible Aim 2 participants, asking them to talk through, in real time, what they would do to address the listed determinants and how they would carry out those strategies, rather than writing their thoughts down or answering structured questions. Data was analyzed using the Rapid and Rigorous Qualitative Data Analysis (RADaR) technique and synthesized using a combined

approach of thematic analysis and ERIC to identify, organize, and interpret strategy–mechanism linkages.

The MRSE is a federally required for HCCs by the ASPR to fulfill CA obligations under the HPP. The HPP was the only explicit dedicated federal funding aimed at strengthening healthcare system disaster readiness by coordinating preparedness, response, and recovery across the complex network of healthcare organizations (Sen-Crowe et al., 2020). As of 2023, it is estimated that more than 300 HCCs across the United States have conducted the MRSE (ASPR, n.d.-a). The MRSE is designed to be a functional disaster preparedness exercise with the goal of assessing the capability and capacity of HCCs to manage patient surge. A functional exercise tests how an organization responds to a simulated realistic disaster scenario by focusing on plans, policies, and coordination without deploying an actual response.

Since the MRSE is designed at the federal level but implemented locally, it provides a unique opportunity to examine how FEMA's disaster management model, "Federally Supported, State Managed, and Locally Executed," is translated into practice. Understanding the perspectives and experiences of HCC leaders and participants implementing the MRSE can reveal key determinants that either facilitate (enablers) or hinder (barriers) successful execution of this federally designed exercise. The unique methodology of this study also provides an opportunity to be generalized as an approach for other disaster preparedness exercises, offering a way to qualitatively evaluate these exercises in relation to implementation outcomes.

Building on the results of Aim 2, which explored HCC leaders' and members' perceptions of the implementation of the MRSE in 2024 and identified barriers and facilitators of implementation, this study references those thematic determinants to conduct further analysis. The goal of this study is to investigate potential strategies and mechanisms HCCs have used or

considered using to support MRSE implementation or overcome specified barriers. The guiding question for this study was: ***What implementation strategies and mechanisms do HCC leads and members propose to address perceived barriers and support enablers for future MRSE implementation?***

Interviews were conducted using a modified think-aloud approach (Solomon, 1995; Güss, 2018; Noushad et al., 2023). Participants were individuals affiliated with HCCs within a single, anonymized United States Midwest state participating in the HPP CA with ASPR. The study participants represented diverse roles across the health care preparedness system, including public health, emergency management, and health care organization partners, and are collectively referred to as HCC members. Using RADaR as the primary data analysis technique, the identified strategy–mechanism pairs were synthesized using an integrated parallel approach that combined thematic analysis with mapping to ERIC strategies. They were also mapped to higher-order categories using frameworks from pre-existing peer-reviewed studies to enhance practical application and analysis. By leveraging prior research and established theoretical frameworks, including IRLM and ERIC, this study further demonstrates the utility of implementation science tools to assess and strengthen disaster preparedness exercises.

The goal of this research is to extend beyond a traditional AAR, which typically focuses on evaluating performance and identifying areas for improvement following a preparedness exercise or response. This study emphasizes the identification of actionable strategies and mechanisms to strengthen exercise implementation. The secondary goals of this study are to equip HCCs with practical approaches to strengthen MRSE implementation, offer a methodological framework applicable to other disaster preparedness exercises, and demonstrate the application of implementation science in real-world preparedness settings.

4.3 Literature Review

This literature review aims to understand whether strategies and mechanisms are currently used to support and improve the implementation of disaster preparedness exercises by leveraging identified lessons learned and opportunities for improvement and if so, how. Disaster preparedness exercises are generally recognized as essential tools for strengthening response capability and system readiness (Noh & Bae, 2025; Uemura et al., 2021). Competency-based training approaches including simulations, tabletop exercises, and drills have been shown to strengthen communication, leadership, and operational skills necessary for effective emergency response (Uemura et al., 2021). Disaster preparedness exercises play a critical role in building both capability and capacity within health systems and are associated with improved competence, response readiness, and coordination across stakeholders (Noh & Bae, 2025). Exercises provide an opportunity for stakeholders to translate theoretical knowledge into practice, reinforcing both individual and system-level preparedness. In healthcare settings, integrating disaster exercises into quality improvement processes further enhances preparedness by systematically identifying strengths, gaps, and opportunities for improvement (Sheikhbardsiri et al., 2022). However, a 2025 scoping review highlighted persistent gaps in emergency preparedness exercise design, including limited public health–focused research, unclear triggers for conducting exercises, and the need for evidence-based frameworks, technologies, and evaluation approaches (Chambers et al., 2025). Current literature provides limited guidance on translating evaluation findings into actionable, sustained improvements (Farahmandnia et al., 2025; Singleton et al., 2014).

A major framework guiding disaster preparedness exercises in the United States is the Homeland Security Exercise and Evaluation Program (HSEEP), outlining a five-phase lifecycle—program management, design and development, conduct, evaluation, and

improvement planning. Evaluation and improvement planning are integral components of HSEEP. Evaluation is embedded throughout the exercise lifecycle, utilizing multiple data sources such as observations, interviews, and surveys to assess performance and identify gaps. Evaluation findings are documented in After-Action Reports and Improvement Plans (AAR/IPs), which are intended to include measurable corrective actions that are tracked over time (DHS, 2020). However, existing evidence indicates substantial variability in how effectively these processes are implemented; an analysis of AAR's found that higher-quality AAR/IPs focused on corrective actions, whereas weaker reports often failed to clearly distinguish between recommendations and actionable improvements which limits their usefulness for continuous quality improvement (Singleton et al., 2014).

In addition to HSEEP, FEMA emphasizes a broader continuous improvement framework for disaster preparedness exercises. Through tools such as the National Continuous Improvement Guidance, Continuous Improvement Technical Assistance Program (CITAP), and PrepToolkit FEMA promotes an ongoing learning cycle in which exercise findings are systematically collected, validated, implemented, and evaluated (FEMA, 2023). This process follows four phases—discovery, validation, resolution, and evaluation to reinforce the concept that exercises should function as part of a continuous learning system rather than isolated events (FEMA, 2023). These tools provide structured approaches for tracking corrective actions and assessing whether implemented changes lead to measurable improvements in preparedness outcomes (FEMA, 2022).

A review of the literature showed that while many studies reference HSEEP and disaster preparedness exercises, few detail how to operationalize improvements, focusing instead on identifying gaps rather than translating findings into structured implementation approaches.

(Aminafshar et al., 2026; McCormick et al., 2014; Obaid et al., 2017; Renger et al., 2021). For example, Obaid and colleagues (2017) used HSEEP to guide a multi-agency disaster preparedness exercise and identified key areas for improvement, including strengthening interagency coordination, enhancing communication and public messaging, improving use of incident command systems, and increasing knowledge of resource request and documentation processes. This article emphasized the importance of ongoing training, clearer roles, and structured follow-up to translate exercise insights into sustained preparedness improvements (Obaid et al., 2017). Similarly, a 2021study by Renger and colleagues using HSEEP-guided exercises reported improvements in clarifying and standardizing processes, reducing workflow inefficiencies, and strengthening coordination across teams. The authors mention that the exercises identified communication gaps, redundant steps, and breakdowns at handoff points which led to more streamlined and coordinated operations; however, the study did not explain how these improvements were achieved (Renger et al., 2021). Across studies spanning more than a decade, needed improvements consistently center on coordination, communication, and role clarity (Aminafshar et al., 2026; McCormick et al., 2014). The earlier article identified corrective actions related to communication, command structure, resource coordination, and patient tracking (McCormick et al., 2014). Relatedly, more recent research highlights similar gaps in coordination, role clarity, and resource management, with proposed strategies such as enhancing scenario realism and strengthening interagency collaboration (Aminafshar et al., 2026). This persistence suggests limited progress over time, and across studies there remains little guidance on how to implement these improvements in practice (Aminafshar et al., 2026; McCormick et al., 2014; Obaid et al., 2017; Renger et al., 2021).

Additionally, some studies have focused on improving evaluation methods. One study

found that inconsistent exercise quality and a lack of standardized evaluation limit effectiveness; in turn the authors developed and pilot-tested an online toolkit to standardize performance measurement using predefined metrics and data collection forms, improving the relevance, consistency, and usefulness of data for performance assessment and after-action reporting (Agboola et al., 2015).

Similarly, Sheikhbardsiri (2022) developed and validated a 50-item checklist, informed by semi-structured interviews identifying key gaps and best practices, to assess disaster exercise design across four domains: coordination, planning, resources, and communication. While these tools strengthen evaluation rigor, they primarily focus on measuring performance rather than guiding the implementation of exercise-related improvements.

A systematic review of studies from 2021–2023 identified best practices and gaps in healthcare disaster preparedness, finding that effective readiness requires a multifaceted approach that includes— comprehensive planning, simulation-based exercises, continuous training, strong coordination, clear communication, community engagement, technology advancements, and ongoing evaluation to strengthen system readiness and resilience (Ersöz Genç & Genç, 2025). The authors suggest that future research should prioritize developing and evaluating new interventions and examining the long-term effects of existing strategies on disaster resilience and outcomes. Coincidentally, around the same time, a qualitative study examining disaster preparedness exercise implementation used interviews with 23 health sector managers in Iran to identify key barriers, facilitators, and strategies (Farahmandnia et al., 2025). Barriers included weak leadership, limited funding, bureaucratic constraints, and poor coordination, while facilitators included strong leadership, trained personnel, adequate resources, and realistic exercise design. While the authors proposed strategies focused on strengthening

leadership, improving funding, enhancing coordination, and standardizing evaluation, they emphasized the need for future research to draw on insights from experts and practitioners to identify practical solutions for overcoming challenges in disaster exercise implementation.

While the aforementioned studies align with the goal of identifying challenges and linking them to actionable strategies for disaster preparedness exercises, to the authors' knowledge, no studies explicitly apply implementation science frameworks to examine how strategies operate through underlying mechanisms in disaster preparedness exercises. Additionally, few studies use implementation science nomenclature directly, such as framing challenges as determinants (barriers and facilitators) or conceptualizing actions as implementation strategies and mechanisms. To address this gap and systematically understand how strategies can be selected and applied, it is important to draw on implementation science. Implementation strategies are theory-informed approaches used to enhance the adoption, implementation, and sustainment of innovations, and are selected based on contextual factors, barriers, and facilitators (Kirchner et al., 2020). However, given that implementation science is a relatively new field, a key gap remains in understanding how implementation strategies work; although strategies are often explicitly named, they are frequently poorly specified and lack clear links to underlying mechanisms, highlighting the need to identify and measure strategy–mechanism relationships to improve their effectiveness (Lewis et al., 2022). Mechanisms refer to the underlying processes through which these strategies produce their effects, helping to explain how and why change occurs within a given context (Vejnoska et al., 2022). In the context of disaster preparedness exercises, these concepts are critical for understanding not only what improvements are needed, but also how they can be effectively implemented within complex, multi-organizational systems such as HCCs.

Implementation science identifies and addresses contextual barriers and facilitators to ensure that evidence-based practices are successfully adopted and sustained in real-world settings, thereby improving their public health impact (Bauer & Kirchner, 2020b). Despite its relevance to disaster research, implementation science remains underutilized in the disaster management and disaster science literature (Bell et al., 2023; Binagwaho et al., 2022; Øvretveit & Ohrling, 2021; Phillips et al., 2008). Within the disaster preparedness context, most studies focus on evaluating exercise performance rather than the implementation of the exercises themselves, creating a gap between identifying determinants (barriers and facilitators) and developing actionable strategies to address them (Agboola et al., 2015; Sheikhbardsiri et al., 2022; Singleton et al., 2014).

Implementation science includes a wide range of theories, models, and frameworks (TMFs) that help identify barriers and facilitators, guide strategy selection, inform evaluation, and explain mechanisms of change; however, these TMFs are often underutilized or not fully applied in practice (Weight et al., 2025). Implementation science frameworks such as the Expert Recommendations for Implementing Change (ERIC) taxonomy provide structured classifications of implementation strategies, while the Implementation Research Logic Model (IRLM) offers a method for linking determinants, strategies, mechanisms, and outcomes (Powell et al., 2015; Smith et al., 2020; Waltz et al., 2015).

Participatory approaches, including stakeholder engagement and co-design methods, are increasingly recognized as valuable for identifying feasible and contextually appropriate implementation strategies (Friedman, 2022a; Kilbourne et al., 2019; Nepal et al., 2010). This participatory, expert-informed approach aligns with broader disaster research emphasizing strategies to strengthen and improve disaster preparedness exercises (Ersöz Genç & Genç, 2025;

Farahmandnia et al., 2025).

Overall, the literature highlights that disaster preparedness exercises are essential for improving system readiness, but current evaluation approaches are insufficient for ensuring sustained improvement (Agboola et al., 2015; Sheikhbardsiri et al., 2022; Singleton et al., 2014). While frameworks such as HSEEP and FEMA's continuous improvement model provide structure, current literature provides limited guidance on translating evaluation findings into actionable implementation strategies (Farahmandnia et al., 2025; Singleton et al., 2014). Within the United States, HCCs, supported through the HPP, play a central role in coordinating and implementing regional disaster preparedness exercises such as the MRSE. This gap is particularly evident in the context of HCC-led exercises such as MRSE, where barriers and facilitators are frequently identified but not systematically linked to strategies and mechanisms that support implementation (Barnett et al., 2020). Incorporating participant-informed insights is particularly important in disaster preparedness, where frontline experience and local context shape implementation success—particularly within HCCs.

Therefore, this study seeks to address this gap by examining the implementation strategies and underlying mechanisms proposed by HCC leaders and members to overcome identified barriers and support enablers in MRSE implementation. By applying implementation science frameworks to this context, this study aims to provide a structured and replicable approach for linking determinants, strategies, and mechanisms, ultimately supporting continuous learning and strengthening preparedness across HCCs.

4.4 Methods

To better understand the strategies and mechanisms that HCC members have used or considered in response to major determinants, this study employed a five-step qualitative methodological approach, as outlined in Figure 4.1. The intended outcome of this study was to identify strategies and mechanisms provided by HCC members for the highest-ranked barriers and enablers.

Figure 4.1 Aim 3 Methods Analytic Workflow Overview



Note. Following data preparation, data were coded and reduced using RADaR to generate strategy–mechanism statements. Inductive thematic analysis and deductive mapping to ERIC strategies were conducted in parallel, with results integrated into a comprehensive synthesis.

This multi-step iterative analysis approach was informed by several established qualitative thematic analysis methodologies. Ahmed and colleagues'(2025) six-phase framework of thematic analysis provides a systematic yet flexible and reflexive structure for interpreting qualitative data, guiding analysis from familiarization and coding through theme development and reporting to produce credible and meaningful insights. Morgan and Nica's (2020) Iterative Thematic Inquiry (ITI) methods further informed this approach by using continuous thematic development rather than step-by-step coding. In addition, this study drew on Watkins' Rapid and Rigorous Qualitative Data Analysis (RADAR) technique, with determinants cleaned, organized, and assessed using Excel. RADaR supports efficient yet rigorous analysis by systematically reducing raw textual data into concise, structured tables without sacrificing analytic depth or transparency (Watkins, 2017).

Data collection included a two-part follow-up interview with participants from Aim 2 interviews—the first part focused on validation of the thematic determinants, and the second portion employed a modified think-aloud method, capturing all analytic field notes in real time. Data was then transferred and organized, followed by an iterative data cleaning process and segmentation using the RADaR technique. The analysis combined inductive thematic analysis and deductive mapping to ERIC strategies to summarize strategies and mechanisms (Powell et al., 2015). Finally, the data was integrated and assessed within the RADaR to identify determinants with strong strategy and mechanism alignment based on frequency patterns across the two parallel analysis methods, which resulted in the selection of a few determinants for further synthesis— summarizing the strategies and mechanisms developed.

This study, while independent in data collection through synthesis, builds upon the results from Aim 2 and references findings from Aim 1. Each of the three studies were developed and guided by components of the IRLM. This three-part research study focused on the 2024 MRSE cycle, with additional informal insights from the 2025 MRSE. Aim 1 characterized the MRSE using implementation science frameworks (CFIR 2.0, Proctor Outcomes, and RE-AIM) through document analysis to better understand how the exercise was designed. Aim 2 examined local implementation of the MRSE by identifying participant perceptions, barriers, and enablers through 10 semi-structured interviews with participants from a state-level HCCs in an anonymized Midwestern U.S. state participating in the HPP CA with ASPR. Participants represented diverse roles across public health, emergency management, and healthcare organizations and are collectively referred to as HCC members.

Study participants were not formally trained in IRLM terminology, which required the sole interviewer to balance methodological rigor with practical applicability in real time while

capturing analytic field notes. Each participant reviewed and discussed a subset of thematic determinants identified in Aim 2— three facilitations and four barriers.

The analytic process outlined in Figure 4.1 emphasized rigor, transparency, and fidelity to participant experiences, ensuring that both context and intent were preserved (Ahmed et al., 2025; Morgan & Nica, 2020; Poduthase, 2015). Rigor was achieved through a structured, multi-step methodological approach including the use of both inductive and deductive analyses. Transparency was maintained through clear documentation, structured datasets that created a data audit trail, a separate qualitative audit trail, and adherence to the Standards for Reporting Qualitative Research (SRQR) (O'Brien et al., 2014). Fidelity was preserved by capturing real-time analytic field notes, incorporating member checking, and maintaining the original context of participant responses.

The identities of the state, organizations, and participants are not disclosed to protect confidentiality. This study received IRB exemption from the University of Michigan Medical School (IRBMED; HUM00246148) and was funded by the University of Michigan Rackham Graduate Student Research Grant. The author reports no conflicts of interest.

4.4.1 Data Collection

The data collection methods for this study focused on validating and further investigating findings from a prior study (Aim 2), which examined the major determinants experienced by HCC members within a single HPP CA state. in implementing the MRSE. Interviews conducted virtually using a modified think-aloud approach, this study explored the strategies and mechanisms participants would use to address barriers and strengthen enablers. The modified think-aloud approach enables participants to verbalize their real-time thought processes while engaging with a task (Güss, 2018; Noushad et al., 2023; Solomon, 1995). For this study, the

think-aloud method was adapted from the traditional format in which participants are typically observed while completing a task to a more structured, discussion-based activity. Participants talked through an abbreviated IRLM that listed select determinants identified in Aim 2 and focused specifically on them identifying potential associated strategy and mechanisms, while the interviewer documented responses through real-time analytic field notes rather than observing task completion. This adaptation allowed participants to actively engage with the framework, think through and articulate their ideas without focusing on writing, providing deeper insight into their thought process and decision-making and how they respond to complex implementation challenges.

The interview participants included individuals who completed the Aim 2 study which included a survey and semi-structured interview. At the conclusion of those interviews, participants received a follow-up email thanking them for their participation and inviting them to schedule their Aim 3 (follow-up/ round 2) interview using Calendly, which allowed them to easily select a time that worked best for their schedule. Aim 3 interviews were intentionally scheduled to begin shortly (approximately one month) after Aim 2 data collection to maintain engagement and minimize loss to follow-up (Norvell et al., 2016).

Given the quick turnaround between round 1 and round 2 follow-up interviews, the RADaR method was used to support rapid analysis in parallel with scheduling Aim 3 interviews (Watkins, 2017). This rapid coding technique, used on Aim 2 interview data to prepare for Aim 3, began by organizing responses into barriers and facilitators. An inductive approach was then used to identify patterns within those categories and group them into broader thematic determinants. This RADaR coding process resulted in approximately 22 thematic determinants (12 barriers and 10 enablers).

Determinants were initially ranked based on how often they were mentioned across interviews (n = 10) and how frequently they appeared within individual interviews, with higher frequency interpreted as greater importance. This ranking was then used to select which determinants would be explored as part of the IRLM modified think-aloud activity, due to interview time constraints, reviewing all 22 determinants was not feasible. Attempting to review all 22 determinants would have resulted in an overly long and burdensome interview and limited the ability to have a robust discussion of strategies and mechanism (Jamshed, 2014)

Following initial RADaR coding and conclusion of Aim 3 interviews, the Aim 2 interview transcripts were re-coded using finalized thematic determinants, resulting in minor changes in frequency and ranking. These differences did not affect determinant selection for Aim 3, only their relative order. There was no negative impact the study's validity or overall intent. Additional details are provided in the subsection, "Notes on the Impact of Rapid Analysis from Aim 2 on Aim 3 Data Collection."

Nine of the ten participants from round 1 interviews (Aim 2) agreed to participate in Aim 3 interviews. Interviews were conducted between late July and early August 2025 and ranged from approximately 35 to 60 minutes, totaling approximately 400 minutes (over 6.5 hours) of data. Interviews were conducted via Zoom Workplace (version 6.5.5), audio-recorded, and transcribed using AI-assisted tools (Zoom AI Companion and Otter.ai). At the beginning of each session, informed consent, confidentiality, and use of AI transcription were reviewed and confirmed.

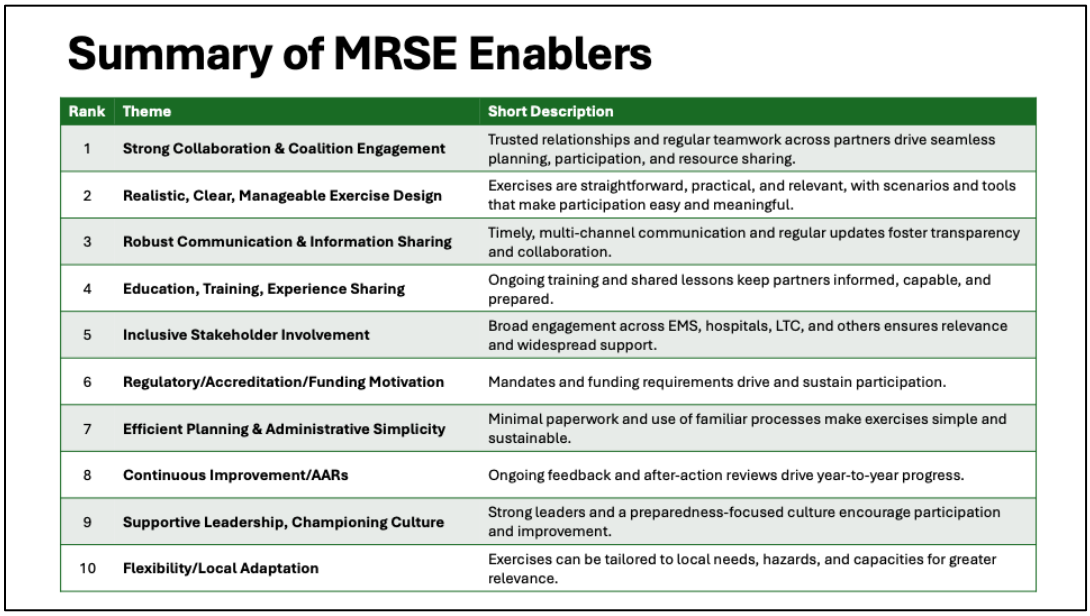
Each interview included two components: (1) member checking to validate the determinant themes from Aim 2 and (2) a structured think-aloud activity using an abbreviated IRLM. Enablers (facilitators) were reviewed first, followed by barriers. During member

checking, participants were asked to reflect on whether the determinants accurately represented their experience and to identify any missing or misrepresented elements. Any clarifications or disagreements were documented directly on shared visual materials. During the think-aloud portion, participants worked through selected high-ranking determinants (three enablers and four barriers), reflecting on how to overcome barriers or strengthen enablers and identifying associated strategies and mechanisms. The abbreviated IRLM template included the determinant, a brief definition, and space to capture strategies and mechanisms. Participants openly talked through their thought process while the interviewer summarized key points and documented responses via a shared screen in real time as electronic analytic field notes.

The list of enablers used for member checking during the interviews is displayed in .

Figure 4.2. Following member checking, the top three enablers from the list were selected for deeper exploration. The abbreviated IRLM template, which displayed the determinant, a brief definition, and space to capture strategy and mechanism components, is shown on Figure 4.3. A standardized template was used for the electronic analytic field notes in accordance with RADaR Step 1, which emphasizes ensuring that all data transcripts are formatted consistently (Watkins, 2017). The enabler determinant's themes reviewed included: (1) Strong Collaboration & Coalition, Engagement, (2) Realistic, Clear, Manageable Exercise Design, and (3) Robust Communication & Information Sharing.

Figure 4.2 Enabler Rank List Interview Visual used for Member Checking

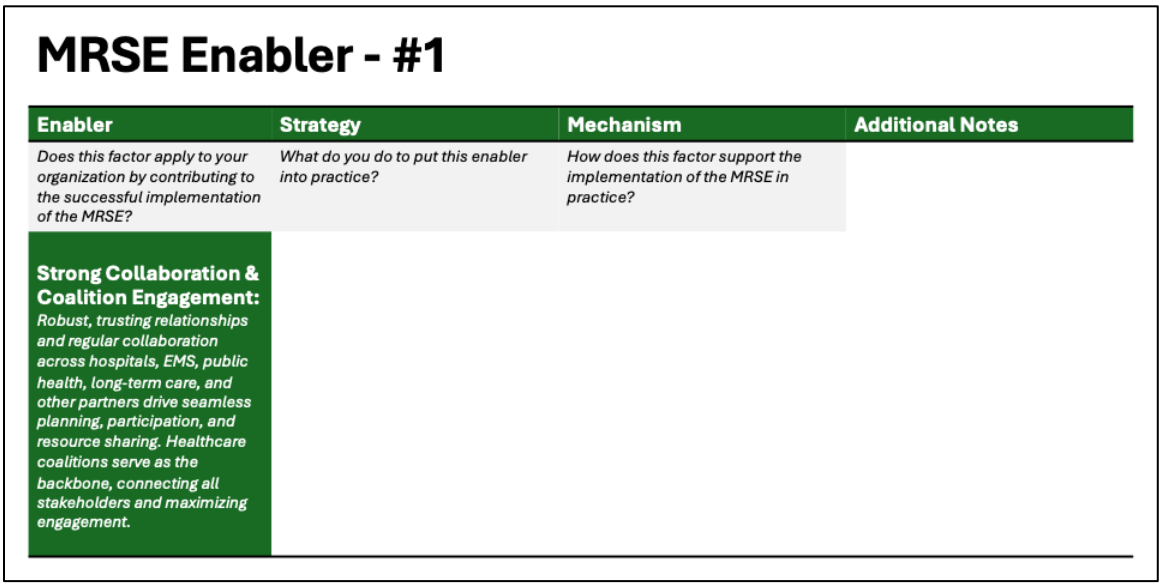


Summary of MRSE Enablers

Rank	Theme	Short Description
1	**Strong Collaboration & Coalition Engagement**	Trusted relationships and regular teamwork across partners drive seamless planning, participation, and resource sharing.
2	**Realistic, Clear, Manageable Exercise Design**	Exercises are straightforward, practical, and relevant, with scenarios and tools that make participation easy and meaningful.
3	**Robust Communication & Information Sharing**	Timely, multi-channel communication and regular updates foster transparency and collaboration.
4	**Education, Training, Experience Sharing**	Ongoing training and shared lessons keep partners informed, capable, and prepared.
5	**Inclusive Stakeholder Involvement**	Broad engagement across EMS, hospitals, LTC, and others ensures relevance and widespread support.
6	**Regulatory/Accreditation/Funding Motivation**	Mandates and funding requirements drive and sustain participation.
7	**Efficient Planning & Administrative Simplicity**	Minimal paperwork and use of familiar processes make exercises simple and sustainable.
8	**Continuous Improvement/AARs**	Ongoing feedback and after-action reviews drive year-to-year progress.
9	**Supportive Leadership, Championing Culture**	Strong leaders and a preparedness-focused culture encourage participation and improvement.
10	**Flexibility/Local Adaptation**	Exercises can be tailored to local needs, hazards, and capacities for greater relevance.

Note. Initial rapid frequency coding of thematic enablers identified across participant interviews. This summary table was used during member checking to validate and refine qualitative findings related to factors from Aim 2 supporting MRSE implementation.

Figure 4.3 Abbreviated Implementation Research Logic Model (IRLM) Visual Used for Think-Aloud Activity



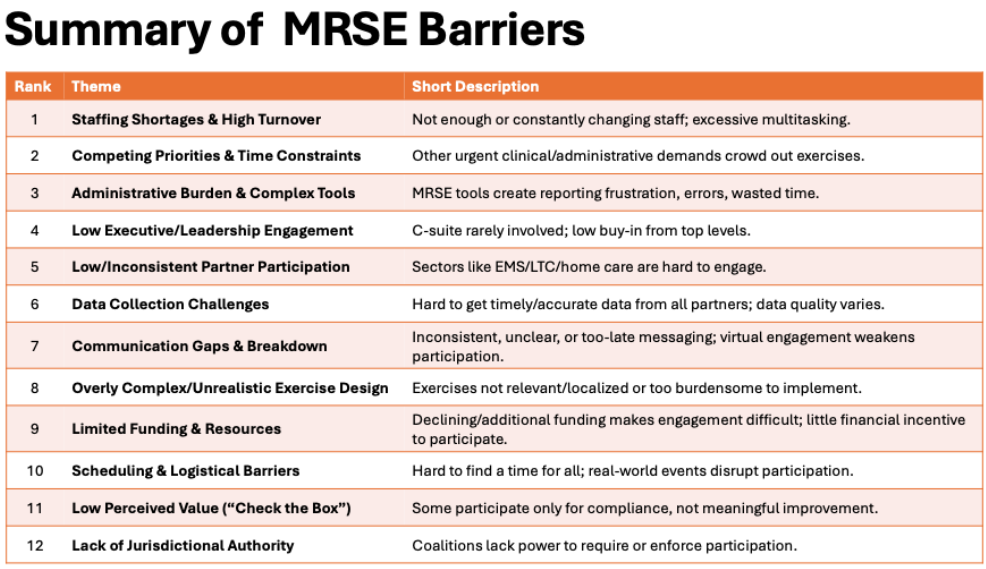
MRSE Enabler - #1

Enabler	Strategy	Mechanism	Additional Notes
Does this factor apply to your organization by contributing to the successful implementation of the MRSE?	*What do you do to put this enabler into practice?*	*How does this factor support the implementation of the MRSE in practice?*	
Strong Collaboration & Coalition Engagement: *Robust, trusting relationships and regular collaboration across hospitals, EMS, public health, long-term care, and other partners drive seamless planning, participation, and resource sharing. Healthcare coalitions serve as the backbone, connecting all stakeholders and maximizing engagement.*			

Note: Sample abbreviated Implementation Research Logic Model (IRLM) visual used during the think-aloud interview activity to guide participant reflection on implementation strategies, mechanisms, and MRSE determinants adapted from the IRLM framework (Smith et al., 2020). A complete version of the interview guide and activity materials is provided in Appendix H.

After completing the enabler review, the ranked list of barriers (n = 12) as shown on Figure 4.4 was reviewed with participants. Four barriers were then discussed as part of the think-aloud IRLM activity using the same layout as the enablers, as shown on Figure 4.3. The barrier determinant themes reviewed included: (1) Staffing Shortages & High Turnover, (2) Competing Priorities & Time Constraints, (3) Administrative Burden & Complex Tools, and (4) Low Executive/Leadership Engagement.

Figure 4.4 Enabler Rank List Interview Visual used for Member Checking



Summary of MRSE Barriers

Rank	Theme	Short Description
1	**Staffing Shortages & High Turnover**	Not enough or constantly changing staff; excessive multitasking.
2	**Competing Priorities & Time Constraints**	Other urgent clinical/administrative demands crowd out exercises.
3	**Administrative Burden & Complex Tools**	MRSE tools create reporting frustration, errors, wasted time.
4	**Low Executive/Leadership Engagement**	C-suite rarely involved; low buy-in from top levels.
5	**Low/Inconsistent Partner Participation**	Sectors like EMS/LTC/home care are hard to engage.
6	**Data Collection Challenges**	Hard to get timely/accurate data from all partners; data quality varies.
7	**Communication Gaps & Breakdown**	Inconsistent, unclear, or too-late messaging; virtual engagement weakens participation.
8	**Overly Complex/Unrealistic Exercise Design**	Exercises not relevant/localized or too burdensome to implement.
9	**Limited Funding & Resources**	Declining/additional funding makes engagement difficult; little financial incentive to participate.
10	**Scheduling & Logistical Barriers**	Hard to find a time for all; real-world events disrupt participation.
11	**Low Perceived Value ("Check the Box")**	Some participate only for compliance, not meaningful improvement.
12	**Lack of Jurisdictional Authority**	Coalitions lack power to require or enforce participation.

Note. Initial rapid frequency coding of thematic barriers identified across participant interviews. This summary table was used during member checking to validate and refine qualitative findings related to factors from Aim 2 supporting MRSE implementation.

Electronic analytic field notes, recorded in real time on a shared screen, were used as the primary data source to capture participants' reflections, examples, and emerging ideas from the interviews. The live notes paraphrased and summarized participants' think-aloud responses while maintaining clarity and preserving their original intent. The notes were intentionally recorded on a shared screen to allow participants to verify and confirm the accuracy of what was captured.

Keeping them in a digital format made them easy to organize, reference, and use in the analysis using the RADaR technique.

Following each interview, participant-specific IRLM PowerPoint files were saved to the research Dropbox on the University of Michigan's secure server using de-identified pseudonym file names. Interview transcripts generated through Zoom and Otter.ai were downloaded and securely stored in the same location.

Notes on Rapid Analysis Impact of Aim 2 on Aim 3 Data Collection Activity

Aligned with mixed methods best practices, this subsection provides transparency regarding how preliminary Aim 2 findings, which were later reassessed and refined, were used to inform Aim 3 data collection. To reduce potential loss to follow-up and maintain participant engagement given federal ambiguity regarding federal funding for the Hospital Preparedness Plan (HPP) and subsequently Healthcare Coalitions (HCC), rapid coding analysis was conducted shortly after Aim 2 interviews to support the timely scheduling of Aim 3 interviews with the same participants. Initial rapid coding was conducted in Excel using high-level categorizations to identify barriers and facilitators, followed by more detailed coding in MAXQDA.

Consistent with the RADaR approach described previously, this rapid analysis prioritized efficiency while maintaining analytic rigor, enabling the development and initial ranking of thematic determinants used to guide Aim 3 data collection activities. Subsequent re-coding of Aim 2 transcripts using finalized thematic determinants as a deductive codebook resulted in minor changes to code frequencies and rank ordering. These changes in rankings would have affected which barriers and facilitators were selected for Aim 3 if finalized earlier; however, they only impacted the relative order. Because rank ordering was used primarily to guide member checking and the selection of determinants reviewed during Aim 3, these differences are not expected to impact the validity or overall intent of the study. The preliminary (rapid) and final

rank order from Aim 2 for each determinant group (enablers and barriers) are presented in Table 4.1 and Table 4.2 respectively, for comparison and reference.

Table 4.1 Comparison of Preliminary and Final Qualitative Theme Rankings for Enablers

Thematic Enablers	**Final Rank (Aim 2)**	**Member Checking Rank (Aim 3)**	**Think-aloud Activity (Aim 3)**
Strong Collaboration & Coalition Engagement	1	1	Yes
Robust Communication & Information Sharing	2	3	Yes
Inclusive Participant Involvement	3	5	
Efficient Planning & Administrative Simplicity	3	7	
Realistic, Clear, Manageable Exercise Design	5	2	Yes
Supportive Leadership, Championing Culture	6	9	
Continuous Improvement/AARs	7	8	
Regulatory/Accreditation/Funding Motivation	8	6	
Education, Training, Experience Sharing	9	4	
Flexibility/Local Adaptation	10	10	

Table 4.2 Comparison of Preliminary and Final Qualitative Theme Rankings for Barriers

Thematic Barriers	**Final Rank (Aim 2)**	**Member Checking Rank (Aim 3)**	**Think-aloud Activity (Aim 3)**
Low Executive/Leadership Engagement	1	4	Yes
Competing Priorities & Time Constraints	2	2	Yes
Overly Complex/ Simplistic Exercise Design	3	8	
Limited Funding & Resources	4	9	
Administrative Burden & Complex Tools	5	3	Yes
Low/Inconsistent Partner Participation	6	5	
Staffing Shortages & High Turnover	7	1	Yes
Low Perceived Value (“Check the Box”)	8	11	
Lack of Jurisdictional Authority	9	12	
Communication Gaps & Breakdown	10	7	
Data Collection Challenges	11	6	
Scheduling & Logistical Barriers	12	10	

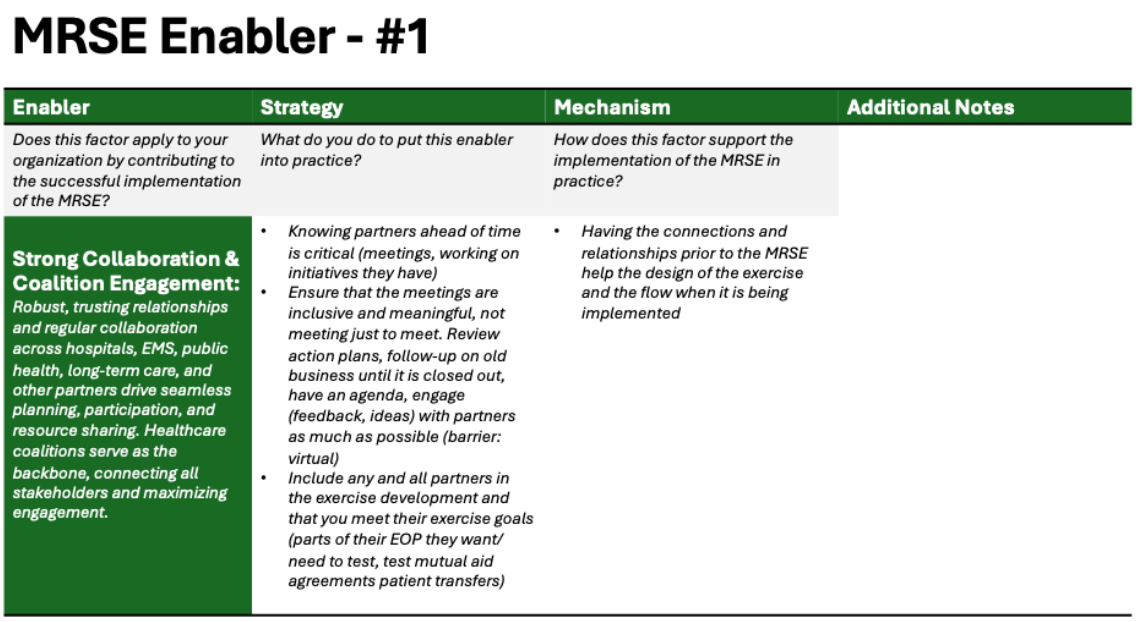
Following the conclusion of all interviews, the analytic field notes captured during the IRLM think-aloud activity were transferred from PowerPoint into Excel for systematic analysis. For each interview, the de-identified pseudonym, determinant category (enabler or barrier), determinant theme, and associated notes were included. Notes were initially documented with each individual strategy or mechanism captured on separate rows, ensuring that each distinct idea was represented independently for clarity and systematic analysis.

Step 2 in the five-step qualitative methodological approach focused on data preparation, aligned with Step 2 of the RADaR technique: placing formatted data transcripts into an all-inclusive data table (Watkins, 2017). Within this step, all electronic analytic field notes from the nine interviews, covering the seven determinants, were transferred from the PowerPoint template into Excel.

Each bullet point or note from the PowerPoint slides was translated into an individual row in the Aim 3 dataset. The dataset included structured columns for Interview (listing the pseudonym to enable cross-reference to transcripts as needed), Determinant Type/Category (denoting whether it was a barrier or enabler), Determinant (the respective thematic name), and analytic field notes separated into Strategy and Mechanism columns based on the notes captured in the PowerPoint template.

This process focused on vertical structuring to ensure that each analytic field note was represented as its own row, preserving the integrity and traceability of the data. An example of analytic field note transfer from PowerPoint (Figure 4.5) to Excel (Figure 4.6) is provided below for one interview and one determinant. This process was completed for all electronic field notes, resulting in 238 rows of data.

Figure 4.5 Example of Completed Think-aloud Interview Analytic Field Notes

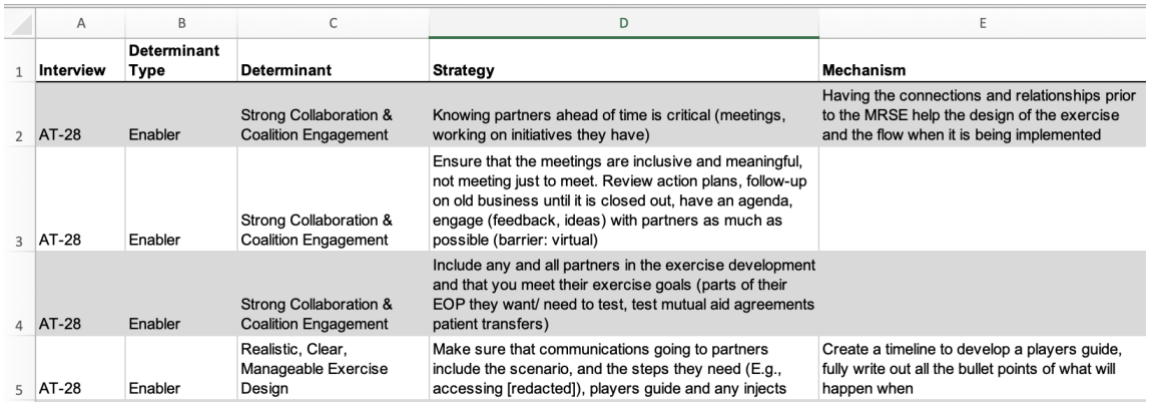


MRSE Enabler - #1

Enabler	Strategy	Mechanism	Additional Notes
Does this factor apply to your organization by contributing to the successful implementation of the MRSE?	*What do you do to put this enabler into practice?*	*How does this factor support the implementation of the MRSE in practice?*	
Strong Collaboration & Coalition Engagement: *Robust, trusting relationships and regular collaboration across hospitals, EMS, public health, long-term care, and other partners drive seamless planning, participation, and resource sharing. Healthcare coalitions serve as the backbone, connecting all stakeholders and maximizing engagement.*	• *Knowing partners ahead of time is critical (meetings, working on initiatives they have)* • *Ensure that the meetings are inclusive and meaningful, not meeting just to meet. Review action plans, follow-up on old business until it is closed out, have an agenda, engage (feedback, ideas) with partners as much as possible (barrier: virtual)* • *Include any and all partners in the exercise development and that you meet their exercise goals (parts of their EOP they want/ need to test, test mutual aid agreements patient transfers)*	• *Having the connections and relationships prior to the MRSE help the design of the exercise and the flow when it is being implemented*	

Note. Example showing how analytic field notes related to the enabler "Strong Collaboration and Coalition Engagement" were transferred from PowerPoint into Excel to support data organization and synthesis during analysis.

Figure 4.6 Example of Analytic Field Note Transfer and Vertical Structuring in Excel for Enabler 1 (Strong Collaboration and Coalition Engagement)



	A	B	C	D	E
1	**Interview**	**Determinant Type**	**Determinant**	**Strategy**	**Mechanism**
2	AT-28	Enabler	Strong Collaboration & Coalition Engagement	Knowing partners ahead of time is critical (meetings, working on initiatives they have)	Having the connections and relationships prior to the MRSE help the design of the exercise and the flow when it is being implemented
3	AT-28	Enabler	Strong Collaboration & Coalition Engagement	Ensure that the meetings are inclusive and meaningful, not meeting just to meet. Review action plans, follow-up on old business until it is closed out, have an agenda, engage (feedback, ideas) with partners as much as possible (barrier: virtual)	
4	AT-28	Enabler	Strong Collaboration & Coalition Engagement	Include any and all partners in the exercise development and that you meet their exercise goals (parts of their EOP they want/ need to test, test mutual aid agreements patient transfers)	
5	AT-28	Enabler	Realistic, Clear, Manageable Exercise Design	Make sure that communications going to partners include the scenario, and the steps they need (E.g., accessing [redacted]), players guide and any injects	Create a timeline to develop a players guide, fully write out all the bullet points of what will happen when

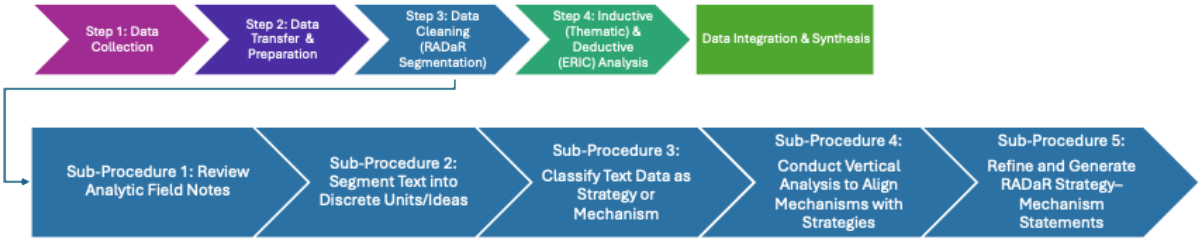
Note. Example of analytic field notes after transfer to Excel, showing vertical structuring by interview and determinant, with strategy and mechanism content organized into discrete rows. Some information has been redacted to maintain confidentiality.

4.4.2 Data Cleaning

Within this study's five-step qualitative methodological approach (Figure 4.1), step three focuses on iterative Data Cleaning through RADaR segmentation, emphasizing the transformation of analytic field notes into discrete, analyzable units such that each row reflected a single idea. This data cleaning step is aligned with Steps 3 and 4 of the RADaR technique: (3) reducing the all-inclusive data table to produce a Phase 2 dataset and (4) further reducing and refining the Phase 2 dataset to produce structured analytic tables (Watkins, 2017).

The electronic analytic field notes, transferred into Excel during the Data Preparation step, were reviewed and iteratively refined, with Zoom and OtterAI transcripts referenced as needed to ensure fidelity to participant intent and context. The data cleaning step included standardizing language, removing redundancies, consolidating overlapping responses, and segmenting text into discrete units. When a single row contained multiple ideas, content was divided into separate rows to ensure clarity and consistency. This was accomplished using an iterative five sub-procedure methodological approach, as summarized in Figure 4.7: (1) reviewing analytic field notes, (2) segmenting text into discrete units, (3) classifying each unit as a strategy (what) or mechanism (how), (4) conducting vertical analysis by interview and determinant to ensure alignment between strategies and mechanisms, and (5) refining and standardizing RADaR strategy–mechanism statements across participants.

Figure 4.7 Qualitative Methodological Approach and Data Cleaning Sub-Procedures



Note. The phased blue analytic workflow was adapted from the RADaR technique (Watkins, 2017).

Most of the analytic field notes during data cleaning were determined to be mechanisms rather than clearly defined strategies. When strategies were not explicitly stated, the researcher reviewed each interview to interpret and develop corresponding strategy themes based on participant context, referencing transcripts as needed. If a strategy was identified without a corresponding mechanism, the mechanism field was left blank.

This iterative process expanded the dataset shown in Figure 4.6 into the Aim 3 RADaR tracker, transforming analytic field notes into structured strategy and mechanism fields. The original notes were preserved in a separate worksheet to maintain an audit trail (Figure 4.8), ensuring clarity, consistency, and traceability of the data.

Figure 4.8 Example of RADaR Data Cleaning and Tracker Development in Excel

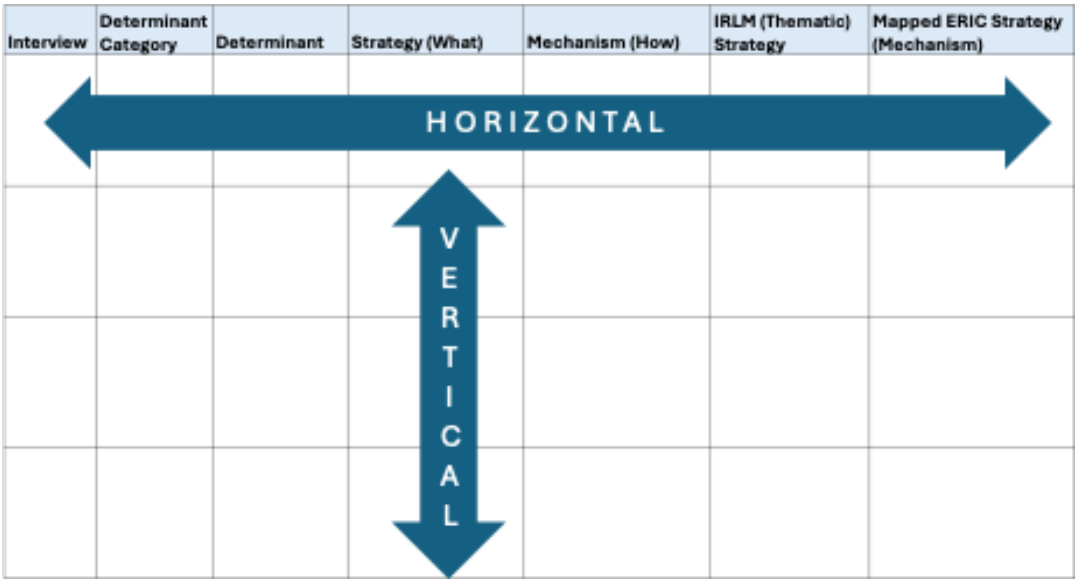
Original Data Source (Aim 2)			Data Collection, Cleaning, and Analysis Method	
Interview	Determinant Category	Determinant	RaDAR Strategy (What)	RaDAR Mechanism (How)
DF-28	Barrier	Low Executive/Leadership Engagement	Identify a champion to coordinate with the Executives	Work with different levels of C-suite such as a director to champion and partner with to work with the Executive Board and CEO who may have existing influence to partner with as an intermediary (eg, Director of Nursing)
PH-22	Enabler	Robust Communication & Information Sharing:	Test the equipment in the field during the exercise and discuss backup plans	Verify with County Emergency Management and partner organizations (eg, tower providers) that all necessary equipment is available and functional, and discuss backup plans to address potential failures during the exercise
JW-24	Enabler	Robust Communication & Information Sharing:	Leverage multiple communication channels during an exercise	Utilize [redacted] and email communications with links to training and reference documents to disseminate information efficiently and support real-time coordination during the exercise

Note. Excerpt of RADaR data cleaning and tracker development in Excel used to organize determinants, strategies, and mechanisms across interviews. Following the transfer of analytic field notes, content was separated into individual rows to ensure each row represented a single discrete idea for analysis and synthesis.

4.4.3 Data Analysis

Following Data Cleaning, within this study's five-step qualitative methodological approach (Figure 4.1), Data Analysis represents Step 4. This step aligns with the RADaR technique transitioning from refining data tables (Step 4) to developing final project deliverables using the completed dataset (Step 5) (Watkins, 2017). Data analysis proceeded through parallel inductive and deductive pathways. Inductive analysis involved thematic synthesis of strategies, while deductive analysis mapped findings to ERIC implementation strategies and cluster groups. Inductive analysis was conducted vertically across determinant categories, and deductive analysis was conducted horizontally, reviewing each row individually. An overview of this analytic approach is provided in Figure 4.9 below.

Figure 4.9 Horizontal and Vertical Analysis Overview



Note: This analysis method and graphical was adapted from "Rapid and Rigorous Qualitative Data Analysis: The "RADaR" Technique for Applied Research" (Watkins, 2017)

Thematic strategies were developed through an inductive analysis process that involved iteratively grouping and refining similar strategies across participants using vertical analysis as depicted in Figure 4.9. Individual strategy statements were reviewed and assigned one-word labels to capture their core idea. These labels were then compared within each determinant category across participants to identify patterns and similarities. Strategies with similar labels were grouped together and, through repeated review and refinement, were consolidated into broader, macro-level thematic strategies that represented shared approaches across interviews while maintaining alignment with participant context.

In parallel, deductive analysis was conducted using horizontal analysis looking across each row mapping each RADaR-developed strategy–mechanism pair to one of the 73 Expert Recommendations for Implementing Change (ERIC) strategy that best reflected participant intent and context (Powell et al., 2015). Strategies were then grouped using existing categorization frameworks, organizing multiple strategies into ERIC Strategy Clusters and ERIC Strategy Categories to support practical summarization (Hero et al., 2023, Waltz et al., 2015). The two framework groupings are summarized in Table 4.3.

The Excel VLOOKUP function was used to map ERIC groupings, supported by a separate sheet listing all ERIC strategies and their corresponding ERIC Strategy Clusters and ERIC Strategy Categories. The comparison between these grouping approaches is beyond the scope of this study. Results from both analytic pathways were integrated into the Aim 3 RADaR tracker to produce a comprehensive qualitative and quantitative synthesis of implementation strategies and mechanisms.

Table 4.3 ERIC Strategy Groupings Used for Summarization

Framework	Grouping Method	ERIC Strategy Groupings / Clusters
ERIC Strategy Clusters ***Waltz et al. (2015)***	Multi-step participatory research used to organize 73 ERIC strategies into conceptual clusters	1. Engaging consumers 2. Using evaluative and iterative strategies 3. Changing infrastructure 4. Adapting to context 5. Developing participant relationships 6. Utilizing financial strategies 7. Supporting clinicians 8. Providing interactive assistance 9. Training and educating participants
ERIC Strategy Categories *Hero et al. (2023)*	Systematic literature review conducted for PCORI to categorize ERIC strategies into implementation-focused groupings	1. Utilizing financial strategies 2. Tailoring, iterating, and adapting to context 3. Preparing sites for implementation 4. Providing interactive assistance and site support 5. Engaging external partners and resources 6. Training site staff and clinicians 7. Mobilizing site staff for implementation 8. Supporting clinician practice change 9. Engaging patients and families

Note. ERIC strategies were grouped using "Use of concept mapping to characterize relationships among implementation strategies and assess their feasibility and importance: results from the Expert Recommendations for Implementing Change (ERIC) study" (Waltz et al., 2015) and "Implementation Strategies for Evidence Based Practice in Health and Health Care: A Review of the Evidence"(Hero et al., 2023). Strategies that could not be aligned with the Hero et al. groupings were labeled as "Other."

4.4.4 Data Integration and Synthesis

Data integration and synthesis represent the final step in the study's five-step qualitative methodological approach (Figure 4.1), aligned with RADaR Step 5 to draft deliverables and results using the final phase of the data table (Watkins, 2017). This step focused on synthesizing mechanisms using the final RADaR analytic dataset. Pivot tables and cross-tabulations were developed to summarize data across determinants, thematic strategies, and ERIC strategy clusters, enabling structured comparison and identification of patterns.

Determinants included in the final synthesis were selected using a data-driven approach based on the integration of RADaR-derived thematic strategies and ERIC cluster groupings, with selection informed by frequency and convergence. Two cross-tabulated matrices were developed

for each determinant category (enablers and barriers). The first matrix mapped determinants (columns) to RADaR thematic strategies (rows), while the second mapped determinants (columns) to ERIC strategy clusters (rows). In both matrices, cell values represented the total number of RADaR strategy–mechanism pairs.

Comparison across these matrices enabled the identification and prioritization of determinants based on the frequency of alignment with specific RADaR thematic strategies and ERIC strategy clusters. Following prioritization, mechanisms were filtered using the corresponding determinant, RADaR thematic strategy, and ERIC strategy cluster identified through cross-tabulation analyses. This filtering approach ensured that only mechanisms aligned with the strongest determinant–thematic strategy–ERIC strategy cluster relationships were included in the synthesis.

The filtered mechanisms were then synthesized using a RADaR approach to identify thematic patterns. Mechanisms were consolidated based on similarity within each prioritized determinant. This approach provided a structured method for organizing mechanisms in alignment with determinant categories and supporting subsequent analysis.

4.5 Results

This section summarizes the results and findings from the modified think-aloud follow-up interviews conducted with participants from Aim 2, which focused on understanding barriers and facilitators to MRSE implementation. Aim 2 included interviews with 10 participants and resulted in the identification of 22 thematic determinants. Of those 10 participants, nine participated in the follow-up Aim 3 interviews, which ranged from approximately 30 to 60 minutes and totaled about 400 minutes (over 6.5 hours) of data. These results summarize strategies and mechanisms for key determinants related to MRSE implementation.

In accordance with the five-step methodological framework, the results are presented in alignment with each step: (1) Data Collection, (2) Data Transfer and Preparation, (3) Data Cleaning (RADaR Segmentation), (4) Inductive (thematic) and Deductive (ERIC) Analysis, and (5) Data Integration and Synthesis (Figure 4.1).

The first portion of interviews focused on member checking of thematic determinants identified in Aim 2. Participants generally affirmed the accuracy and relevance of the list of 10 enablers (Figure 4.2) and 12 barriers (Figure 4.4), with minimal changes limited to individual ranking preferences. No substantial disagreements or corrections were identified. Of the list of 22 determinants validated in the first portion of the interview, seven were included in the think-aloud activity.

Participants engaged in a modified think-aloud activity using an abbreviated IRLM to identify strategies and mechanisms for seven selected determinants. These included three enablers— (1) Strong Collaboration and Coalition Engagement, (2) Realistic, Clear, Manageable Exercise Design, and (3) Robust Communication and Information Sharing and four barriers— (1) Staffing Shortages and High Turnover, (2) Competing Priorities and Time Constraints, (3) Administrative Burden and Complex Tools, and (4) Low Executive/Leadership Engagement. These discussions generated a comprehensive set of analytic field notes, forming the foundation for subsequent analysis. The initial transfer of analytic field notes from PowerPoint into Excel resulted in 238 rows of data.

Table 4.4 Count of Strategies and Mechanisms by Thematic Determinant

Thematic Determinants	Count of Analytic Field Note Bullets
Barrier	**125**
Administrative Burden & Complex Tools	30
Competing Priorities & Time Constraints	31
Low Executive/Leadership Engagement	34
Staffing Shortages & High Turnover	30
Enabler	**113**
Realistic, Clear, Manageable Exercise Design	33
Robust Communication & Information Sharing	38
Strong Collaboration & Coalition Engagement	42
Total	**238**

Note. These results reflect preliminary data prior to data cleaning and the consolidation of analytic field notes from PowerPoint-based think-aloud bullet points across all interviews.

Following RADaR data cleaning and segmentation, the dataset expanded into 266 strategy–mechanism pairings. This process resulted in 266 strategy–mechanism pairings. Most participant responses focused on mechanisms rather than explicitly named strategies; therefore, many strategies were inferred based on the intent of each mechanism and summarized accordingly. To ensure maximal completeness each mechanism was then assigned a corresponding strategy using the raw analytic field notes, resulting in 163 unique strategies. Of these, five strategies were identified without an associated mechanism, resulting in a total of 262 mechanisms.

The most common strategy–mechanism pairings were related to strong collaboration and coalition engagement (18%), building trust, communication, and information sharing (17%), and effective leadership engagement (17%). Additional findings identified barriers associated with competing priorities and time constraints (16%), administrative burden and complex tools (16%), and equity and language barriers (12%). Collectively, the findings demonstrate that both relationship-driven enablers and operational barriers influenced MRSE implementation.

Table 4.5 Selected Strategies and Mechanisms Identified Through Aim 3 RADaR Analysis

Thematic Determinant	Analytic Field Notes	RADaR Strategy	RADaR Mechanism
Low Executive/ Leadership Engagement (Barrier)	Work with different levels of C-suite / director champion to partner to work with the Board and CEO who may have existing influence to partner with as an intermediary (e.g., Director of Nursing)	Identify a champion to coordinate with executives	Partner with influential leaders (e.g., Director of Nursing) who can serve as intermediaries to engage the C-suite in MRSE planning and participation
Staffing Shortages & High Turnover (Barrier)	Internal method to periodically check for new people (multiple redundances for contacts at organizations... 1, 2, 3) sharing if turnover comes how people will be notified of turnover at an organization communication within the MOU... building a Microsoft Turnover Form	Maintain updated contact information and continuity plans	Assign multiple points of contact per organization and use systematic tools to track turnover and ensure role continuity
Competing Priorities & Time Constraints (Barrier)	Split up the MRSE amongst multiple days to get more buy-in and accommodate for schedules across hospitals considering other exercises and prep	Increase flexibility in exercise scheduling and design	Split the MRSE across multiple days or offer virtual options to better align with partner schedules and operational demands
Administrative Burden & Complex Tools (Barrier)	Use technology as a benefit, e.g., MS Form and plug-in into the appropriate spots on the larger worksheet… simplify the data collection	Leverage existing tools and simplify reporting requirements	Use familiar platforms and streamlined data collection processes to reduce reporting burden while still meeting MRSE requirements
Robust Communication & Information Sharing (Enabler)	Test different types of patients during the MRSE that require different resources from different partners. Meet via Zoom to review and discuss resources Using Real-time Webinars to show different communication channels (E.g. [redacted statewide communication tool], testing alerts to have people update the system live (E.g., tabletop activity, testing coordination between the partners)	Test multiple communication channels during the MRSE	Use tools such as [redacted statewide communication tool], email, and webinars to practice redundant communication methods and improve real-time coordination

Thematic Determinant	Analytic Field Notes	RADaR Strategy	RADaR Mechanism
Realistic, Clear, Manageable Exercise Design (Enabler)	State HHS expects EM to use HSEEP, AARs– playbooks, templates, master scenarios, evaluation guides tend to be more standardized with the information included	Reference existing resources to inform exercise design	Apply standardized materials (e.g., HSEEP templates and prior AARs) to create scenarios that are clear, realistic, and aligned with local capabilities
Strong Collaboration & Coalition Engagement (Enabler)	Collaboration outside of the exercise environment; regular meetings, trainings, education sessions, going to conferences together... collaborating outside of the exercise lends well to collaborate for the exercise	Foster authentic relationships across HCC partners	Engage partners through regular meetings, shared planning activities, and collaborative exercises to strengthen trust and participation

Note. Cleaning and reduction of raw analytic field notes using the RADaR technique may have resulted in multiple discrete rows derived from a single set of notes; therefore, the example shown may not represent all rows generated from the original raw data.

Following data segmentation using the RADaR, thematic strategies were developed through inductive analysis. From 163 unique strategies, 15 macro-level thematic strategies were identified through inductive analysis. The list of determinants is including in Table 4.6. These thematic strategies reflect shared approaches across participants and emphasize practical, relationship-driven, and efficiency-focused solutions to implementation challenges.

Table 4.6 RADaR Thematic Strategies and Grouped Strategy Counts

RADaR Thematic Strategies	Determinant Category	Associated Strategies (n)
Build a strong coalition of partners and regularly coordinate and collaborate to strengthen engagement and participation in the exercise	Enabler	41
Design a flexible, realistic, and relevant MRSE scenario that can be tailored to align and test local operational needs and capabilities, while meeting regulatory standards and licensing requirements	Enabler	33
Enhance communication, education, and accessibility to ensure all partners and executives are informed, engaged, and equipped for effective participation	Barrier	24
Design a streamlined, efficient, and flexible MRSE scenario that aligns with defined objectives while remaining adaptable to partner needs, schedules, and real-world events	Barrier	23
Conduct targeted training and drills, and share relevant resources before and during the exercise to strengthen participant capabilities and skills	Enabler	22

RADaR Thematic Strategies	Determinant Category	Associated Strategies (n)
Spend time adequately planning the exercise thoroughly by incorporating diverse input and clearly outlining roles, expectations, and objectives	Enabler	22
Streamline and simplify MRSE reporting to reduce administrative burden, focus on essential information, and ensure actionable insights for partners	Barrier	22
Increase partner and executive buy-in by demonstrating the value of the MRSE and fostering a culture of preparedness across organizations	Barrier	19
Build Trust, Relationships, and support to Strengthen Collaboration, Engagement, and Retention	Barrier	13
Clearly communicate exercise expectations, objectives, and logistics in advance to ensure all partners are informed, prepared, and engaged	Enabler	13
Leverage regulatory, accreditation, and other disaster training requirements	Barrier	9
Maintain accurate and up-to-date contact lists by regularly tracking staff changes, assigning multiple points of contact, and using systematic tools to ensure continuity despite turnover	Barrier	8
Mobilize champions to engage executives, strengthen leadership commitment, and elevate healthcare preparedness as a strategic priority	Barrier	8
Clarify and assign roles and responsibilities to ensure the right participants are engaged, and decisions are made at the appropriate level	Barrier	6
Advocate for policy, funding, and legal frameworks that strengthen cross-jurisdictional healthcare collaboration and coordination	Barrier	3
Total		**266**

Note. RADaR thematic strategies derived from cleaned analytic field notes and grouped by associated determinant category. Frequencies reflect the number of identified strategy statements linked to each thematic strategy across Aim 3 interviews.

To further contextualize findings within implementation science, each strategy–mechanism pair was mapped to a single ERIC implementation strategy. Of the 73 ERIC strategies, 38 strategies were mapped to at least one of the 266 RADaR strategy-mechanism pairs. ERIC strategies that were mapped to more than 10 of the RADaR strategy-mechanism pairs are presented in Table 4.7.

Table 4.7 ERIC Implementation Strategies Frequently Mapped to MRSE RADaR Strategy–Mechanism Pairs

ERIC Strategy	Count of Mapped Pairings
Develop and implement tools for quality monitoring	24
Promote network weaving	20
Develop a formal implementation blueprint	18
Involve executive boards	17
Change accreditation or membership requirements	16
Change record systems	15
Promote adaptability	12
Organize clinician implementation team meetings	11
Tailor strategies	11
Conduct educational meetings	10

Note. ERIC implementation strategies mapped to more than 10 MRSE RADaR strategy–mechanism pairs (n = 266). Counts reflect the frequency of pairings aligned with each ERIC strategy. Waltz et al. (2015). ERIC strategy clusters were used as the grouping framework due to their comprehensive categorization of implementation strategies.

To support interpretation, strategies were grouped using established ERIC classification frameworks. Although the ERIC Strategy Categories developed for a 2023 Patient-Centered Outcomes Research Institute (PCORI) report are more recent, this classification omitted 27 of the 73 ERIC strategies limiting its utility for comprehensive categorization. Therefore, the Waltz and colleagues (2015) ERIC Strategy Clusters were selected for primary use, because it provides groupings for all 73 strategies. The results of mapping ERIC strategies to the eight ERIC Strategy Clusters are presented in Table 4.8. The most frequently represented cluster was "Develop participant interrelationships," accounting for 74 of 266 pairs (28%), whereas "Utilize financial strategies" was the least represented, with 3 of 266 pairs. These results demonstrate strong alignment between participant-identified RADaR strategies and established implementation science frameworks.

Table 4.8 Distribution of ERIC Strategy Clusters Across MRSE Strategy–Mechanism Pairs

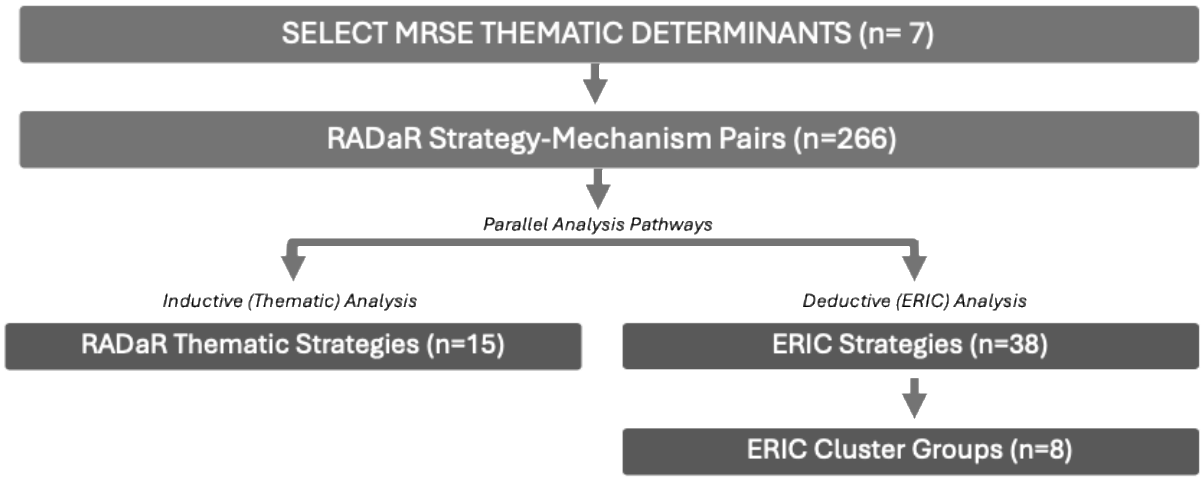
ERIC Strategy Cluster	Mapped Pairs	
	(n)	%
Develop participant interrelationships	74	28%
Use evaluative and iterative strategies	66	25%
Train and educate participants	47	18%
Change infrastructure	33	12%
Adapt and tailor to context	23	9%
Provide interactive assistance	15	6%
Support clinicians	5	2%
Utilize financial strategies	3	1%
Total	**266**	**100%**

Note. Distribution of MRSE RADaR strategy–mechanism pairs across ERIC strategy clusters. Counts and percentages reflect the frequency of mapped pairings within each ERIC cluster category (n = 266). ERIC strategy clusters were based on Waltz et al. (2015).

To summarize the parallel analysis graphically, Figure 4.10 was developed to show how seven determinants were translated into 266 RADaR strategy–mechanism pairs, which were then analyzed through two concurrent pathways. Inductive analysis produced 15 RADaR thematic strategies using vertical comparison across determinants, while deductive analysis mapped each strategy–mechanism pair to 38 ERIC implementation strategies and grouped them into eight ERIC Strategy Clusters using horizontal analysis. This figure illustrates the parallel analytic pathways used in this study and how results from both approaches were integrated to produce a comprehensive synthesis of implementation strategies and mechanisms across enablers and barriers.

To support the synthesis of strategies and mechanisms, determinants included in the final synthesis were selected using a data-driven approach based on frequency and convergence across both RADaR thematic strategies and ERIC cluster mappings. Cross-tabulation analysis was conducted to examine relationships between determinants, thematic strategies, and ERIC groupings.

Figure 4.10 Graphic Representation of Parallel Thematic and ERIC Mapping Analysis



Note. Visual representation of the parallel analytic workflow used in Aim 3, illustrating the integration of inductive thematic analysis with deductive ERIC strategy mapping during RADaR data reduction and synthesis.

The matrices for enablers and barriers are presented separately. The first matrix maps determinants (columns) to RADaR thematic strategies (rows), showing the total number of strategy–mechanism pairs mapped from each of the thematic determinant to the corresponding thematic strategy— Table 4.9 for enablers and Table 4.11 for barriers. The second matrix maps determinants (columns) to ERIC strategy clusters (rows), showing the total number of strategy–mechanism pairs mapped from each determinant to the corresponding ERIC Strategy Cluster— Table 4.10 for enablers and Table 4.12 for barriers. This column-based mapping highlights which thematic strategies and ERIC clusters are most strongly associated with each determinant, based on the frequency of strategy–mechanism pairings.

Table 4.9 Enabler Determinants Mapped to RADaR Thematic Strategies by Strategy-Mechanism Pairs

Enabler RADaR Thematic Strategy	Realistic, Clear, Manageable Exercise Design	Robust Communication & Information Sharing:	Strong Collaboration & Coalition Engagement	Total
Build a strong coalition of partners and regularly coordinate and collaborate	3	5	33	41
Clearly communicate exercise expectations, objectives, and logistics in advance engaged	3	10	-	13
Conduct targeted training and drills, and share relevant resources	-	17	5	22
Design a flexible, realistic, and relevant MRSE scenario that can be tailored	23	5	5	33
Spend time adequately planning the exercise thoroughly	16	4	2	22
Enabler Strategy-Mechanism Pairs	**45**	**41**	**45**	**131**

Note. This table presents a cross-tabulation of enabler determinants (columns) and shortened RADaR-derived thematic strategies (rows). Cell values represent the total number of strategy–mechanism pairings identified between each determinant and thematic strategy. Row totals indicate the frequency of each thematic strategy across determinants, while column totals reflect the distribution of strategy–mechanism pairings within each determinant (N = 131). Darker shading indicates higher frequencies of strategy–mechanism pairings within each column.

Based on Table 4.9, strategy–mechanism pairings were concentrated within a subset of thematic strategies across enabler determinants. Strong Collaboration and Coalition Engagement demonstrated the highest concentration, with 33 of 45 (73%) RADaR strategy–mechanism pairs mapping to the thematic determinant "Build a strong coalition of partners and regularly coordinate and collaborate." The enabler Realistic, Clear, and Manageable Exercise Design also showed relative alignment across two thematic strategies, with the RADaR strategy–mechanism pairs most frequently associated with the thematic determinants "Design a flexible, realistic, and relevant MRSE scenario that can be tailored" (n = 23 of 45, 51%) and "Spend time adequately planning the exercise thoroughly" (n = 16 of 45, 35%). Across all enabler determinants the thematic strategy "Build a strong coalition of partners and regularly coordinate and collaborate" had the highest number of strategy–mechanism pairs (n = 41).

Table 4.10 Enabler Determinants Mapping to ERIC Strategy Clusters by Strategy-Mechanism Pairs

Enabler RADaR ERIC Strategy Cluster	Realistic, Clear, Manageable Exercise Design	Robust Communication & Information Sharing:	Strong Collaboration & Coalition Engagement	Total
Adapt and tailor to context	11	4	1	16
Change infrastructure	2	2	5	9
Develop participant interrelationships	12	7	20	39
Provide interactive assistance	1	4	3	8
Support clinicians	1	3		4
Train and educate participants	6	10	9	25
Use evaluative and iterative strategies	12	11	6	29
Utilize financial strategies			1	1
Enabler Strategy-Mechanism Pairs	**45**	**41**	**45**	**131**

Note. This table presents a cross-tabulation of enabler determinants (columns) and ERIC strategy clusters (rows). Cell values represent the total number of strategy–mechanism pairings mapped between each determinant and ERIC cluster. Row totals summarize the frequency of each ERIC strategy cluster, and column totals indicate the distribution of strategy–mechanism pairings across determinants (N = 131). Darker shading indicates higher frequencies of strategy–mechanism pairings within each column.

Assessment of enabler strategy–mechanism pairings across ERIC strategy clusters, Table 4.10, shows greater distribution across clusters for the determinants Realistic, Clear, and Manageable Exercise Design and Robust Communication and Information Sharing. Whereas Strong Collaboration and Coalition Engagement demonstrates a higher concentration of pairings within the ERIC cluster "Develop participant interrelationships," with 20 of 45 (44%) strategy–mechanism pairs mapping to this cluster. Across all enabler determinants, the ERIC strategy cluster "Develop participant interrelationships" had the highest number of strategy–mechanism pairs (n = 39), followed by "Use evaluative and iterative strategies" (n = 29) and "Train and educate participants" (n = 25).

Table 4.11 Barrier Determinants Mapped to RADaR Thematic Strategies by Strategy-Mechanism Pairs

Barrier RADaR Thematic Strategy	Administrative Burden & Complex Tools	Competing Priorities & Time Constraints	Low Executive/ Leadership Engagement	Staffing Shortages & High Turnover	Total
Advocate for policy, funding, and legal frameworks	-	-	1	2	3
Build trust, relationships, and support	1	-	4	8	13
Clarify and assign roles and responsibilities	-	-	3	3	6
Design a streamlined, efficient, and flexible MRSE scenario	-	17	4	2	23
Enhance communication, education, and accessibility	9	4	6	5	24
Increase partner and executive buy-in	1	6	6	6	19
Leverage regulatory, accreditation, and other disaster training requirements	-	4	4	1	9
Maintain accurate and up-to-date contact lists	-	-	-	8	8
Mobilize champions	-	-	6	2	8
Streamline and simplify MRSE reporting	21	1	-	-	22
Barrier Strategy-Mechanism Pairs	**32**	**32**	**34**	**37**	**135**

Note. This table presents a cross-tabulation of barrier determinants (columns) and RADaR-derived thematic strategies (rows, shortened). Cell values represent the total number of strategy–mechanism pairings identified between each determinant and thematic strategy. Row totals indicate the frequency of each thematic strategy across determinants, while column totals reflect the distribution of strategy–mechanism pairings within each determinant (N = 135). Color intensity reflects the frequency of pairings within each column, with darker shading indicating higher values.

Based on Table 4.11, strategy–mechanism pairings for barriers demonstrated greater variation across determinants. Competing Priorities and Time Constraints and Administrative Burden and Complex Tools determinants showed the strongest associations with one distinct thematic strategy. Specifically, *Administrative Burden and Complex Tools* was most strongly associated with the thematic strategy "Streamlining and simplifying MRSE reporting" (n = 21 of 32, 66%), while *Competing Priorities and Time Constraints* aligned most closely with "Designing streamlined and flexible MRSE scenarios" (n = 17 of 32, 53%). Across all barriers the thematic strategy "Enhance communication, education, and accessibility" had the highest number of strategy–mechanism pairs overall (n = 24) and was distributed relatively evenly.

Table 4.12 Enabler Determinants Mapping to ERIC Strategy Clusters by Strategy-Mechanism Pairs

Barrier RADaR ERIC Strategy Cluster	Administrative Burden & Complex Tools	Competing Priorities & Time Constraints	Low Executive/ Leadership Engagement	Staffing Shortages & High Turnover	Total
Adapt and tailor to context	-	4	-	3	7
Change infrastructure	1	6	6	11	24
Develop participant interrelationships	2	5	19	9	35
Provide interactive assistance	2	-	1	4	7
Support clinicians	1	-	-	-	1
Train and educate participants	4	4	6	8	22
Use evaluative and iterative strategies	22	13	1	1	37
Utilize financial strategies	-	-	1	1	2
Total Barriers Mapped	**32**	**32**	**34**	**37**	**135**

Note. This table presents a cross-tabulation of barrier determinants (columns) and ERIC strategy clusters (rows). Cell values represent the total number of strategy–mechanism pairings identified between each determinant and ERIC strategy cluster. Row totals summarize the frequency of each ERIC cluster across determinants, while column totals reflect the distribution of strategy–mechanism pairings within each determinant (N = 135). Color intensity reflects the frequency of pairings within each column, with darker shading indicating higher values.

In contrast to the RADaR thematic strategy cross-tabulation, there was less variation across ERIC strategy clusters, with three of the four determinants showing a relatively strong association with a single dominant ERIC cluster. Administrative Burden and Complex Tools (n = 22 of 32, 69%) and Competing Priorities and Time Constraints (n = 13 of 32, 41%) were most strongly associated with "Use evaluative and iterative strategies." Low Executive/Leadership Engagement was most strongly mapped to "Develop participant interrelationships" (n = 19 of 34, 56%). Across all barrier determinants the ERIC Strategy Clusters with the greatest number of pairings were "Use evaluative and iterative strategies" (n = 37) and "Develop participant interrelationships" (n = 35).

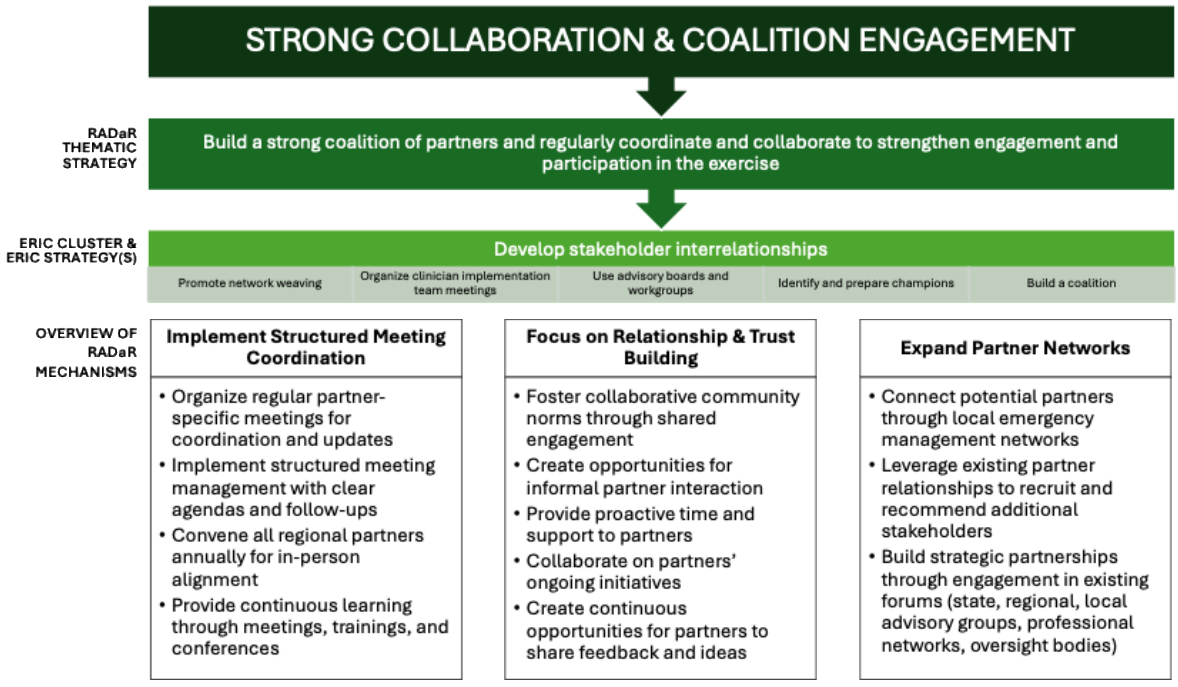
Based on these cross-tabulation matrices, three determinants (one enabler and two barriers) were identified as the most influential and consistently supported for final synthesis of thematic mechanisms. The enabler determinant was *Strong Collaboration and Coalition Engagement;* the two barrier determinants were *Administrative Burden and Complex Tools* and

Competing Priorities and Time Constraints across the seven analyses conducted during follow-up interviews.

Final Mechanism Synthesis Results

For the prioritized enabler *Strong Collaboration and Coalition Engagement,* the strongest alignment was with RADaR thematic strategy "Build a strong coalition of partners and regularly coordinate and collaborate" and the ERIC strategy cluster "Develop participant interrelationships." Seventeen mechanisms were identified and synthesized into three higher-order categories including: (1) Structured Meeting Coordination (n = 4), (2) Relationship Building and Trust Development (n = 5), and (3) Network Expansion and Partner Engagement (n = 8). A summary diagram of this synthesis is provided in Figure 4.11.

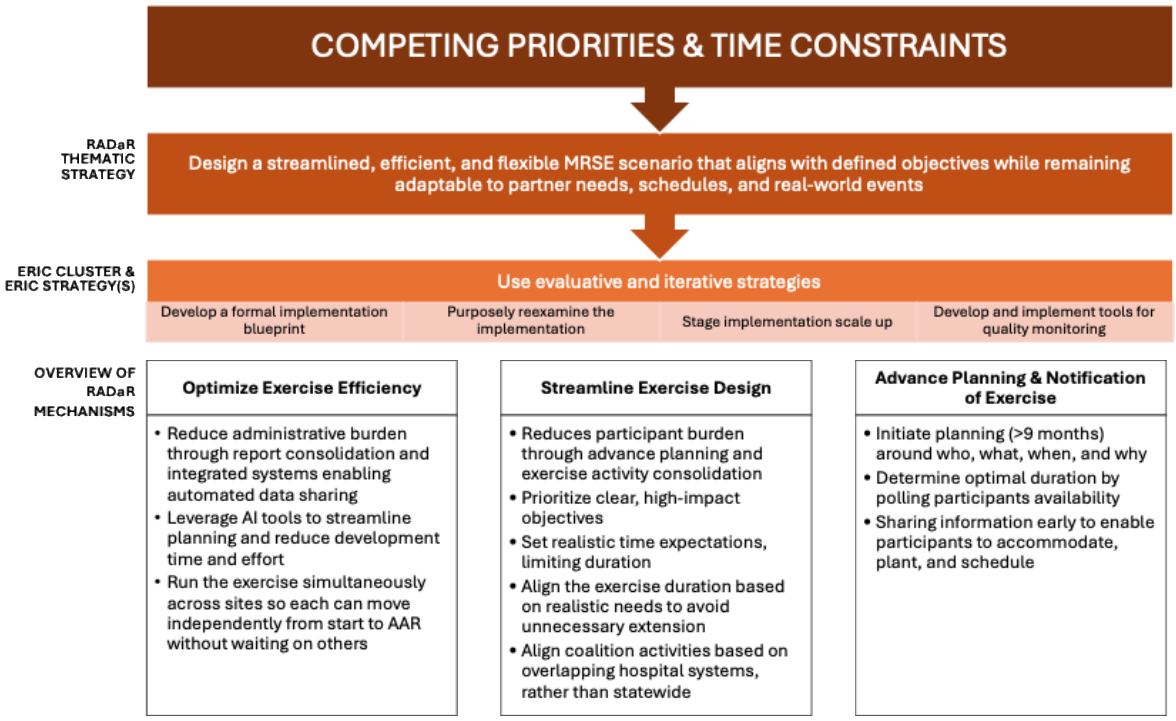
Figure 4.11 MRSE Mechanism Synthesis for Determinant Enabler Strong Collaboration and Coalition Engagement



Note. This figure illustrates the synthesis of mechanisms for the prioritized determinant, derived from cross-tabulation analyses identifying the strongest alignment between RADaR thematic strategies and ERIC strategy clusters, which were used to filter and group mechanisms into higher-order categories.

For the prioritized barrier *Competing Priorities and Time Constraints,* the strongest alignment was with the RADaR thematic strategy "Design a streamlined, efficient, and flexible MRSE scenario" and the ERIC strategy cluster "Use evaluative and iterative strategies." Eleven mechanisms were identified and grouped into three categories: (1) Optimize Exercise Efficiency (n = 3), (2) Streamline Exercise Design (n = 5), and (3) Advance Planning and Notification of Exercise (n = 3). A summary diagram of this synthesis is provided in Figure 4.12.

Figure 4.12 MRSE Mechanism Synthesis for Determinant Barrier Competing Priorities & Time Constraints

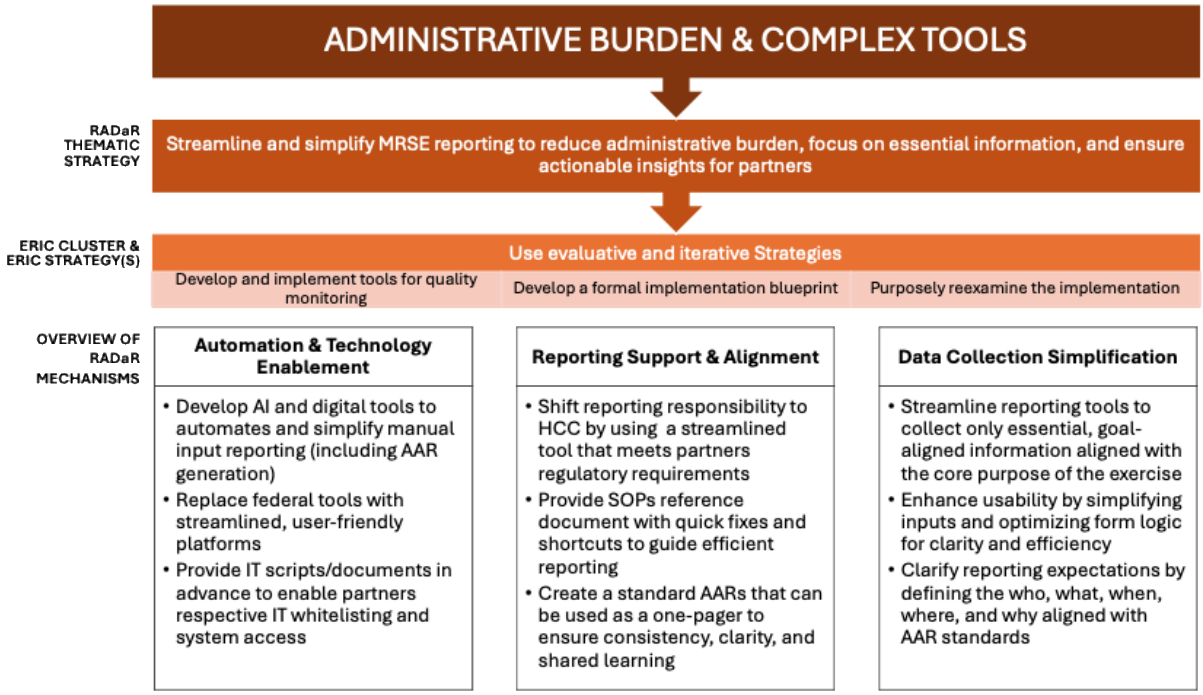


Note. This figure illustrates the synthesis of mechanisms for the prioritized determinant, derived from cross-tabulation analyses identifying the strongest alignment between RADaR thematic strategies and ERIC strategy clusters, which were used to filter and group mechanisms into higher-order categories.

For the prioritized barrier *Administrative Burden & Complex Tools,* the strongest alignment was with the RADaR thematic strategy "Streamline and simplify MRSE reporting" and the ERIC strategy cluster "Use evaluative and iterative strategies." Nineteen mechanisms were identified and grouped into three categories: (1) Automation & Technology Enablement (n

= 7), (2) Reporitng Support & Alignment (n = 6), and (3) Data collection Simplification (n = 6). A summary diagram of this synthesis is provided in Figure 4.13.

Figure 4.13 MRSE Mechanism Synthesis for Determinant Barrier Administrative Burden & Complex Tools



Note. This figure illustrates the synthesis of mechanisms for the prioritized determinant, derived from cross-tabulation analyses identifying the strongest alignment between RADaR thematic strategies and ERIC strategy clusters, which were used to filter and group mechanisms into higher-order categories.

4.6 Discussion

This study focused on identifying strategies and mechanisms for select determinants to support MRSE implementation, demonstrating the value of integrating implementation science frameworks into disaster preparedness research. In an effort to move beyond traditional evaluation and improvement approaches used in preparedness exercises (e.g., HSEEP AARs), it advances toward actionable improvement implementation planning vis-à-vis a participant-informed approach. Additionally, this research demonstrates the feasibility of applying implementation science tools in non-clinical, complex settings such as disaster preparedness.

Aim 2 results identified 22 thematic determinants (10 enablers and 12 barriers) that either facilitated or posed challenges to MRSE implementation. Based on initial rapid coding frequency counts, the number of times participants mentioned each determinant, were used as a pseudo-impact indicator. From this, seven determinants were selected for further analysis in this study to explore potential strategies and mechanisms with participants through follow-up interviews that could be implemented to improve MRSE implementation. Across these seven determinants, through modified think-aloud interview analytic field notes, 266 strategy–mechanism pairs were identified using the RADaR data cleaning and analysis approach. Of the 266 pairs, the strategies were analyzed and synthesized inductively through thematic analysis into 15 thematic strategies and deductively through mapping to 38 of the 73 ERIC implementation strategies and eight ERIC cluster groupings. From the pairs, 261 unique mechanisms were identified.

This integrated analytic approach enabled both the identification of context-specific strategies and alignment with established implementation science frameworks. The convergence of inductive (thematic) and deductive (ERIC) analyses supported the organization of complex qualitative data into structured, actionable strategy–mechanism groupings. Results from both analytic pathways were integrated into the Aim 3 RADaR dataset.

Across the 15 thematic strategies, there was a clear emphasis on strengthening collaboration and trust within the coalition and across partner groups prior to the exercise; enhancing communication, training, and engagement; and designing exercises that are realistic, flexible, and aligned with real-world operational constraints. Additional strategies focused on improving the planning process; ensuring role clarity; increasing leadership buy-in; leveraging existing systems and requirements; and reducing administrative burden to support effective MRSE implementation. Across the mapped ERIC strategies, most strategies were grouped into a

few key areas including: **"**Use evaluative and iterative strategies," "Develop participant interrelationships," and "Train and educate participants." Across both thematic and ERIC strategies, there was strong alignment in emphasizing collaboration, continuous improvement, and capacity building for successful MRSE implementation. Together, these findings suggest that effective implementation is driven by strengthening partnerships, supporting ongoing learning, and designing approaches that align with real-world constraints while reducing burden for participants, highlighting the importance of building both capacity and capability.

Mechanisms explain how strategies operate in practice across different situations and contexts. Of the 261 RADaR mechanisms for the MRSE, identified from the analytic field notes, these actions suggest "how" the listed strategies can be translated into practice. Collectively the mechanisms focus on— standardizing tools and reporting (e.g., HSEEP templates, simplified forms); leveraging technology (AI, Microsoft Forms, communication platforms) to automate data collection and coordination; maintaining up-to-date contact lists, training systems, and communication channels; structuring exercise planning (advance scheduling, defined roles, clear escalation pathways); hosting regular trainings and drills; and embedding exercises into existing workflows and regulatory requirements. Together, these mechanisms suggest that successful implementation of the MRSE can be achieved through practical approaches coordinated by the HCC MRSE Leaders that enhance coordination, reduce burden, and support consistent execution across partners.

The complete synthesis of RADaR strategy–mechanism pairs across the seven selected determinants highlights that successful MRSE implementation and improvement is not driven by individual strategies, but by coordinated groups of strategies put into action through context-specific mechanisms. Across determinants, the findings show that implementation is shaped by

approaches that address both structural (e.g., administrative burden, staffing constraints, competing priorities) and relational (e.g., executive engagement, partner coordination) determinants, while also emphasizing the importance of exercise design from planning through execution. Related to the structural determinants the implementation of the MRSE can be strengthened through mechanisms that streamline processes, leverage technology, and align exercises with real-world operations and regulatory requirements. Whereas the mechanisms related to the relational determinants suggests focusing on building partnerships, improving communication, and increasing participant buy-in. Together, these findings across structural, relational, and exercise design factors suggest that MRSE implementation requires balancing efficiency and feasibility with ongoing relationship-building and engagement across the HCC. These strategies and mechanisms ultimately strengthen the capacity and capability of the HCC to successfully implement the MRSE.

To support the practical use of the findings, a subset of determinants was selected for full synthesis and visual development based on convergence across the inductive and deductive analyses. These visuals connect each determinant to potential strategies and corresponding mechanisms, providing a clear summary that HCC leaders can use to inform next steps in developing implementation plans. The three prioritized determinants included: (1) Strong Collaboration and Coalition Engagement (Figure 4.11), (2) Administrative Burden and Complex Tools (Figure 4.12), and (3) Competing Priorities and Time Constraints (Figure 4.13) highlights where implementation improvement efforts may have the most impact. Strong Collaboration and Coalition Engagement functioned as a foundational enabler, with mechanisms centered on structured coordination, relationship development, and network expansion. This suggests that collaboration is not an end goal but an active ongoing process that requires intentional effort.

Administrative Burden and Complex Tools emerged as a critical barrier, with mechanisms emphasizing simplification, automation, and standardization. This barrier makes evaluation more difficult to obtain high-quality reports, which in turn may limit downstream improvement efforts from the exercise. Competing Priorities and Time Constraints highlighted the importance of designing exercises that align with real-world operational demands; the mechanisms focused on efficiency, flexibility, and advance planning. These findings provide a foundation for translating participant-informed insights into actionable implementation strategies. At a broader systems level, these findings suggest a need to align federal preparedness expectations with local implementation capacity, ensuring that requirements for exercises such as the MRSE are supported by practical, scalable implementation strategies. Although not the primary focus of this study, these findings also highlight potential equity implications, as organizations with fewer resources or less established infrastructure may face greater challenges in implementing preparedness activities, underscoring the need for scalable and adaptable strategies that account for variation in capacity across coalition members.

These findings directly address gaps identified in prior literature, which has consistently emphasized the identification of challenges in disaster preparedness exercises without providing structured approaches for implementation. Consistent with prior studies highlighting persistent issues in coordination, communication, and role clarity, this study not only confirms these challenges but extends the literature by explicitly linking these determinants to actionable implementation strategies and underlying mechanisms.

A key contribution of this study is the development and application of an integrated analytic approach that combines inductive thematic analysis with deductive mapping to ERIC strategies and uses cross-tabulation to identify convergence and prioritize determinants for

synthesis. The inductive analysis ensured that findings remained grounded in participant experience, while deductive mapping provided alignment with established frameworks, enhancing rigor and applicability. This methodological approach enabled the translation and synthesis of complex qualitative data into structured, implementation-relevant outputs while maintaining fidelity to participant intent.

Overall, this study provides a structured approach for moving upstream from determinants identified during exercise implementation, rather than focusing only on unmet outcomes. It also actively involved participants in generating practical solutions and identifying actionable implementation strategies and mechanisms. This, in turn, suggests an opportunity to reframe how AARs and Improvement Plans are conducted, developed, and used. Rather than serving solely as retrospective evaluation tools used as a checkbox activity and then stored on the shelf, AARs can be expanded to include the identification of determinants, selection of targeted strategies, and explicit specification of mechanisms to inform actionable Improvement Plans to improve the implementation future preparedness exercises. Implementation science theories, models, and frameworks provide various tools to guide and strengthen these processes rather than requiring teams to start from scratch. This was demonstrated in the prior study (Aim 2), which used the CFIR determinants framework to identify barriers and facilitators and in this study using the IRLM to guide the approach and ERIC to identify strategies. Incorporating these approaches can support consistent translation of lessons learned into sustained improvements and provide a structured pathway for implementation planning in future preparedness cycles.

The findings of this research also highlight the opportunity for academia to play a more active role in disaster preparedness activities across the preparedness continuum, particularly in applying research methods to support quality improvement and advance disaster management.

Ensuring that data generated from disaster preparedness activities is translated into actionable knowledge requires not only on practice evaluation, but intentional methodological investigation.

4.6.1 Limitations

Several limitations should be considered when interpreting these findings. The sample was limited to healthcare workers and disaster managers within a single ASPR HCC CA region, which may reduce generalizability. This study provides insight into MRSE implementation within a specific HPP CA state context, the applicability of these findings may vary across HCC regions with different structures, resources, and levels of maturity. However, while findings are context-specific, the structured methodological approach offers transferability across HCC settings and other preparedness systems.

Additionally, data focused on the 2024 MRSE cycle, while interviews were conducted after the 2025 MRSE, introducing potential recall bias. Participants were not formally trained on implementation science approaches or guided on distinguishing between strategies and mechanisms, which resulted in variability in responses.

For the analysis, thematic coding was conducted by a single researcher, limiting the ability to assess inter-rater reliability (O'Connor & Joffe, 2020). Although field notes were cross-referenced with transcripts to maintain fidelity, additional coders or follow-up validation could have strengthened reliability. Despite these limitations, the study maintains rigor through a systematic and transparent analytic approach, integrating established frameworks with iterative review to produce credible and actionable findings.

Additionally, although there was general alignment between the inductively derived thematic strategies and deductively mapped ERIC strategies, full convergence between these two analyses (15 thematic strategies, 8 ERIC Strategy Clusters) was not completed. This suggests

that while participant-informed approaches are broadly consistent with established implementation science frameworks, they also introduce important context-specific nuance that may not be fully captured by existing taxonomies such as ERIC. Furthermore, given that the 73 ERIC strategies were originally developed within clinical settings and aligned with CFIR 1.0, their direct application to disaster preparedness contexts may be limited without adaptation. Lastly, the ERIC frameworks used were developed based on CFIR 1.0 and for direct patient care innovations, whereas this study applied CFIR 2.0 in a disaster preparedness context, which may limit transferability.

4.6.2 Future Research

Future research should focus on the need to adapt ERIC strategies to disaster preparedness contexts, potentially developing disaster-specific implementation strategy taxonomies. Additional work is also needed to explore how this approach can be integrated into routine AAR processes and scaled across different preparedness systems, testing the identified mechanisms in real-world settings. Although out of scope for this study, there is a need for further examination of how system-level factors, such as coalition structure and resource capacity, influence implementation effectiveness to better support broader generalizability of findings and strengthen preparedness efforts overall.

While this study intentionally used a bottom-up approach to understand participant perspectives, future work could explore a more structured approach such as guiding participants to select from predefined ERIC strategies and describe how they would implement the strategy to generate context-specific mechanisms. This may streamline analysis and improve translation into practice while maintaining rigor and grounding in participant input, especially for practitioners without implementation science expertise or support teams. Together, this work positions

implementation science as a critical bridge between evaluation and action in disaster preparedness.

4.7 Conclusion

This study focused on identifying implementation strategies and mechanisms to address barriers and support enablers for the MRSE, an annual disaster preparedness exercise implemented locally by HCC in alignment with federal CA requirements under the HPP. Using modified think-aloud interviews, HCC leads and participants described strategies they have used or would apply in practice, which were then categorized using the ERIC taxonomy to support synthesis and understanding. By combining inductive (thematic) and deductive (ERIC mapping) analytic approaches, this study translated participant-informed insights into structured strategy–mechanism pairs. The synthesized findings highlight that successful implementation and improvement of the MRSE is not driven by individual strategies, but by coordinated groups of strategies operationalized through mechanisms that strengthen collaboration, reduce administrative burden, and align exercises with real-world operational contexts.

The final step of the HSEEP exercise process is Improvement Planning (IP), which involves finalizing the AAR and IP. This step is critical to document strengths, identify areas for improvement, and assign corrective actions. This study introduces a structured and replicable methodological approach that moves beyond traditional evaluation in disaster preparedness exercises. By systematically linking determinants, strategies, and mechanisms, this approach supports the translation of lessons learned from prior exercise implementation into actionable and sustained improvements. This reframes the traditional HSEEP AAR/IP into a tool for improvement and implementation planning, ultimately ensuring that exercise insights translate into tangible improvements.

Overall, this work contributes to disaster preparedness research by demonstrating how implementation science can be applied in real-world settings to support continuous learning, adaptation, and system-level resilience, providing a pathway for translating evaluation into action and strengthening the capacity and capability of HCC and other disaster practitioners over time. This approach provides a scalable and replicable model for bridging the gap between evaluation (knowledge) and implementation of actionable improvements (practice) in disaster preparedness, ultimately supporting continuous improvement sustained preparedness activities over time to strengthen resilience.

Chapter 5 Discussion, Implications, and Conclusion

5.1 Discussion

As defined in the Introduction chapter, disasters are the result of a hazard and the subsequent impact on human life. Hazards become disasters when the event exceeds the capacity and capability of the impacted communities' systems. The goal of disaster management is to mitigate, prepare for, respond to, and recover from hazard events in ways that minimize harm and reduce impact severity. A critical component of disaster management is to properly assess the hazard and determine how systems should respond. As the COVID-19 pandemic demonstrated— disasters often involve uncertainty, unknown variables, and rapidly changing conditions. While some disaster responses may function in predictable and structured ways, disaster situations can quickly evolve into complex or chaotic environments with much of the information needed to make informed judgments and decisions incomplete. The Cynefin Framework helps illustrate how disasters can shift from clear, complicated, complex, and chaotic environments, requiring different approaches to decision-making and coordination depending on the level of uncertainty and instability present (Gray, 2017).

This dissertation argues that disaster preparedness exercises should not only be viewed as compliance activities, but also as knowledge generation and knowledge management activities. Disaster preparedness activities provide opportunities to identify gaps in capacity and capability before disasters occur. Capacity refers to the resources, staffing, infrastructure, and systems available to respond. Capability refers to whether systems can effectively coordinate, communicate, adapt, and operationalize under stress. Training often focuses on procedural

knowledge, while exercises should test system capacity, coordination, adaptability, and operational capability under stress.

Using the MRSE as a case analysis, this dissertation sought to better understand how healthcare systems prepare for disasters. Knowledge generation refers to the creation of tacit and experiential knowledge through participating in and operationalizing preparedness activities; while knowledge management refers to how that knowledge is captured, organized, translated, shared, and used to inform future practice (Farnese et al., 2019). Conducting exercises prior to hazard events allows organizations, communities, and systems to generate knowledge, build relationships, and better understand how response systems function during uncertain conditions. To ensure this knowledge is retained and translated into practice over time, organizations must establish infrastructure such as knowledge management systems to support adaptation, information sharing, and decision-making. This ongoing cycle of knowledge, practice, and data reflects a continuous improvement process that can be understood through the Learning Health System (LHS) framework (Friedman, 2022a; Friedman et al., 2024; Friedman & Greene, 2025). Disaster management already functions as a recurring and often overlapping multi-phase cycle of mitigation, preparedness, response, and recovery. Applying LHS principles strengthens this continuum by emphasizing how data generated through activities such as disaster preparedness exercises can be translated into knowledge (D2K), operationalized into practice (K2P), and continuously refined through ongoing learning (P2D).

As demonstrated through the methodological framework, this dissertation shows how implementation science can be used to understand and improve upon the knowledge generated by interventions, such as disaster preparedness exercises. The experiential and tacit knowledge generated by disaster preparedness exercises can strengthen disaster resilience over time

(Kusumastuti et al., 2021). The experiential knowledge is gained through participating in exercises and operationalizing response activities, while tacit knowledge develops through repeated engagement with policies, procedures, communication structures, and organizational practices. Exercises are not intended to determine exactly what decisions will be made during a hazard event but, rather to help organizations go through the motions of response.

Grounded in the FEMA disaster management model of federally supported, state-managed, and locally executed preparedness, this study explored how a federally designed exercise was operationalized through state structures and experienced locally by disaster preparedness practitioners. Aim 1 examined the MRSE as an implementation object through document analysis and preparedness guidance review. Aim 2 examined barriers and facilitators influencing local implementation across HCCs. Aim 3 moved beyond identifying determinants by exploring what implementation strategies and mechanisms participants believed could strengthen preparedness exercise implementation and resilience over time. The primary ethos of this dissertation is strengthening disaster resilience through preparedness.

The field of disaster management has a plethora of guidance documents, frameworks, manuals, and recommendations explaining what should happen during disasters. Previous disaster preparedness literature has consistently identified recurring challenges related to communication, coordination, leadership engagement, surge management, and implementation follow-through (Aminafshar et al., 2026; McCormick et al., 2014; Obaid et al., 2017; Renger et al., 2021). The findings from this dissertation reinforced many of those same challenges while also demonstrating the importance of acknowledging the unique implementation context of HCCs as sociotechnical systems in which the MRSE intervention is implemented.

The findings from this dissertation also support the idea that disaster preparedness

exercises are knowledge-generating and knowledge-to-practice activities designed to help systems assess their capacity and capability to respond to hazards. This study generated learnings related to communication pathways, surge coordination, staffing, operational readiness, leadership engagement, and organizational relationships. However, as highlighted by several participants, these learnings only become meaningful when they are translated into practice. Exercises may identify lessons observed, but lessons are not truly learned until action is taken (Parker, 2020). Typically, AARs are used to evaluate performance and improve future exercises or responses by highlighting successes, identifying gaps, and recommending actionable improvements. However, they tend to provide less structure for understanding implementation determinants and selecting context-specific strategies and mechanisms needed to achieve desired outcomes.

This methodological approach should not be limited to improving disaster preparedness exercises. These methods may also be applied in real-time disaster response settings to rapidly identify determinants and develop implementation strategies and mechanisms that support effective action under dynamic conditions. Although the foundation of this research focused on a specific disaster preparedness use case within healthcare, primarily related to medical surge events often associated with PHEs, the concepts, methods, and frameworks developed in this dissertation have the potential to be applied across other hazard types and phases of the disaster management cycle. In doing so, implementation science may provide a systematic approach for understanding, improving, and accelerating the translation of lessons learned into practice across a variety of disaster contexts.

The LHS model and implementation science frameworks used in this study provide a systematic approach and shared language to help translate lessons learned into practice. This

dissertation argues that implementation science can help disaster management better understand why preparedness efforts succeed or fail and how lessons from exercises can support sustained system improvement. When shared infrastructure such as common language and tools are established, accessible, and accepted, the conceptual LHS cycle can become a practical model (Friedman & Greene, 2025; Lannon et al., 2021). This practical model can be used to strengthen disaster resilience over time at the individual, organizational, and systems levels.

5.1.1 Integration Across the Three Aims

Existing literature consistently demonstrates that disaster preparedness exercises are widely accepted as essential preparedness activities, yet many evaluation processes remain focused on documenting completion rather than understanding implementation processes and sustained improvement. This dissertation examined how implementation science frameworks can be used to better understand and strengthen disaster preparedness exercises, using the federally mandated MRSE as a case analysis. Across three studies, the findings demonstrated that local organizational context, leadership engagement, collaboration, communication, and operational capacity strongly shape preparedness implementation and outcomes.

Aim 1 established the conceptual and analytic foundation for this dissertation by examining federal support for the MRSE using implementation science frameworks. This aim used deductive qualitative document analysis of three federally developed MRSE guidance documents: the Situation Manual, Exercise Evaluation Plan, and Exercise Planning and Evaluation Tool. The primary objectives of the MRSE are centered on patient surge management, coordination, information sharing, resource management, and preparedness planning (ASPR, 2023). CFIR 2.0 was used to code the contents within the standardized documents across various domains while Proctor's Implementation Outcomes and RE-AIM

frameworks were used to categorize the intended exercise outcomes.

Using a framework-based deductive coding in MAXQDA, enabled the ability to identify which sociotechnical CFIR 2.0 factors were emphasized within the federal MRSE guidance. The findings demonstrated that the federal guidance documents primarily emphasized constructs within the Implementation Process and Innovation domains. The most frequently coded constructs within those domains focused on planning, engagement, execution, evaluation, and adaptability. Whereas there was significantly less emphasis on organizational context, external factors, or individual characteristics. Using Proctor's Implementation Outcomes and RE-AIM frameworks, most intended outcomes were categorized as Service Outcomes related to efficiency and safety, while the remaining outcomes focused on implementation adoption through HCC member and executive engagement in preparedness activities.

Overall, the findings suggest the MRSE is primarily designed to strengthen operational readiness and coalition coordination. A major contribution of Aim 1 is framing the MRSE as more than a federal requirement, rather positioning it and other disaster preparedness activities as an implementation intervention shaped by intended outcomes, contextual factors, and mechanisms of change. This framing is important because implementation cannot be fully evaluated without understanding what the intervention is intended to do, for whom, and under what conditions.

Aim 2 examined the perceptions of the MRSE based on the experience of local HCC leaders and members. Using a convergent parallel mixed-methods design, the study examined barriers and facilitators influencing MRSE implementation categorizing determinants based on CFIR 2.0. The survey questions incorporated concepts from pCAT, RE-AIM, iPRISM, Proctor's implementation outcomes, and the MRSE Situation Manual. The semi-structured interviews

provided deeper insight into how participants understood the objectives and purpose of the MRSE and the major challenges and facilitators impacting the implementation and execution at the local level. The use of multiple implementation science frameworks helped expand traditional approaches to disaster exercise evaluation.

The results from the Aim 2 survey demonstrated that participants generally valued the MRSE and viewed functional exercises as the most useful preparedness activity. However, participation in the MRSE did not necessarily mean participants had a shared understanding of the exercise objectives or intended outcomes. This finding is important because successful implementation depends not just on completing the exercise, but on participants active engagement— understanding its purpose, seeing value in participation, and connecting the exercise to real-world preparedness outcomes. The Aim 2 qualitative interviews centered on thematically identifying the barriers and facilitators influencing local implementation. Facilitators included coalition establishment, repeated exercise participation, strong partner relationships, adaptability, and shared learning. Barriers included competing priorities, staffing limitations, administrative burden, inconsistent engagement, funding constraints, EMS coordination challenges, and gaps in AAR follow-through. Collectively, these findings suggest that the MRSE functions less as a single intervention and more as a preparedness mechanism that depends heavily on local context and coalition infrastructure.

Aim 3 built upon the findings of Aims 1 and 2 by identifying implementation strategies and mechanisms participants believed could strengthen future MRSE implementation. Aim 3 used a multi-step qualitative approach to identify implementation strategies and mechanisms for select MRSE thematic barriers and enablers identified in Aim 2. Data was collected through follow-up modified think-aloud interviews using an abbreviated IRLM. During the interviews,

participants reflected on strategies and mechanisms to address key determinants while analytic field notes were captured in real time. Data was subsequently organized and iteratively reduced using the Rapid and Rigorous Qualitative Data Analysis (RADaR) approach. Initial synthesis combined inductive thematic analysis of participant-generated strategies and deductive mapping to ERIC strategies and clusters. Findings were integrated into a final RADaR dataset and synthesized to develop strategy-mechanism summaries for select determinants with strong agreements across the two analysis methods.

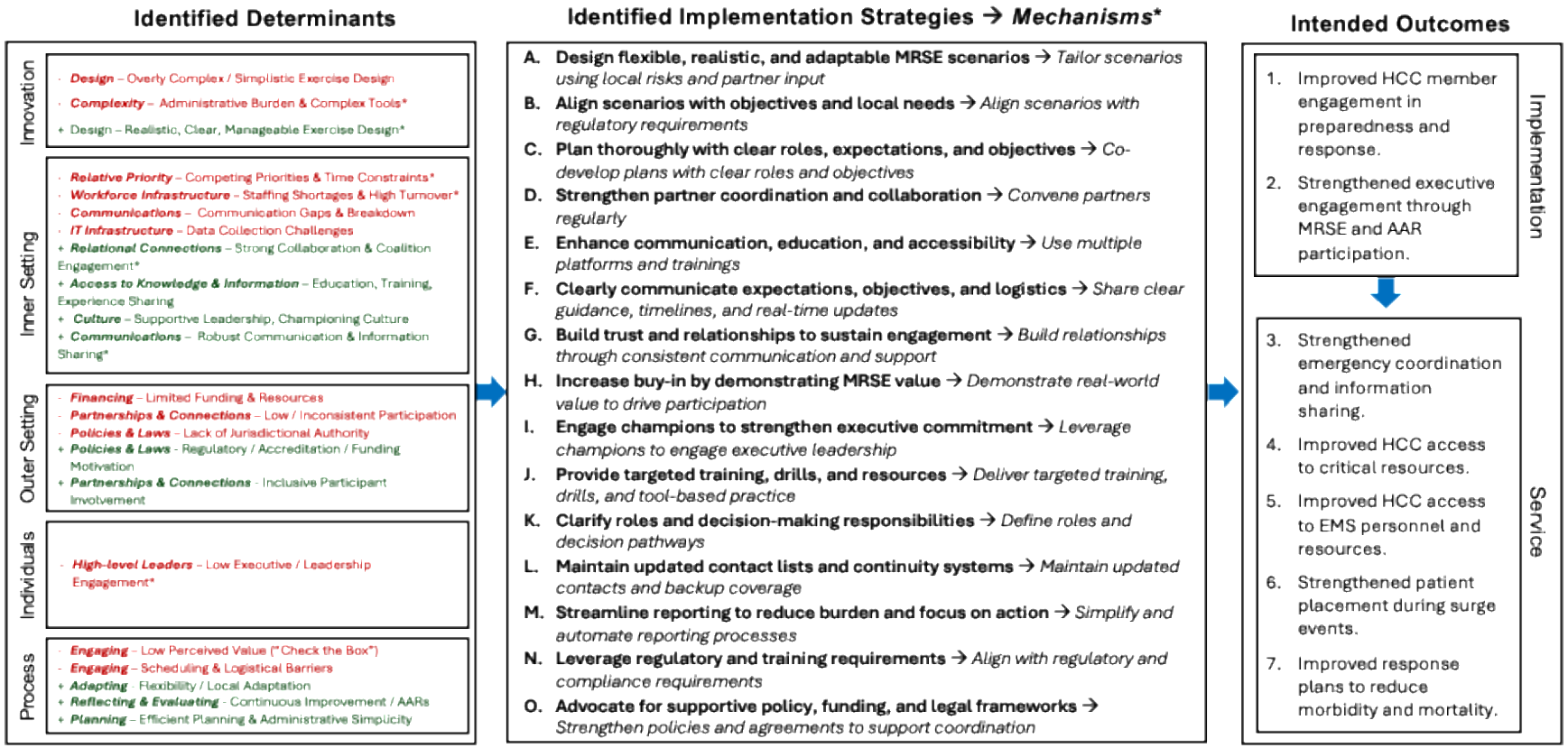
The primary contribution of Aim 3 was moving beyond identifying determinants and focusing on identifying practical improvement strategies based on participant experience. Participants emphasized strategies focused on strengthening collaboration, improving communication and training, clarifying roles, increasing leadership buy-in, reducing administrative burden, and designing realistic and flexible exercises. These strategies aligned closely with ERIC implementation strategy clusters such as stakeholder engagement, training and education, evaluative and iterative strategies, and infrastructure support.

An IRLM, Figure 5.1, was used to synthesize findings across all three aims by linking determinants, implementation strategies, mechanisms, and outcomes within the MRSE. The integrated findings are consistent with and extend prior literature on disaster preparedness exercises. Farahmandnia and colleagues (2025), identified categories of barriers to successful disaster exercise implementation including organizational management, structural and administrative systems, ineffective policymaking, social participation, and exercise organization. These categories closely align with the barriers identified in Aim 2, including leadership engagement, administrative burden, staffing limitations, funding constraints, communication challenges, and coordination barriers. Farahmandnia and colleagues also emphasized that

exercises provide opportunities to test policies and procedures, train staff, improve communication, and strengthen coordination across organizations. These findings closely align with how participants in this dissertation described the MRSE in Aim 2 and Aim 3.

Although the MRSE is federally guided and standardized, implementation occurs within highly variable sociotechnical systems shaped by people, relationships, funding, staffing, governance structures, technologies, and local histories. These findings suggest that implementation strategies become effective when the corresponding mechanisms are understood within local context. For example, strategies focused on communication and training functioned by reducing uncertainty and strengthening participant confidence; while coalition-building strategies operated through trust, familiarity, and sustained engagement across organizations. Collectively, these mechanisms contributed to improved coordination, information sharing, preparedness engagement, and operational planning. Together, the findings across all three aims suggest that the implementation of disaster preparedness exercises at the local level generate learnings (data), but implementation strategies and mechanisms determine whether that learning translates into knowledge to sustain preparedness and response improvements (practice).

Figure 5.1 Implementation Research Logic Model (IRLM) for the execution of the MRSE



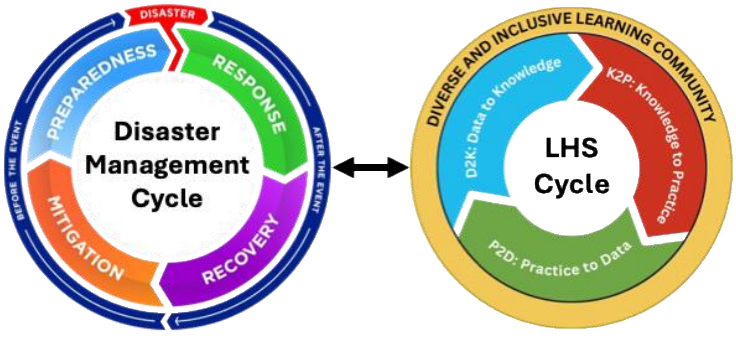
Note. Adapted from Smith, Li, and Rafferty (2020). This IRLM integrates findings across all three aims by linking CFIR-informed determinants, RADaR-derived implementation strategies and mechanisms, and MRSE outcomes. Facilitators/enablers are shown in green text and barriers are shown in orange text, with mapped CFIR sub-constructs displayed in bold. Strategies (bolded) and mechanisms (italicized) are presented as paired constructs (Strategy → Mechanism) to illustrate how implementation processes influence engagement, coordination, communication, resource access, and broader system-level preparedness outcomes.

5.1.2 Framing Disaster Management as a Learning (Health) System

A significant framing established in this dissertation is that disaster management should be conceptualized as a learning system (or learning health system [LHS]). Applying this conceptual model to the disaster preparedness phase, exercises serve as interventions to generate operational experience, tacit knowledge, experiential knowledge, and data that can support continuous learning and improvement. As demonstrated using CFIR 2.0 domains and constructs disaster preparedness depends on people, policies, technologies, organizations, communication systems, infrastructure, leadership, and relationships.

Accordingly, preparedness capacity and capabilities cannot solely be strengthened by revising exercise scenarios, completing AARs, or updating manuals. Translating lessons observed into lessons learned requires strengthening the systems and infrastructure capable of capturing findings, translating knowledge into action, implementing improvements, and reassessing performance over time. The existing LHS framework provides a useful way to conceptualize these ideas (Friedman, 2022a).

Figure 5.2 Disaster Management as a Continuous Learning System



Note. Adapted from "Disaster Management Cycle Black," by FPCreativeStock, Dreamstime.com, Image ID 252319546 (https://www.dreamstime.com/disaster-management-cycle-black-image252319546), and the LHS Cycle is adapted from the Learning Health System Loop, University of Michigan Department of Learning Health Sciences (https://medschool.umich.edu/departments/learning-health-sciences/about).

Disaster management is already conceptualized through the cyclical phases of mitigation, preparedness, response, and recovery. Integrating an LHS perspective into this cycle emphasizes how knowledge generated during one phase should inform future practice across the broader disaster management continuum. Figure 5.2 illustrates the high-level integration of the Disaster Management Cycle with continuous learning processes adapted from LHS principles. This framing conceptualizes disaster preparedness as an ongoing learning system that strengthens resilience across mitigation, preparedness, response, and recovery.

Building upon the conceptualization of disaster management as a LHS and the work of Tan and colleagues (2023), disaster management can be viewed as a nested, multi-level learning system, as illustrated in Figure 5.3. Tan and colleagues highlighted that healthcare resilience spans multiple hierarchical levels, including individual (micro), organizational (meso), health system (macro), and broader societal or international (meta) levels; while also emphasizing strengthening resilience occurs across pre-event, intra-event, post-event, and trans-event phases. Consistent with this framing, this dissertation conceptualizes preparedness activities such as the MRSE as implementation interventions operating within broader sociotechnical systems. At Level 1, individual preparedness activities such as the MRSE function as implementation interventions designed to influence preparedness outcomes. At Level 2, learning generated through these interventions informs broader preparedness systems, relationships, and coordination processes. At Level 3, preparedness learning contributes to resilience across the larger disaster management continuum.

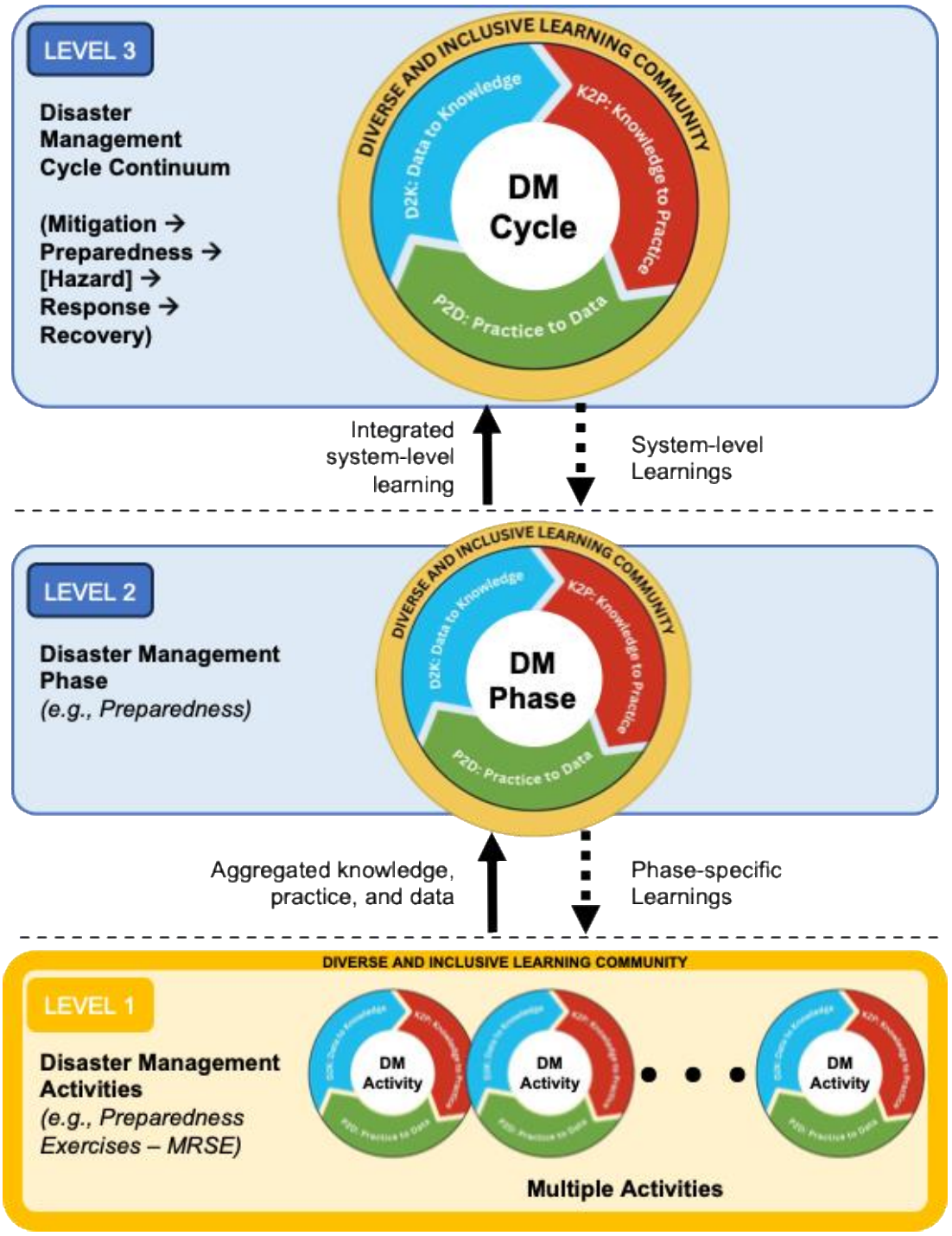
This framing highlights the interconnected and dynamic nature of preparedness systems, where local implementation generates learning that informs broader preparedness infrastructure, while federal and state systems simultaneously provide guidance, resources, and policy

structures that shape local preparedness practice and ongoing system adaptation. Within this framing, it is important to note that convening bodies similar to HCCs can be conceptualized as learning communities. These learning communities are an important infrastructure component of the disaster management systems as highlighted throughout this study, that serve as mechanisms for learning, coordination, and continuous improvement. Although this research was broadly focused on how healthcare systems prepare for medical surge, which is generally categorized as a PHE, there is a high-level assumption that this conceptualization can be applied across various hazard events.

The findings from this dissertation also suggest opportunities for strengthening disaster management knowledge infrastructure. Existing literature consistently demonstrates that lessons identified through AARs are often inconsistently documented, difficult to access, and challenging to translate into sustained operational improvement (Savoia et al., 2012). From an LHS perspective, this creates barriers in moving effectively from data to knowledge and from knowledge to practice. The findings therefore suggest a need for more standardized terminology, reporting structures, and knowledge management systems. This may include improving the accessibility of AARs, strengthening reporting consistency, organizing implementation strategies and lessons learned, and developing systems capable of making preparedness knowledge more actionable for both researchers and practitioners.

Implementation science provides a structured approach for translating lessons learned from disasters and exercises into sustained organizational and system change. Rather than viewing exercises solely as preparedness activities, they can be conceptualized as interventions that generate knowledge and support continuous system improvement.

Figure 5.3 Multi-Level Disaster Preparedness as a Learning System Across the Disaster Management Cycle Continuum



Note. The three phase cycle is adapted from the Learning Health System Loop, University of Michigan Department of Learning Health Sciences (https://medschool.umich.edu/departments/learning-health-sciences/about).

Although not formally explored in this research, a LHS approach may help overcome the preparedness paradox. The *preparedness paradox* refers to the challenge that disasters occur infrequently, resulting in long periods between events during which critical knowledge, skills, relationships, and lessons learned can be lost, making it difficult for systems to sustain preparedness and continuously improve over time (Kruger et al., 2019). By applying a learning framework that captures both tacit and explicit knowledge, ensures that knowledge reaches the right people at the right time, and supports continuous learning, adaptation, and improvement between disasters, disaster management systems may be better positioned to translate lessons learned into future preparedness and response activities.

5.1.3 Federal Preparedness Infrastructure, Resilience, and Equity

This dissertation was grounded in the FEMA conceptual model that disaster management is "federally supported, state-managed, and locally executed preparedness" (FEMA, 2024). As demonstrated throughout this research, each level of this structure matters. Federal support is operationalized through funding and guidance that establish preparedness expectations and standardized exercise requirements, as demonstrated through funding for HCCs and guidance for the MRSE. States manage implementation through cooperative agreement structures and preparedness oversight, helping balance standardization with local flexibility. HCCs and local partners operationalize preparedness through relationships, coordination, and execution, translating preparedness into practice through facilitation, communication, and adaptation to local realities.

Implicitly, this dissertation suggests that HCCs should be recognized as preparedness infrastructure. HCCs create formal structures for organizations that may otherwise compete to build relationships, coordinate resources, share information, and practice response activities

together before disasters occur (Barnett et al., 2020). The value of preparedness infrastructure may not always be visible during routine operations but, like infrastructure more broadly its importance becomes most apparent when systems are stressed or begin to fail (Star & Ruhleder, 1996).

At the time of writing this dissertation, the disaster management landscape in the United States is on the precipice of major change and uncertainty due to proposed restructuring and potential policy changes affecting federal agencies such as FEMA, CDC, and ASPR (ASPR, 2026). The President's Council to Assess the FEMA (2026) report identified fragmented coordination, staffing shortages, administrative burden, and implementation complexity as persistent barriers limiting preparedness effectiveness. Subsequently, recommending major changes to the U.S. disaster management system, including shifting greater responsibility for disaster management activities to states and local governments; as well as reducing FEMA's operational role through streamlined funding mechanisms, simplified assistance programs, and greater reliance on state-managed systems. The results of this report will likely be used to support the proposed presidential FY 2027 federal budget reductions and broader federal restructuring for disaster management, including the potential elimination of the HPP (OMB, 2026).

Despite these uncertainties, recent HPP guidance has continued to emphasize the importance of HCC coordination, preparedness exercises, medical surge planning, and strengthening state and local readiness capabilities (ASPR, 2026). The ASPR guidance has reiterated that the current HPP cooperative agreement cycle is expected to last through the existing agreement period, which is expected to continue through FY 2028.

These ongoing national discussions reinforce several findings from this dissertation. The

findings do not suggest that the current preparedness systems function perfectly or that existing structures should remain unchanged without reform. Rather, they suggest that disaster preparedness depends on sustained coordination infrastructure, relationship-building, implementation capacity, and continuous learning processes to strengthen resilience across the disaster management continuum. More importantly, this dissertation suggests that preparedness infrastructure should be evaluated not only by disaster outcomes, but also by the systems and relationships that support coordination before disasters occur.

As disaster management systems in the United States continue to evolve, attention should be given to how preparedness infrastructure is built, connected, and improved over time through modular and adaptable system improvements (Star & Ruhleder, 1996). These infrastructural elements are even more prevalent to acknowledge pending future restructuring efforts because true weaknesses and strengths in existing preparedness systems may not become visible until real-world emergencies place stress on coordination systems.

Importantly, disaster preparedness systems are also shaped by broader social and community conditions that influence resilience before disasters occur. This dissertation recognizes that disaster preparedness and disaster outcomes are shaped by more than hazards alone. Communities experience disasters differently based on existing sociotechnical inequities. Factors such as access to healthcare, transportation, communication systems, organizational coordination, and resource availability may predetermine preparedness capabilities and capacity and recovery outcomes before a disaster occurs (Raker et al., 2020; McQueen et al., 2023). The findings from this dissertation suggest that disaster preparedness exercises, such as the MRSE, may provide opportunities to identify operational and coordination gaps that could disproportionately affect vulnerable populations.

This dissertation also supports the idea that disaster resilience includes tacit and experiential knowledge gained through preparedness activities and lived community experience. Local communities possess existing relationships, local knowledge, adaptive practices, and informal support systems that contribute to preparedness and resilience. Drawing from Yosso's Community Cultural Wealth framework, disaster resilience can be framed as a form of community capital strengthened by both formal preparedness infrastructure and existing community assets (Yosso, 2005).

5.2 Methodological Contributions

A secondary aim of this dissertation was to demonstrate the utility of applying implementation science approaches within disaster management research and practice. As shown throughout the three aims, there is potential value for healthcare policymakers, regulatory and accrediting agencies, hospital administrators, disaster management professionals, and researchers in using implementation science as a methodological approach to better understand and evaluate disaster preparedness activities. This dissertation suggests that integrating disaster science and implementation science may help bridge the gap between research knowledge (what we know) and practice (what we do) by providing more systematic approaches for understanding how preparedness activities are implemented, experienced, evaluated, and improved in real-world settings. In turn, these approaches may support more effective and resilient healthcare disaster management systems by strengthening preparedness learning, coordination, and continuous improvement processes.

The literature review in Chapter 1 identified only a small number of publications proposing methodological approaches for integrating implementation science into disaster management, with limited empirical application identified in the field (Bell et al., 2023;

Binagwaho et al., 2022; Øvretveit & Ohrling, 2021). This dissertation builds upon that emerging body of work by applying implementation science frameworks across the three interconnected study aims to evaluate the implementation of the MRSE, a federally designed disaster preparedness exercise. The frameworks referenced included CFIR 2.0, RE-AIM, Proctor Implementation Outcomes, ERIC, and the IRLM. These implementation science frameworks were used to retrospectively examine implementation processes, determinants, outcomes, and improvement opportunities within a real-world local HCC preparedness setting. Rather than using these frameworks only for prospective intervention planning, this dissertation demonstrated their utility for evaluating preparedness activities after implementation and for helping organize complex preparedness findings in a more systematic way.

Another methodological contribution of this dissertation was the use of a pragmatic multimethod case study design to examine the MRSE across different phases of implementation and evaluation. Rather than relying on a single data source, this study integrated document analysis, surveys, semi-structured interviews, and participatory think-aloud methods to examine planning, execution, learning, and improvement processes. This approach allowed for a more comprehensive understanding of preparedness implementation while remaining feasible within the context of a single dissertation study. Developing a novel approach to complement and strengthen the existing exercise evaluation and AAR process.

The participatory application of the IRLM in Aim 3 is also a significant methodological contribution by demonstrating how implementation science tools can support collaborative reflection and strategy development. Through guided think-aloud interviews, participants reflected on determinants, strategies, and mechanisms identified in earlier aims, illustrating how implementation science frameworks may function not only as analytic tools, but also as

structured approaches for facilitating preparedness learning and improvement discussions.

Finally, this dissertation contributes a transferable multi-method methodological approach for integrating implementation science into disaster preparedness research and evaluation with quantitative and qualitative data strands. In particular, this study demonstrated the utility of combining established implementation science frameworks with qualitative and mixed-method approaches, including thematic analysis, directed qualitative analysis (DQA), Rigorous and Accelerated Data Reduction (RADaR) Technique, and deductive analysis, to establish a robust methodological approach for empirical disaster preparedness research. Although intentionally focused on one specific exercise (the MRSE) and one state context, the overall approach combining sociotechnical analysis, determinant assessment, implementation outcome evaluation, and participatory strategy-mechanism development may be adaptable to other preparedness exercises and public health preparedness initiatives.

5.3 Implications

This dissertation demonstrates how implementation science can be applied to disaster preparedness exercises within a system that is federally supported, state managed and locally executed. By viewing preparedness exercises as implementation interventions, implementation science theories, models, and frameworks can be used to generate actionable knowledge that strengthens future preparedness and response. For example, CFIR can identify contextual barriers and facilitators, RE-AIM can evaluate implementation outcomes, and ERIC can provide a standardized taxonomy for documenting implementation strategies (Damschroder, Reardon, Opra Widerquist, et al., 2022; Glasgow et al., 1999; Powell et al., 2015).

Collectively, the implications of this research suggest that disaster preparedness exercises should not only be understood as operational activities, but also as opportunities for learning,

relationship building, and continuous system improvement. Framing disaster preparedness as both a sociotechnical system and a Learning Health System (LHS) also demonstrates how implementation science concepts and frameworks may be applied beyond traditional healthcare settings.

5.3.1 Implications for Disaster Practice

The practical application of this dissertation is to support HCCs, emergency managers, healthcare preparedness leaders, and disaster practitioners in using implementation science tools to better understand and improve preparedness exercise implementation. The findings reinforce that the success of disaster preparedness activities not only depends on completing the exercise itself but, also on— coalition building, leadership engagement, communication, relationship management, local adaptation, and improvement plan follow-through after exercises occur. The findings also highlight opportunities for stronger academic researcher–practitioner–community partnerships to support preparedness evaluation, implementation support, knowledge translation, and continuous preparedness improvement.

5.3.2 Implications for Disaster Policy

At the federal level, these findings suggest that standardized disaster preparedness exercises may benefit from additional implementation guidance that helps practitioners account for local implementation context in addition to exercise design guidance. The findings also suggest there may be value in providing supplemental operational guidance on adaptation and tailoring strategies to help maintain the core components and intended fidelity of the exercise while still allowing flexibility for local implementation. At the state and local levels, the findings reinforce the importance of balancing standardization with local flexibility while recognizing that implementation context differs across coalitions, organizations, and regions.

5.3.3 Implications for Learning Health System Model and Implementation Science

This dissertation demonstrates that the LHS model and implementation science frameworks may have value beyond traditional clinical and healthcare interventions and can be applied within broader disaster research settings. Implementation science frameworks such as CFIR, RE-AIM, ERIC, Proctor implementation outcomes, and the IRLM can provide useful structure for understanding preparedness implementation within complex real-world settings. More specifically, these dissertation findings suggest that preparedness activities generate implementation-related data (quantitative and qualitative); that can be captured and translated formally or informally into tacit and experiential knowledge; and finally, can then be translated into practice in a cyclical nature.

5.3.4 Implications for Applying Implementation Science to Disaster Management

Its various fields, it has been generally established that it can take 15 to 20 years for scientific discoveries to become routine practice (Z. S. Morris et al., 2011). The primary goal of implementation science is to address this research-to-practice gap by studying methods and strategies that accelerate the uptake of evidence-based practices into real-world settings (Eccles & Mittman, 2006). Both implementation research and intervention research focus on studying an intervention, such as a policy, practice, program, or procedure. However, intervention research primarily examines the effectiveness and safety of the intervention itself. In contrast, implementation science focuses on how proven interventions are integrated into real-world practice, studying the processes that support their adoption, implementation, and sustainment while evaluating related implementation outcomes.

As this dissertation demonstrates, there is an opportunity for disaster management to move beyond intervention research. Disaster preparedness exercises have been established as a

proven intervention for preparing organizations and communities to respond to hazard events. As such, greater attention can now be directed toward understanding how the knowledge, lessons learned, and best practices generated through these exercises are translated into routine preparedness activities, implemented across organizations, and sustained over time. Implementation science offers an opportunity to transform disaster management into a more intentional learning system. The lessons learned, contextual determinants, implementation strategies, and outcomes could be systematically codified within knowledge management systems, creating a library of evidence-informed preparedness practices. Combined with emerging artificial intelligence (AI) tools, these resources could support continuous learning and aid in decision making to accelerate the translation of knowledge into practice and reduce the need for repeated disasters before meaningful improvements are realized.

5.3.5 Implications for Disaster Science and Research

This dissertation provides a practical example of how implementation science can be integrated into disaster preparedness research and evaluation. The findings from Aim 2 emphasize a persistent challenge within disaster management that lessons identified through exercises and disasters are frequently documented but not consistently translated into sustained operational change. This findings from Aim 3 highlight an opportunity to strengthen preparedness knowledge translation by moving beyond simply identifying what should be done toward better understanding how preparedness improvements can be operationalized in practice. An unintended finding of this research suggests opportunities to improve consistency in preparedness reporting, terminology, and subsequent knowledge management while supporting stronger connections between disaster research and operational preparedness practice.

Additionally, an important implication of this study is that broader federal policy and

funding instability may influence participation in disaster preparedness research. During participant recruitment for follow-up interviews, delays in ASPR CA renewals associated with federal workforce and spending reduction efforts likely increased workload demands and job security concerns among state-level HCC leaders and staff. These conditions may have negatively affected research participation, recruitment, and the availability of preparedness personnel to engage in evaluation and learning activities.

5.4 Limitations

Although a careful and systematic approach was taken throughout this research process, this dissertation has several limitations that should be considered before applying these methods or extrapolating these findings more broadly. First, the study was limited to one anonymized HPP CA state consisting of multiple HCCs. Although this decision was intentional to reduce potential confounding variation related to state-level governance and preparedness structures, it limits broader generalizability across states, territories, and disaster preparedness systems.

Second, the sample size was relatively small. The final survey sample included 15 respondents, and 10 participants completed semi-structured interviews. While the qualitative findings provided meaningful depth and insight into participant experiences, the quantitative findings should be interpreted more cautiously because there was not enough data to fully assess whether perceptions of the exercise differed based on participant role within the HCC or differences across HCCs.

Third, the timing of data collection likely influenced participation and responses. Although this study was intended to focus on the 2024 MRSE, which was implemented individually by each HCC; data collection occurred while participants were simultaneously preparing for and participating in the 2025 MRSE, which was implemented using a statewide

approach. The data collection phase also occurred during broader uncertainty related to federal preparedness funding and ASPR cooperative agreement renewals. These external factors may have affected participation, influenced which individuals chose to participate, and shaped participant perceptions regarding preparedness sustainability and implementation challenges.

Fourth, due to data sharing limitations this study did not have access to ASPR Evaluation Reporting Tool data or deidentified MRSE AARs. As a result, participant perspectives and reported experiences could not be directly compared with formal exercise evaluation records, increasing the potential for recall bias.

Finally, this dissertation was conducted primarily by a single investigator who designed the study, collected and coded the data, and conducted the analysis. Although systematic methods and established frameworks were used throughout the research process, the findings remain subject to potential investigator bias and interpretive subjectivity.

5.5 Future Research

This dissertation provides foundational work for future implementation focused preparedness research. Future research should continue examining how implementation science methods, frameworks, and learning system approaches can be applied within disaster preparedness settings. This dissertation focused specifically on the implementation of the HCC MRSE. However, the findings suggest broader opportunities to better understand how disaster preparedness activities are implemented, adapted, operationalized, and sustained across preparedness systems.

One important next step is validating the implementation determinants, implementation strategies, and methodological approaches used in this dissertation across broader preparedness settings and jurisdictions. Future studies should examine the implementation of the MRSE across

multiple HPP CA recipients to better understand how governance structures, coalition maturity, geography, funding environments, and local implementation context influence preparedness implementation. Comparative multi-site studies may help determine which findings are context-specific and which may be generalized applicable across preparedness systems. Future research could also prospectively test the implementation strategies identified in Aim 3 within disaster preparedness exercises to better understand feasibility, acceptability, sustainability, and operational impact.

There is also an opportunity to use consensus-building approaches such as Delphi panels involving implementation scientists, disaster researchers, emergency managers, and disaster practitioners to further refine and validate the implementation approaches used in this dissertation. That research may help determine whether implementation science frameworks such as CFIR, ERIC, RE-AIM, Proctor implementation outcomes, and the IRLM require adaptation for use in disaster preparedness. Alternatively, it may also identify the need to develop disaster-specific definitions and terminology to improve conceptual fit, consistency, and operational usability within disaster preparedness research and practice.

This research also highlights opportunities to strengthen preparedness knowledge translation, organizational learning, and consistency in preparedness reporting and terminology across disaster preparedness systems. Preparedness activities generate operational experience through disaster scenarios, leading to the development of tacit knowledge, experiential knowledge, and implementation-related lessons. Unfortunately, majority of this information remains fragmented across organizations, jurisdictions, exercises, and AARs. Future work may build upon the methods in this research to determine how contextual information can be incorporated into disaster preparedness guidance documents, frameworks (e.g., HSEEP, and

AAR templates to better support preparedness learning and implementation improvement.

Future research should also continue exploring disaster preparedness as both a sociotechnical system and an LHS, building on the conceptual model introduced in this research. This may include examining how preparedness learning, relationships, coordination, and resilience develop across organizations, coalitions, healthcare systems, and communities over time. Using more sophisticated quantitative methods with larger sample sizes, such as structural equation modeling, may enable the development of inferences to help strengthen understanding of how preparedness infrastructure, governance structures, funding systems, and policy implementation influence long-term preparedness capacity, resilience, and continuous learning.

Finally, there is a unique opportunity that will be further explored by this author to build upon this foundation through the development of a codified library of disaster management implementation strategies linked to contextual determinants, implementation outcomes, and implementation processes. This resource could be developed into a useable knowledge management system (KMS) leveraging artifacts from real-world disaster experiences, including AARs, ongoing research, and other unconventional data sources to better understand disaster impacts and adaptation. For example, insurance appraiser reports may provide valuable insights into how hazards affect individuals, households, and communities at a more granular level, providing perspectives on local impacts, recovery processes, and system adaptations that are often not captured through traditional public health and emergency management data sources.

This innovative disaster management KMS could draw upon implementation process models to describe how evidence and lessons learned are translated into practice and sustained over time. By systematically documenting determinants, implementation strategies, mechanisms, outcomes, and lessons learned, the KMS could support continuous learning, facilitate cross-

jurisdictional knowledge sharing, and potentially leverage artificial intelligence (AI) to identify contextually relevant strategies for future preparedness activities and response decisions. Additional work should examine whether existing repository's, such as ASPR TRACIE, could evolve into this centralized KMS that supports broader translation of preparedness knowledge into operational practice. This approach could help accelerate the translation of knowledge generated from disasters and exercises into practice, reducing the time between lessons observed and lessons applied while strengthening disaster preparedness and resilience across systems—local (organizations, communities, coalitions, and municipalities), regional, state, and federal levels.

5.6 Conclusion

Disaster preparedness activities are more than just compliance activities and opportunities to practice disaster response; they are opportunities for systems (local, regional, state, federal) to learn, adapt, and strengthen resilience before disasters occur. This dissertation applied implementation science to disaster preparedness exercises using the MRSE as a practical case example to examine how a federally supported, state-managed, and locally executed disaster preparedness activity is designed, implemented, experienced, and translated into strategies for improvement.

The findings across the three interconnected aims emphasize that disaster preparedness exercises generate both qualitative and quantitative data. Through intentional coordination and the continual improvement of policies, procedures, communication structures, and organizational practices, this information can be translated into tacit and experiential knowledge and practice. Exercises provide opportunities to identify gaps in capacity and capability before disasters occur while simultaneously strengthening relationships, operational familiarity, coordination, and

system readiness. As the old saying goes, practice makes perfect, and while disaster management may never achieve a perfect response, practice strengthens preparedness. More practice may help disaster responders and practioners become more proficient in assessing capability and capacity while building the operational knowledge and disaster wisdom needed to prepare for and respond to hazards.

Methodologically, this dissertation demonstrated the value of applying implementation science frameworks to disaster research, more specifically disaster preparedness activities. Frameworks such as CFIR, RE-AIM, Proctor implementation outcomes, ERIC, and the IRLM provided structured approaches for understanding implementation determinants, barriers and facilitators, implementation strategies, and the mechanisms through which preparedness improvement may occur. The underlying intent of this dissertation was to reframe disaster preparedness exercise as knowledge-to-practice interventions that are implemented within broader sociotechnical and learning systems.

A central finding across this dissertation was that implementation context matters. While this is generally recognized in disaster research and practice, accounting for context and tailoring interventions within complex environments remains challenging in disaster preparedness activities, as demonstrated by persistent preparedness and response challenges. These challenges occur across constantly evolving contexts, making them difficult to fully address through standardized preparedness exercises alone. Although the MRSE is federally guided and standardized, implementation occurs within highly variable local sociotechnical environments shaped by staffing, funding, governance structures, leadership, technology, relationships, geography, and coalition maturity. As demonstrated in Aim 1, MRSE guidance documents developed federally primarily emphasized the CFIR 2.0 Innovation and Implementation Process

domains, particularly exercise design, adaptability, execution, and reflection and evaluation, with less emphasis on organizational context, participant characteristics, and broader external system influences. As a result, balancing standardization with local adaptation remains an ongoing challenge in disaster preparedness and response efforts.

The findings from Aim 2 demonstrated generally positive perceptions of MRSE implementation, while highlighting ongoing challenges related to long-term sustainability and implementation context. The identified key barriers and facilitators emphasized the importance of leadership engagement, collaboration, communication, organizational capacity, and coalition relationships in shaping MRSE implementation across HCCs. This suggests that implementation success of exercise is not only predicated on completion, but also on whether organizations translate preparedness learning into sustained action. To move beyond traditional exercise reviews and toward implementable targeted strategies, Aim 3 developed strategies to address barriers and strengthen enablers related to MRSE implementation. The strategies and mechanisms emphasized strengthening collaboration and coordination, improving communication, increasing leadership engagement, streamlining reporting and exercise processes, leveraging technology, and designing flexible exercises aligned with real-world operational demands to achieve the intended outcomes and objectives of the MRSE.

This dissertation seeks to reframe disaster management in healthcare through a LHS lens. Disaster management already operates through recurring cycles of phases—mitigation, preparedness, response, and recovery. Applying LHS principles helps frame how information generated through disaster management activities such as disaster preparedness exercises can be translated into knowledge, put into practice, reassessed, and continuously improved over time. However, exercises alone do not guarantee lessons learned rather than observed; learning

requires infrastructure, including systems capable of capturing and storing knowledge as well as implementing improvements. Building on this perspective and viewing HCCs as learning communities, the findings reinforce the importance of preparedness infrastructure. HCCs function as relationship and coordination infrastructure that supports regional preparedness before disasters occur. While the value of this infrastructure may not always be visible during routine operations, its importance becomes most apparent when systems are stressed during emergencies and disasters.

In conclusion, this dissertation contributes a practical and implementation-focused approach to disaster preparedness. Strengthening disaster preparedness requires more than routinely conducting exercises or producing AAR; it requires systems capable of learning, adapting, and continuously improving over time. Implementation science and LHS principles provide a practical mechanism pathway for moving disaster management beyond lessons observed toward sustained preparedness improvement and resilience. The core purpose of this research is to empower individuals, organizations, and communities by highlighting practical ways to translate the tacit and explicit knowledge created from disaster preparedness exercises into future practice. Adapting Yosso's Community Cultural Wealth Model, this work frames preparedness as a form of capital that protects communities by equipping them with the capacity and capabilities to respond and recover from hazard. Using an interdisciplinary systems approach, this research emphasizes practical, real-world preparedness improvement. Ultimately, this work highlights the importance of relationships, coordination, learning, and solving implementation challenges to strengthen disaster resilience in the face of increasing man-made and natural hazards. Because strengthening disaster resilience is not only about improving exercises but, improving how systems learn before lives depend on it.

Appendices

Appendix A

IRB Exemption Determination Letter



Medical School Institutional Review Board (IRBMED) • 2800 Plymouth Road, Building 520, Suite 3214, Ann Arbor, MI 48109-2800 • phone (734) 763 4768 • fax (734) 763 9603 • irbmed@umich.edu

To: Azia Harris-Martin

From:

Michael	Geisser
Amy	Filbrun
Robertson	Davenport

Cc:

Alexandra	Vinson
Andrew	Krumm
Azia	Harris-Martin
Sue Anne	Bell
Amy	Kilbourne

Subject: Notice of Exemption for [HUM00246148]

SUBMISSION INFORMATION:
Title: Michigan Health Care Coalitions (HCCs)
Full Study Title (if applicable): Strengthening Disaster Resilience: Analyzing Healthcare Systems' Utilization of Disaster Management Exercises and Examining Barriers and Facilitators through a Health Care Coalitions' Medical Response Surge Exercise Case Analysis
Study eResearch ID: HUM00246148
Date of this Notification from IRB: 12/2/2024
Date of IRB Exempt Determination: 11/27/2024
UM Federalwide Assurance: FWA00004969 (For the current FWA expiration date, please visit the UM HRPP Webpage)
OHRP IRB Registration Number(s):

IRB EXEMPTION STATUS:
The IRBMED has reviewed the study referenced above and determined that, as currently described, it is exempt from ongoing IRB review, per the following federal exemption category:

> **EXEMPTION 2(i) and/or 2(ii) at 45 CFR 46.104(d):**
>
> **Research that only includes interactions** involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) **if at least one of the following criteria is met**:
>
> **(i)** The information obtained is recorded by the investigator in such a manner that **the identity of the human subjects cannot readily be ascertained**, directly or through identifiers linked to the subjects;
>
> **(ii)** Any disclosure of the **human subjects' responses** outside the research **would not reasonably place the subjects at risk** of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation

Note that the study is considered exempt as long as any changes to the use of human subjects (including their data) remain within the scope of the exemption category above. Any proposed changes that may exceed the scope of this category, or the approval conditions of any other non-IRB reviewing committees, must be submitted as an amendment through eResearch.

Although an exemption determination eliminates the need for ongoing IRB review and approval, you still have an obligation to understand and abide by generally accepted principles of responsible and ethical conduct of research. Examples of these principles can be found in the Belmont Report as well as in guidance from professional societies and scientific organizations.

SUBMITTING AMENDMENTS VIA eRESEARCH:
You can access the online forms for amendments in the eResearch workspace for this exempt study, referenced above.

ACCESSING EXEMPT STUDIES IN eRESEARCH:
Click the "Exempt and Not Regulated" tab in your eResearch home workspace to access this exempt study.



Michael Geisser Co-chair, IRBMED	**Amy Filbrun** Co-chair, IRBMED	**Robertson Davenport** Co-chair, IRBMED

Appendix B

Summary of Study Procedures and Analytic Workflow

Aim 1: Understanding The MRSE Sociotechnical Context

Step	Description	Outputs
Document Identification	Collected publicly available ASPR MRSE guidance and preparedness documents.	Core MRSE documents
Deductive Framework Coding	Conducted deductive coding using CFIR 2.0, RE-AIM, and Proctor Implementation Outcomes frameworks.	Coded document dataset
Frequency and Cross-Framework Analysis	Generated frequency summaries and synthesized findings across implementation science frameworks.	Frequency tables and framework summaries
Conceptual Model Development	Developed a CFIR-informed sociotechnical conceptualization of the MRSE and summarized intended implementation outcomes.	Conceptual model and outcome summary

Aim 2: Assessing Local MRSE Implementation

Step	Description	Outputs
Survey Administration	Distributed a CFIR-informed mixed-methods survey to MRSE participants.	Survey dataset
Quantitative Analysis	Conducted descriptive quantitative analysis of survey responses.	Descriptive statistics
Semi-Structured Interviews	Conducted interviews with a subset of participants.	Interview dataset
Directed Qualitative Analysis	Conducted directed qualitative analysis and thematic coding using CFIR-informed DQA and RADaR approaches.	Barrier and facilitator themes
Mixed-Methods Integration	Integrated quantitative and qualitative findings using joint displays.	Mixed-methods joint displays
Determinant Synthesis	Synthesized key implementation determinants influencing MRSE implementation and participation.	CFIR-informed determinant summary

Aim 3: Improving MRSE Implementation Through The IRLM

Step	Description	Outputs
Modified Think-Aloud Interviews	Conducted follow-up interviews using member checking and an abbreviated IRLM activity focused on high-ranking barriers and enablers.	Analytic field notes and interview transcripts
RADaR Data Structuring and Cleaning	Organized, cleaned, and analyzed interview data using RADaR techniques and horizontal and vertical analytic approaches.	Structured RADaR dataset
ERIC Strategy Mapping	Mapped implementation strategies and mechanisms to ERIC strategies and strategy categories.	ERIC-mapped strategy summaries
Strategy and Mechanism Synthesis	Synthesized implementation strategies and mechanisms associated with major determinants.	Strategy and mechanism synthesis

Discussion: Cross-Aim Integration

Step	Description	Outputs
Cross-Aim Integration	Integrated findings across Aims 1–3 to examine relationships among preparedness design, determinants, implementation strategies, mechanisms, and outcomes.	Cross-aim synthesis
IRLM Development and Interpretation	Developed and synthesized the MRSE-specific Implementation Research Logic Model within the discussion and interpretation of findings.	Final MRSE-specific IRLM

Appendix C

MAXQDA Codebook Report and Overview of Analytic Application

The MAXQDA code system was organized into multiple analytic sections aligned with the study aims. Code System 4. CFIR and 5.3 Outcomes were used in Aim 1 to support deductive document analysis across the five CFIR domains, including the Innovation Domain (4.1), Outer Setting Domain (4.2), Inner Setting Domain (4.3), Individuals Domain (4.4), and Implementation Process Domain (4.5). Implementation outcomes from 5.3 Outcomes were also applied to assess implementation- and service-related outcomes reflected within MRSE guidance documents.

The CFIR codebook used in this study was adapted from: Reardon, C. M., Damschroder, L. J., Ashcraft, L. E., Kerins, C., Bachrach, R. L., Nevedal, A. L., Domlyn, A. M., Dodge, J., Chinman, M., & Rogal, S. (2025). *The Consolidated Framework for Implementation Research (CFIR) User Guide: A five-step guide for conducting implementation research using the framework*. *Implementation Science, 20*(1), 39.

For Aim 2, six open-text questions from 6. Survey Questions were coded using CFIR-informed constructs. Interview transcripts were initially analyzed using 5.1 Determinants as part of a Directed Qualitative Analysis (DQA) process to categorize data into preliminary barriers (5.1.3 Barrier) and enablers (5.1.5 Enabler [Facilitator]). Interview data were then exported to Excel and further analyzed using the RADaR (Rigorous and Accelerated Data Reduction) technique to inductively develop thematic codes under the barrier and enabler categories. These thematic codes were subsequently incorporated back into the MAXQDA codebook and reapplied across transcripts during additional rounds of coding and analysis.

Additionally, seven supplemental interview questions included under 7. Additional Interview Questions were analyzed separately from the primary DQA process because they were not directly focused on implementation barriers and enablers, but rather broader participant reflections related to disaster preparedness, Healthcare Coalitions, and disaster research.

MAXQDA was not used for Aim 3 analyses.

Exported May 15, 2026

CODE SYSTEM

1 RED HIGHLIGHT - NEED TO UDPATE	3
2 Future Ideas	10
3 Good Quotes	25
4 CFIR	1
4.1 I. INNOVATION DOMAIN	80
4.1.1 A. Innovation Source	7
4.1.2 B. Innovation Evidence-Base	22
4.1.3 C. Innovation Relative Advantage	0
4.1.4 D. Innovation Adaptability	16
4.1.5 E. Innovation Trialability	0
4.1.6 F. Innovation Complexity	0
4.1.7 G. Innovation Design	43
4.1.8 H. Innovation Cost	0
4.2 II. OUTER SETTING DOMAIN	18
4.2.1 A. Critical Incidents	4
4.2.2 B. Local Attitudes	0
4.2.3 C. Local Conditions	0
4.2.4 D. Partnerships & Connections	0
4.2.5 E. Policies & Laws	12
4.2.6 F. Financing	2
4.2.7 G. External Pressure	0
4.2.7.1 1. Societal Pressure	0
4.2.7.2 1. Market Pressure	0
4.2.7.3 1. Performance-Measurement Pressure	0
4.3 III. INNER SETTING DOMAIN	38
4.3.1 A. Structural Characteristics	0
4.3.1.1 1. Physical Infrastructure	0
4.3.1.2 2. Information Technology Infrastructure	0
4.3.1.3 3. Work Infrastructure	0
4.3.2 B. Relational Connections	0
4.3.3 C. Communications	0
4.3.4 D. Culture	0

4.3.4.1 1. Human Equality-Centeredness	0
4.3.4.2 2. Recipient-Centeredness	0
4.3.4.3 3. Deliverer-Centeredness	0
4.3.4.4 4. Learning-Centeredness	0
4.3.5 E. Tension for Change	0
4.3.6 F. Compatibility	0
4.3.7 G. Relative Priority	0
4.3.8 H. Incentive Systems	0
4.3.9 I. Mission Alignment	0
4.3.10 J. Available Resources	16
4.3.10.1 1. Funding	0
4.3.10.2 2. Space	0
4.3.10.3 3. Materials & Equipment	3
4.3.11 K. Access to Knowledge & Information	22
4.4 IV. INDIVIDUALS DOMAIN	26
4.4.1 IV. INDIVIDUALS DOMAIN (Roles)	0
4.4.1.1 A. High-level Leaders	0
4.4.1.2 B. Mid-level Leaders	0
4.4.1.3 C. Opinion Leaders	0
4.4.1.4 D. Implementation Facilitators	2
4.4.1.5 E. Implementation Leads	4
4.4.1.6 F. Implementation Team Members	7
4.4.1.7 G. Other Implementation Support	6
4.4.1.8 H. Innovation Delivers	4
4.4.1.9 I. Innovation Recipients	7
4.4.2 IV. INDIVIDUALS DOMAIN (Characteristics)	0
4.4.2.1 A. Need	0
4.4.2.2 B. Capability	4
4.4.2.3 C. Opportunity	0
4.4.2.4 D. Motivation	0
4.5 V. IMPLEMENTATION PROCESS DOMAIN	133
4.5.1 A. Teaming	0
4.5.2 B. Assessing Needs	9
4.5.2.1 1. Innovation Deliverers	0

4.5.2.2 2. Innovation Recipients	3
4.5.3 C. Assessing Context	12
4.5.4 D. Planning	23
4.5.5 E. Tailoring Strategies	2
4.5.6 F. Engaging	20
4.5.6.1 1. Innovation Deliverers	5
4.5.6.2 2. Innovation Recipients	20
4.5.7 G. Doing	39
4.5.7.1 1. Innovation Delivers	19
4.5.7.2 2. Innovation Recipients	3
4.5.8 H. Reflecting & Evaluating	42
4.5.8.1 1. Implementation	30
4.5.8.2 2. Innovation	11
4.5.9 I. Adapting	1
5 IRLM	0
5.1 Determinants	0
5.1.1 2024 - 2025	4
5.1.2 Positive Case	2
5.1.3 Barrier	184
5.1.3.1 Lack of Jurisdictional Authority	9
5.1.3.2 Low Perceived Value (“Check the Box”)	13
5.1.3.3 Scheduling & Logistical Barriers	4
5.1.3.4 Limited Funding & Resources	17
5.1.3.5 Overly Complex/Simplistic Exercise Design	18
5.1.3.6 Communication Gaps & Breakdown	16
5.1.3.7 Data Collection Challenges	6
5.1.3.8 Low/Inconsistent Partner Participation	23
5.1.3.9 Low Executive/Leadership Engagement	19
5.1.3.10 Administrative Burden & Complex Tools	27
5.1.3.11 Competing Priorities & Time Constraints	13
5.1.3.12 Staffing Shortages & High Turnover	17
5.1.4 Interesting Quotes	23
5.1.5 Enabler (Facilitator)	279
5.1.5.1 Supportive Leadership, Championing Culture	27

5.1.5.2 Continuous Improvement/AARs	22
5.1.5.3 Education, Training, Experience Sharing	23
5.1.5.4 Efficient Planning & Administrative Simplicity	31
5.1.5.5 Flexibility/Local Adaptation	9
5.1.5.6 Inclusive Stakeholder Involvement	31
5.1.5.7 Realistic, Clear, Manageable Exercise Design	34
5.1.5.8 Regulatory/Accreditation/Funding Motivation	22
5.1.5.9 Robust Communication & Information Sharing	33
5.1.5.10 Strong Collaboration & Coalition Engagement	46
5.2 Mechanism	22
5.3 Outcomes	2
5.3.1 Implementation	2
5.3.1.1 Reach	0
5.3.1.2 Effectiveness	0
5.3.1.3 Adoption	2
5.3.1.4 Implementation	0
5.3.1.5 Maintenance	0
5.3.2 Service	5
5.3.2.1 Efficiency	3
5.3.2.2 Safety	2
5.3.2.3 Effectiveness	0
5.3.2.4 Patient-centeredness	0
5.3.2.5 Timeliness	0
5.3.3 Clinical/ Patient	0
5.3.3.1 Satisfaction	0
5.3.3.2 Function	0
5.3.3.3 Symptomatology	0
6 Survey Questions	0
6.1 What organization do you primarily represent? (e.g., Regional Healthcare Coalition, Henry Ford Hospital- Main Campus, State of	15
6.2 What is your current job title or position?	15
6.3 In what other ways do you participate in the Healthcare Coalition? (Select all that apply) - Selected Choice	15
6.4 Please provide a brief summary of the 2024 scenario that your Healthcare Coalition (HCC) used during your planning or exercises	15

6.5 What hazards do you believe pose the greatest risk of disaster in your region?	14
6.6 What hazards do you think are most likely to cause a disaster at the national level?	14
6.7 What is your organization's estimated annual spending on disaster preparedness activities?	13
6.8 What are the top five most effective disaster management exercises your organization coordinates,... - Exercise Name/ Type - Ex	61
6.9 Response ID	15
7 Additional Interview Questions	0
7.1 What role should academia play in disaster research?	11
7.2 How have you applied the whole community approach?	5

CODE MEMOS (DEFINITIONS)

4 CFIR

4.1 I. INNOVATION DOMAIN

The "thing" being implemented, e.g., a new clinical treatment, educational program, or city service.

4.1.1 A. Innovation Source

The group that developed and/or visibly sponsored use of the innovation is reputable, credible, and/or trustable.

4.1.2 B. Innovation Evidence-Base

The innovation has robust evidence supporting its effectiveness.

4.1.3 C. Innovation Relative Advantage

The innovation is better than other available innovations or current practice.

4.1.4 D. Innovation Adaptability

The innovation can be modified, tailored, or refined to fit local context or needs.

4.1.5 E. Innovation Trialability

The innovation can be tested or piloted on a small scale and undone.

4.1.6 F. Innovation Complexity

The innovation is complicated, which may be reflected by its scope and/or the nature and number of connections and steps.

4.1.7 G. Innovation Design

The innovation is well designed and packaged, including how it is assembled, bundled, and presented.

4.1.8 H. Innovation Cost

The innovation purchase and operating costs are affordable.

4.2 II. OUTER SETTING DOMAIN
The setting in which the Inner Setting exists, e.g., hospital system, school district, state. There may be multiple Outer Settings and/or multiple levels within the Outer Setting.

4.2.1 A. Critical Incidents
Large-scale and/or unanticipated events disrupt implementation and/or delivery of the innovation.

4.2.2 B. Local Attitudes
Sociocultural values and beliefs encourage the Outer Setting to support implementation and/or delivery of the innovation.

4.2.3 C. Local Conditions
Economic, environmental, political, and/or technological conditions enable the Outer Setting to support implementation and/or delivery of the innovation.

4.2.4 D. Partnerships & Connections
The Inner Setting is networked with external entities, including referral networks, academic affiliations, and professional organization networks.

4.2.5 E. Policies & Laws
Legislation, regulations, professional group guidelines and recommendations, or accreditation standards support implementation and/or delivery of the innovation.

4.2.6 F. Financing
Funding from external entities is available to implement and/or deliver the innovation.

4.2.7 G. External Pressure
External pressures drive implementation and/or delivery of the innovation.

4.2.7.1 1. Societal Pressure
Mass media campaigns, advocacy groups, or social movements drive implementation and/or delivery of the innovation.

4.2.7.2 2. Market Pressure
Competing with and/or imitating peer entities drives implementation and/or delivery of the innovation.

4.2.7.3 3. Performance-Measurement Pressure
Quality or benchmarking metrics or established service goals drive implementation and/or delivery of the innovation.

4.3 III. INNER SETTING DOMAIN
The setting in which the innovation is implemented, e.g., hospital, school, city.

4.3.1 A. Structural Characteristics
Infrastructure components support functional performance of the Inner Setting.

4.3.1.1 1. Physical Infrastructure
Layout and configuration of space and other tangible material features support functional performance of the Inner Setting.

4.3.1.2 2. Information Technology Infrastructure
Technological systems for communication, documentation, data storage, management, reporting, and analysis support functional performance of the Inner Setting.

4.3.1.3 3. Work Infrastructure
Organization of tasks and responsibilities within and between individuals and teams support functional performance of the Inner Setting.

4.3.2 B. Relational Connections
There are high-quality formal and informal relationships, networks, and teams within and across Inner Setting boundaries.

4.3.3 C. Communications
There are high-quality formal and informal information-sharing practices within and across Inner Setting boundaries.

4.3.4 D. Culture
There are shared values, beliefs, and norms across the Inner Setting.

4.3.4.1 1. Human Equality-Centeredness
There are shared values, beliefs, and norms about the equal worth and value of all human beings.

4.3.4.2 2. Recipient-Centeredness
There are shared values, beliefs, and norms around caring for and addressing the needs of recipients.

4.3.4.3 3. Deliverer-Centeredness
There are shared values, beliefs, and norms around caring for and addressing the needs of deliverers.

4.3.4.4 4. Learning-Centeredness
There are shared values, beliefs, and norms around continual improvement and using data to inform practice.

4.3.5 E. Tension for Change
The current situation is intolerable and needs to change.

4.3.6 F. Compatibility
The innovation fits with workflows, systems, and processes.

4.3.7 G. Relative Priority
Implementing and delivering the innovation is important compared to other initiatives.

4.3.8 H. Incentive Systems
Tangible and/or intangible incentives and rewards support implementation and delivery of the innovation.

4.3.9 I. Mission Alignment
Implementing and delivering the innovation aligns with the overarching goals of the Inner Setting.

4.3.10 J. Available Resources
Resources are available to implement and deliver the innovation.

4.3.10.1 1. Funding
Funding is available to implement and deliver the innovation.

4.3.10.2 2. Space
Physical space is available to implement and deliver the innovation.

4.3.10.3 3. Materials & Equipment
Supplies are available to implement and deliver the innovation.

4.3.11 K. Access to Knowledge & Information
Guidance and/or training is accessible to implement and deliver the innovation.

4.4 IV. INDIVIDUALS DOMAIN
The roles and characteristics of individuals.

4.5 V. IMPLEMENTATION PROCESS DOMAIN
The activities and strategies used to implement the innovation.

5 IRLM

5.1 Determinants

5.1.3 Barrier
Used to categorize barriers to MRSE implementation identified during interviews and qualitative analysis.

5.1.3.1 Lack of Jurisdictional Authority
Coalitions lack power to require or enforce participation.

5.1.3.2 Low Perceived Value (“Check the Box”)
Some participate only for compliance rather than meaningful improvement.

5.1.3.3 Scheduling & Logistical Barriers
Scheduling conflicts and real-world events disrupt participation.

5.1.3.4 Limited Funding & Resources
Limited or declining resources make engagement difficult.

5.1.3.5 Overly Complex/Simplistic Exercise Design
Exercises may be overly burdensome, unrealistic, or insufficiently localized.

5.1.3.6 Communication Gaps & Breakdown
Inconsistent, unclear, or delayed communication weakens participation and coordination.

5.1.3.7 Data Collection Challenges
Obtaining timely and accurate data from partners is difficult.

5.1.3.8 Low/Inconsistent Partner Participation
Some sectors, including EMS, LTC, and home care, are difficult to engage consistently.

5.1.3.9 Low Executive/Leadership Engagement
Limited C-suite involvement and leadership buy-in reduce engagement.

5.1.3.10 Administrative Burden & Complex Tools
MRSE tools and reporting requirements create administrative burden and frustration.

5.1.3.11 Competing Priorities & Time Constraints
Clinical and operational demands limit participation in preparedness activities.

5.1.3.12 Staffing Shortages & High Turnover
Insufficient staffing and turnover negatively affect preparedness participation and continuity.

5.1.5 Enabler (Facilitator)
Used to categorize facilitators supporting MRSE implementation and participation.

5.1.5.1 Supportive Leadership, Championing Culture
Supportive leadership and preparedness-focused culture encourage participation and improvement.

5.1.5.2 Continuous Improvement/AARs
After-action reviews and feedback processes support ongoing improvement.

5.1.5.3 Education, Training, Experience Sharing
Training and shared experiences improve preparedness knowledge and capabilities.

5.1.5.4 Efficient Planning & Administrative Simplicity
Simplified processes and minimal paperwork support sustainable implementation.

5.1.5.5 Flexibility/Local Adaptation
Exercises can be adapted to local hazards, needs, and context.

5.1.5.6 Inclusive Stakeholder Involvement
Broad stakeholder engagement supports relevance and participation.

5.1.5.7 Realistic, Clear, Manageable Exercise Design
Exercises are practical, understandable, and operationally feasible.

5.1.5.8 Regulatory/Accreditation/Funding Motivation
Funding requirements, mandates, and accreditation standards encourage participation.

5.1.5.9 Robust Communication & Information Sharing
Timely communication and information sharing support transparency and collaboration.

5.1.5.10 Strong Collaboration & Coalition Engagement
Trusted relationships and coordination across organizations support preparedness activities.

5.3 Outcomes

5.3.1 Implementation
Implementation-related outcomes associated with preparedness activities and MRSE participation.

5.3.2 Service
Service-related outcomes associated with healthcare preparedness and delivery systems.

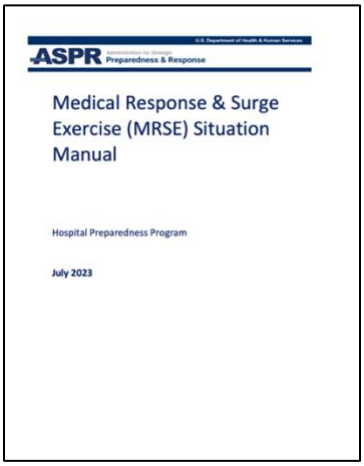
5.3.3 Clinical/Patient
Clinical and patient-related outcomes associated with preparedness implementation.

6 Survey Questions
Survey questions used to support quantitative and qualitative data collection in Aim 2.

7 Additional Interview Questions
Supplemental interview questions used to capture broader reflections related to preparedness, Healthcare Coalitions, and disaster research.

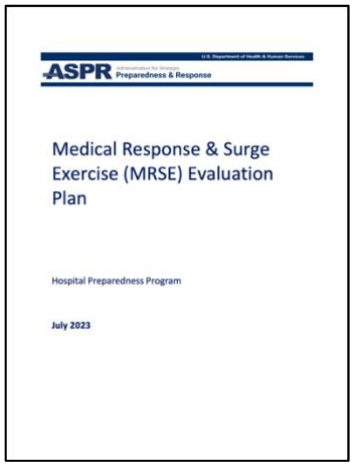
Appendix D

Federal MRSE Guidance Documents Reviewed in Aim 1(Chapter 2)



The Medical Response Surge Exercise (MRSE) Situation Manual is a 70-page document published in July 2023 and publicly available on the Administration for Strategic Preparedness and Response (ASPR) website. ASPR describes the Situation Manual as the core document provided to all exercise participants. It provides detailed guidance for planning and conducting the MRSE, including the exercise purpose, objectives, scenario information, participant roles, discussion prompts, and implementation activities intended to support coordinated preparedness planning, discussion, and response activities during a simulated medical surge event.

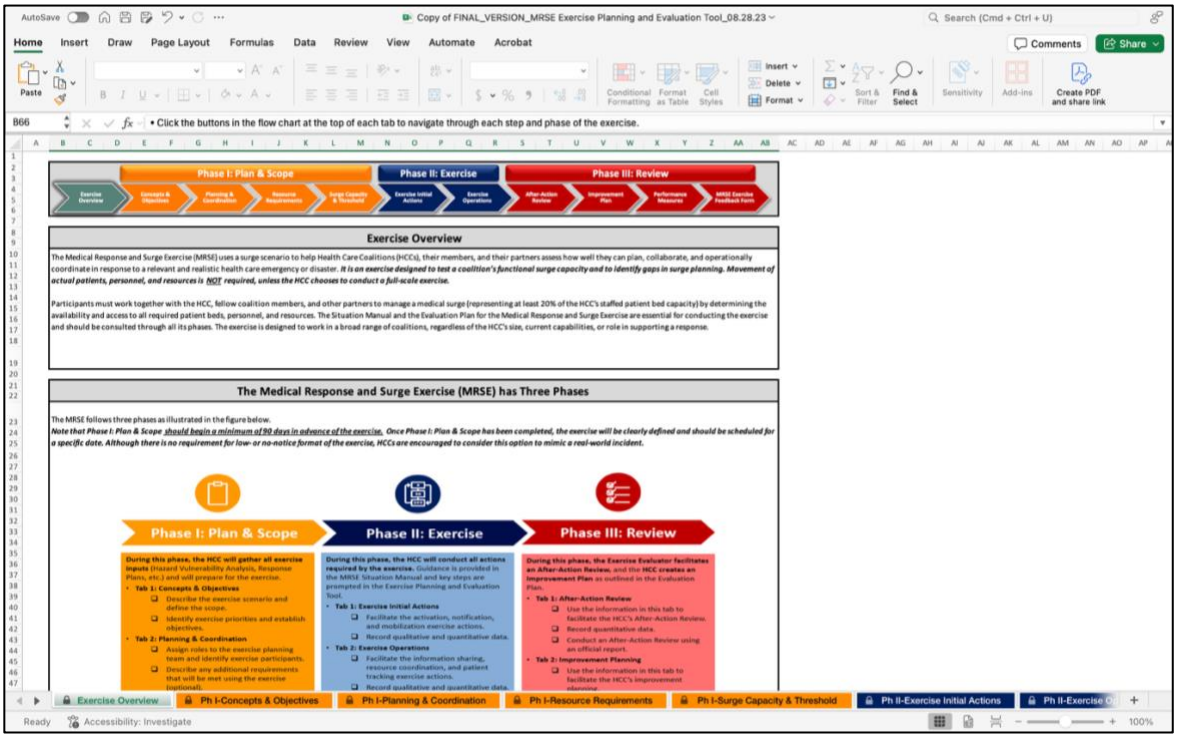
Administration of Strategic Preparedness and Response (ASPR). (2023, July). *Medical Response & Surge Exercise (MRSE) Situation Manual*. Department of Homeland Security (DHS). https://aspr.hhs.gov/HealthCareReadiness/guidance/MRSE/Documents/MRSE_Situation%20Manual_508_09.27.23.pdf



The ASPR Medical Response Surge Exercise (MRSE) Evaluation Plan is a 38-page document published in July 2023 and publicly available on the Administration for Strategic Preparedness and Response (ASPR) website. The document outlines the goals and purpose of exercise evaluation for Healthcare Coalitions (HCCs) and provides guidance for Exercise Evaluators during the MRSE process. It includes instructions for supporting exercise implementation, gathering and documenting observations, facilitating the After-Action Review process, and translating exercise findings into an After-Action Report and Improvement Plan (IP) in collaboration with exercise participants.

Administration of Strategic Preparedness and Response (ASPR). (2023, July). *Medical Response & Surge Exercise (MRSE) Evaluation Plan*. https://aspr.hhs.gov/HealthCareReadiness/guidance/MRSE/Documents/MRSE_Evaluation_Plan_508_09.27.23.pdf

The ASPR Medical Response Surge Exercise (MRSE) Exercise Planning and Evaluation Tool is an Excel-based document consisting of 11 worksheets. When converted to PDF, the document resulted in 179 unformatted pages and was subsequently reformatted and scaled to 35 pages for analysis. The version analyzed in this study was published in August 2023. Although not directly publicly accessible online, the document was available upon request through ASPR MRSE points of contact. The tool is primarily used by the Exercise Evaluator to document planning decisions, exercise activities, evaluation findings, and review processes throughout the MRSE. It includes sequentially organized worksheets that support exercise planning, data collection, and evaluation activities, including documentation related to Hospital Preparedness Program (HPP) cooperative agreement performance measures, After-Action reporting, and Improvement Planning activities.



Administration of Strategic Preparedness and Response (ASPR). (2023, August). *MRSE Exercise Planning and Evaluation Tool*.

Appendix E

Aim 1 Complete MAXQDA Output

Code System	MRSE Situation Manual	MRSE Evaluation Plan	MRSE Exercise Planning and Evaluation Tool	TOTAL
I. INNOVATION DOMAIN	32.60%	6.50%	51.70%	27.00%
A. Innovation Source	2.90%	2.30%		2.40%
B. Innovation Evidence-Base	1.60%	1.00%		1.20%
C. Innovation Relative Advantage				
D. Innovation Adaptability	21.00%			12.60%
E. Innovation Trialability				
F. Innovation Complexity				
G. Innovation Design	14.20%	3.10%	51.70%	15.00%
H. Innovation Cost				
II. OUTER SETTING DOMAIN	2.80%	9.20%	2.00%	4.60%
A. Critical Incidents	1.60%	3.60%		2.00%
B. Local Attitudes				
C. Local Conditions				
D. Partnerships & Connections				
E. Policies & Laws	1.00%	5.10%	2.00%	2.30%
F. Financing	0.20%	0.40%		0.30%
G. External Pressure				
1. Societal Pressure				
1. Market Pressure				
1. Performance-Measurement Pressure				
III. INNER SETTING DOMAIN	21.10%	23.00%	5.50%	19.90%
A. Structural Characteristics				
1. Physical Infrastructure				

2. Information Technology Infrastructure				
3. Work Infrastructure				
B. Relational Connections				
C. Communications				
D. Culture				
1. Human Equality-Centeredness				
2. Recipient-Centeredness				
3. Deliverer-Centeredness				
4. Learning-Centeredness				
E. Tension for Change				
F. Compatibility				
G. Relative Priority				
H. Incentive Systems				
I. Mission Alignment				
J. Available Resources	5.50%		5.50%	3.90%
1. Funding				
2. Space				
3. Materials & Equipment				
K. Access to Knowledge & Information	15.60%	23.00%		16.00%
IV. INDIVIDUALS DOMAIN	3.70%	1.90%	19.60%	4.90%
IV. INDIVIDUALS DOMAIN (Roles)				
A. High-level Leaders				
B. Mid-level Leaders				
C. Opinion Leaders				
D. Implementation Facilitators	0.90%			0.60%
E. Implementation Leads	1.00%			0.60%
F. Implementation Team Members	0.20%		14.20%	1.60%
G. Other Implementation Support	0.30%	0.60%	2.10%	0.60%
H. Innovation Delivers	0.80%	0.30%		0.60%
I. Innovation Recipients	0.20%		3.30%	0.50%
IV. INDIVIDUALS DOMAIN (Characteristics)				
A. Need				
B. Capability	0.60%	1.90%		0.90%
C. Opportunity				
D. Motivation				

V. IMPLEMENTATION PROCESS DOMAIN	32.70%	58.70%	21.20%	39.10%
A. Teaming				
B. Assessing Needs	0.80%		6.90%	1.20%
1. Innovation Deliverers				
2. Innovation Recipients	0.80%			0.50%
C. Assessing Context	3.40%		2.90%	2.40%
D. Planning	5.10%	4.00%	2.30%	4.50%
E. Tailoring Strategies	0.70%			0.40%
F. Engaging	10.70%		5.20%	7.00%
1. Innovation Deliverers	1.00%			0.60%
2. Innovation Recipients	10.70%		5.20%	7.00%
G. Doing	5.20%	36.90%	3.90%	14.30%
1. Innovation Delivers	0.70%	36.90%		11.20%
2. Innovation Recipients	0.70%			0.40%
H. Reflecting & Evaluating	5.80%	17.80%		8.70%
1. Implementation	4.00%	9.60%		5.20%
2. Innovation	1.30%	8.20%		3.20%
I. Adapting	0.40%			0.30%
NOT CODED	7979.00	4859.00	60893.00	73731.00
CODED	100.0% (134,470)	100.0% (65,909)	100.0% (24,412)	100.0% (224,791)
WHOLE TEXT	142449.00	70768.00	85305.00	298522.00

MAXQDA Code Coverage (Characters of coded segments)

Appendix F

Aim 2 Qualtrics Survey Instrument (Chapter 3)

Enhancing Disaster Resilience Survey - HCC MRSE

Survey Flow

Standard: Introduction (2 Questions)
Standard: Consent (3 Questions)
Block: Demographics and Coalition Involvement (14 Questions)
Standard: MRSE Participation and Engagement (10 Questions)
Standard: MRSE Participant Feedback (9 Questions)
Standard: Disaster Preparedness Insights and Experiences (9 Questions)
Standard: Compensation (5 Questions)
End Survey:

Start of Block: Introduction

Enhancing Disaster Resilience: Insights from Healthcare Coalitions Survey Thank you for your interest in participating in the *Strengthening Disaster Resilience: A Comprehensive Analysis of Healthcare Coalitions' Medical Surge Response Exercises* research study. By collaborating with researchers and practitioners, we can enhance our ability to protect communities and reduce the impact of disasters. **Participant Eligibility Criteria:** You are 18 years of age or older. You are a Healthcare Coalition Leader or a representative of a Coalition Partner organization from one of the eight Healthcare Coalitions OR on the ASPR MRSE Team. You have participated in at least one 2024 Medical Surge Response Exercise (MRSE) phase. **Overview of Survey Part 1** - Consent Form for Participation in Research Study **Part 2** - Demographics and Coalition Involvement **Part 3** - MRSE Participation and Engagement **Part 4** - MRSE Participant Feedback **Part 5** - Disaster Preparedness Insights and Experiences. While we encourage you to complete the survey in a single sitting, you can save your progress and return later if necessary. The survey should take approximately 20-25 minutes to complete.

Do you meet the eligibility criteria?

- ○ Yes, I meet the eligibility criteria and would like to proceed with the survey.
- ○ No, I do not meet the eligibility criteria.

End of Block: Introduction

Start of Block: Consent

Part 1 - University of Michigan Consent To Be Part Of A Research Study NAME OF STUDY AND RESEARCHERS Title of Project: Strengthening Disaster Resilience with HCC's **Principal Investigator:** Azia Harris-Martin, MPH PhD Candidate at The University of Michigan – Medical School Department of Learning Health Sciences
HUM#00246148 GENERAL INFORMATION You are invited to participate in a research study that explores the factors influencing the planning, execution, and learning processes of the Administration for Strategic Preparedness and Response (ASPR) Medical Response Surge Exercise (MRSE). The study will examine MRSE processes, identify barriers and facilitators, and provide recommendations for improving disaster management exercise design, integrating implementation science into disaster practices, and enhancing the evidence base for Healthcare Coalitions (HCCs). If you choose to participate, you will complete a 20–25-minute online survey and a 75-minute virtual interview. Our goal is to include 50 participants, ensuring equal representation from Healthcare Coalitions. While participation will not directly benefit you, the findings will help improve disaster management exercises by incorporating implementation science at federal, state, and local levels. This may enhance their design, relevance, and effectiveness, ultimately strengthening healthcare system resilience during emergencies. There are no known risks associated with participation, and it is entirely voluntary. The activities involved are non-invasive and should not cause physical or emotional harm. To ensure confidentiality, we will label your survey with a code instead of your name. We will keep a list of participants, but no one outside the research team will be able to identify individual responses. We plan to publish what we learn from this study, but we won't include any personal information that could reveal who answered the survey. The interview will be audio recorded for research purposes, specifically to analyze and improve disaster preparedness strategies. Recordings may be transcribed using artificial intelligence (AI) software to assist with data analysis, and transcriptions will be reviewed for accuracy. All recordings and transcriptions will remain confidential and securely stored. Please feel free to ask any questions or express concerns about the recording or transcription process before or during the interview. As a rule, the researchers will continue to use information about you until the study is over and will keep it secure until it is destroyed. Limited information about you may continue to be used after the study is over, for other research, education, or other activities. But use of this information would not reveal your identity. To thank you for taking part in our study, we'll send you $25 after you take the survey. Participants who complete the entire study will receive $75 in the form of a gift card: $25 for completing the survey and $50 for completing the interview. The University of Michigan finance department will need your name and address for tax reporting purposes. In a calendar year if: 1) your payments total greater than $400 for this study or 2) if you receive payments of greater than $400 for being in more than one study, the University of Michigan

finance department will also require your Social Security Number for tax reporting purposes. If you do not wish to provide your Social Security Number, you may continue to participate in research studies, but you will not be able to receive payment for the remainder of the calendar year. Participation is completely voluntary, and you may withdraw from the study at any time without any consequences, even after starting the survey or interview. Your research records will be securely stored in a password-protected Dropbox account with encryption and access controls. All recordings and transcriptions will remain confidential. No identifying information will be included in any reports or publications resulting from this study. Information collected in this project may be shared with other researchers, but we will not share any information that could identify you. If you have any questions about this research study, please get in touch with the lead researcher, Azia Harris-Martin, at aziahm@umich.edu. You can also reach her faculty advisor, Andrew Krumm, at aekrumm@med.umich.edu or Amy Kilbourne, at amykilbo@med.umich.edu. The University of Michigan Medical School Institutional Review Board (IRBMED) has determined that this study is exempt from IRB oversight.

Consent Form Attestation

- ○ Yes, I consent to participate in this research study.
- ○ I do not consent to participate in this research study.

Consent Electronic Signature

End of Block: Consent

Start of Block: Demographics and Coalition Involvement

Part 2 – Demographics and Coalition Involvement

Q1 Name (First and Last)

_____

Q2 Mobile Number

_____

Q3 Email

_____

Please confirm your email address

_____

Q4 How do you describe yourself?

- ○ Male
- ○ Female
- ○ Non-binary / third gender
- ○ Prefer to self-describe _____
- ○ Prefer not to say

Q5 Choose one or more races that you consider yourself to be

- ☐ American Indian/Native American or Alaska Native
- ☐ Asian or Asian American
- ☐ Black or African American
- ☐ Hispanic, Latinx, or Spanish origin
- ☐ Middle Eastern or North African
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White or Caucasian
- ☐ Other
- ☐ Prefer not to say

Q6 How old are you?

- ○ Under 18
- ○ 18-24 years old
- ○ 25-34 years old
- ○ 35-44 years old
- ○ 45-54 years old
- ○ 55-64 years old
- ○ 65+ years old

Q7 What Healthcare Coalition do you participate in? (Select all that apply)

- ○ Region 1
- ○ Region 2N
- ○ Region 2S
- ○ Region 3
- ○ Region 5
- ○ Region 6
- ○ Region 7
- ○ Region 8
- ○ Other _____

Q8 What organization do you primarily represent? (e.g., Regional Healthcare Coalition, Henry Ford Hospital- Main Campus, State of Michigan)

_____

Q9 What Healthcare Coalition Stakeholder Group best describes your organization?

- ○ Healthcare Coalition Leader
- ○ Hospital / Healthcare Organization
- ○ Public Health Department
- ○ Government Partner
- ○ Emergency Medical Services
- ○ Skilled Nursing/ Long-Term Care
- ○ Other _____

Q10 What is your current job title or position?

_____

Q11 In what other ways do you participate in the Healthcare Coalition? (Select all that apply)

- ☐ National ASPR Workgroup
- ☐ The Regional Coalition Planning Board
- ☐ The Healthcare Coalition Executive Committee
- ☐ The Regional Advisory Committee
- ☐ Regional Coalition Subcommittee Workgroup
- ☐ Other _____
- ☐ None

Q12 Would you be willing to participate in a follow-up 75-minute Zoom interview? *This interview will help gather valuable insights to improve disaster preparedness strategies. As a thank you for your time, you will be eligible to receive an additional $50 in compensation.*

- ○ Yes
- ○ Maybe
- ○ No

End of Block: Demographics and Coalition Involvement

Start of Block: MRSE Participation and Engagement

Part 3 – 2024 MRSE Participation and Engagement

Q13 Did you participate in at least one phase of the 2024 Medical Response Surge Exercise (MRSE)?

- ○ Yes
- ○ No

Q14 On a scale from 1 to 5, how familiar are you with the objectives and intended outcomes of planning, conducting, and reviewing the Medical Response Surge Exercise (MRSE)?

- ○ 1 - Not familiar at all
- ○ 2 - Slightly familiar
- ○ 3 - Moderately familiar
- ○ 4 - Very familiar
- ○ 5 - Extremely familiar

Q15 Have you read the MRSE Situation Manual?

- ○ Yes
- ○ No

Q16 Have you participated in any previous ASPR Exercises? (e.g., Coalition Surge Test and the Hospital Surge Test)

- ○ Yes
- ○ No

Q17 Please provide a brief summary of the 2024 scenario that your Healthcare Coalition (HCC) used during your planning or exercises. If this does not apply to your HCC, please mark "N/A."

_____

Q18 Which phases of the 2024 MRSE did you participate in? (Select all that apply)

- ☐ Exercise Overview
- ☐ Phase I: Plan & Scope
- ☐ Phase II: Exercise
- ☐ Phase III: Review

Q19 How would you rate your level of involvement in the following phases of the 2024 MRSE? *Please select the option that best reflects your participation in each phase*.

	Did Not Participate (0)	Somewhat Participated (1–2)	Fully Participated (3)
Exercise Overview: Developing the exercise			
Phase 1 – Plan & Scope: Planning the exercise implementation			
Phase 2 – Exercise: Conducting or participating in the exercise			
Phase 3 – Review: Reviewing the exercise and improving processes			

Q20 Please estimate the number of hours you and your organization spent on each phase of the 2024 MRSE:

- ○ **Exercise Overview** – *Developing the exercise*

  _____

- ○ **Phase 1: Plan & Scope** – *Planning the exercise implementation*

  _____

- ○ **Phase 2: Exercise** – *Conducting or participating in the exercise*

  _____

- ○ **Phase 3: Review** – *Reviewing the exercise and improving processes*

  _____

Q21 Approximately how many people from your organization participated in the 2024 MRSE exercise?

▼ 0-5 ... 50+

End of Block: MRSE Participation and Engagement

Start of Block: MRSE Participant Feedback

Part 4 – MRSE Participant Feedback

Q22 **In this section, please select the option that best reflects your experience with the 2024 Medical Response Surge Exercise (MRSE) and the organization you referenced in Part 2 of the survey.** Your responses will help assess the outcomes and effectiveness of the 2024 HPP MRSE, using questions adapted from the CFIR pCAT, the University of Colorado Denver iPRISM webtool, and the FEMA HSEEP. These tools are designed to support organizations in evaluating implementation processes, improving outcomes, and ensuring the long-term sustainability of their interventions.

Section 1: Exercise Fundamental Principles - Please indicate your level of agreement with the following statements regarding the 2024 MRSE in your organization.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
1. The 2024 MRSE was guided by senior leadership.	○	○	○	○	○	○
2. The 2024 MRSE was developed with consideration of potential risks	○	○	○	○	○	○
3. The 2024 MRSE was based on organizational capabilities and is driven by clear objectives.	○	○	○	○	○	○
3. The 2024 MRSE was based on organizational capabilities and is driven	○	○	○	○	○	○

by clear objectives.						
5. A consistent methodology was used in the development and conduct of the 2024 MRSE.	○	○	○	○	○	○
6. The 2024 MRSE integrated the contributions and perspectives of the entire community.	○	○	○	○	○	○

Section 2: Outcomes and Objectives - Please indicate your level of agreement with the following statements regarding the 2024 MRSE in your organization.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
1. The MRSE effectively engaged Healthcare Coalition members and executives in preparedness and response planning, increasing their participation in the exercise and After-Action Review.	○	○	○	○	○	○
2. The MRSE strengthened	○	○	○	○	○	○

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
our organization's ability to notify members of incidents and improved processes for coordinating information during emergencies and disasters.						
3. The MRSE enhanced our ability to assess and meet critical resource needs to manage patient surge during emergencies and disasters.	○	○	○	○	○	○
4. The MRSE improved our capacity to secure essential EMS resources for managing patient surge.	○	○	○	○	○	○
5. The MRSE improved our ability to reduce patient morbidity and mortality through appropriate patient	○	○	○	○	○	○

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
placement during large patient surges.						
6.The MRSE improved and validated our response plans, ensuring better coordination and execution during emergencies and disasters.	○	○	○	○	○	○

Section 3: Organizational Understanding and Communication - Please indicate your level of agreement with the following statements regarding the 2024 MRSE in your organization.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
1. People in my organization regularly seek to understand patients' needs and participate in the MRSE to meet those needs better.						
2. I have open lines of communication with everyone needed to execute the MRSE.						
3. I have access to data to help track changes in outcomes						

related to conducting the MRSE.	
4. People in this organization understand the importance of disaster preparedness and recognize the need for the MRSE.	
5. People here see the advantage of implementing the MRSE versus an alternative disaster preparedness exercise.	

Section 4: Alignment and Resources for MRSE Implementation - Please indicate your level of agreement with the following statements regarding the 2024 MRSE in your organization.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
1. The MRSE is aligned with leadership goals.	○	○	○	○	○	○
2. The MRSE is aligned with clinician values.	○	○	○	○	○	○
3. The MRSE is compatible with existing clinical processes.	○	○	○	○	○	○
4. The structures and policies in place here enable us to conduct the MRSE.	○	○	○	○	○	○
5. We have sufficient space to accommodate conducting the MRSE.	○	○	○	○	○	○

Section 5: Time, Resources, and Commitment - Please indicate your level of agreement with the following statements regarding the 2024 MRSE in your organization.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
1. We have sufficient time dedicated to conduct the MRSE.						

2. We have other needed resources to conduct the MRSE (staff, money, supplies, etc.).

3. Higher-level leaders are committed, involved, and accountable for conducting the MRSE.

4. Leaders across the organization are committed, involved, and accountable for conducting the MRSE.

5. The MRSE has been adopted by a high percentage of the intended settings and delivery staff, including those serving socially and economically disadvantaged populations, with strong participation from staff.

Section 6: Impact, Adaptation, and Sustainability - Please indicate your level of agreement with the following statements regarding the 2024 MRSE in your organization.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
1. The staff in my organization consistently deliver the core functions of MRSE with high quality, and the MRSE has been adapted as needed to fit our setting, considering available resources.						
2. The MRSE has reached a high percentage of its intended recipients, including equitable reach to socially and economically disadvantaged populations.						
3. The MRSE is effective for its intended recipients, particularly for socially and economically disadvantaged populations						

4. It is likely that MRSE will continue to be delivered effectively over time in a high percentage of participating settings, and will maintain sustained effectiveness for at least 1-2 years, especially for socially and economically disadvantaged populations.	

Page Break

Section 7: Please evaluate your organization's ability to meet the **MRSE evaluation measures** by selecting one of the following options for each statement:

	Yes	Partially	No
Manage Surge Demand: *Did your organization or region successfully meet the clinical objective of handling 20% of staffed bed surge demand?*			
Confirm Availability of EMS Resources: *Did your organization confirm the availability of EMS resources to support patient surge during the exercise?*			

Conduct Staffed Bed Census and Patient Allocation: *Did your organization conduct a staffed bed census and allocate patients based on available capacity during the exercise?*

Confirm Availability of Personnel: *Was the availability of personnel (e.g., medical staff, support staff) confirmed to ensure sufficient staffing during the exercise?*

Confirm Pharmaceutical Supplies and Equipment: *Did your organization confirm the availability of necessary pharmaceutical supplies and medical equipment to support patient care during the exercise?*

Support for Resource Sharing: *Was resource sharing (e.g., equipment, staff, pharmaceuticals) facilitated among organizations or regions during the exercise?*

Staffed Bed Availability for Patients: *Did your organization confirm that sufficient staffed beds were available for patient care during the exercise?*

Tracking Patient Transfer: *Was there a system to track patient transfers between facilities during the exercise?*	

End of Block: MRSE Participant Feedback

Start of Block: Disaster Preparedness Insights and Experiences

Part 5 – Disaster Preparedness Insights and Experiences

Q23 What hazards do you believe pose the greatest risk of disaster in your region?

_____

Q24 What hazards do you think are most likely to cause a disaster at the national level?

_____

Q25 What is your organization's estimated annual spending on disaster preparedness activities?

_____

Q26 What are the **top five most effective disaster management exercises** your organization coordinates, hosts, or regularly participates in? *Please specify the name or type of each exercise and its frequency. If you cannot identify five, provide as many as you can and leave the remaining fields blank.*

	Exercise Name/ Type	Exercise Frequency
	Short Description	
Exercise 1		▼ Semi-annually ... Other
Exercise 2		▼ Semi-annually ... Other
Exercise 3		▼ Semi-annually ... Other
Exercise 4		▼ Semi-annually ... Other
Exercise 5		▼ Semi-annually ... Other

Q27 Which type of exercise do you find **most effective** for preparing your organization for disasters? (Descriptions of exercise types are provided for reference.)

- ○ Seminars
- ○ Workshops
- ○ Functional Exercise (FE)
- ○ Tabletop Exercise (TTX)
- ○ Full-Scale Exercise (FSE)

Q28 Did you utilize the 2024 MRSE Scenario to meet other disaster management requirements (e.g., The Joint Commission Emergency Management Standard, CMS Emergency Preparedness Rule, etc.)?

- ○ Yes
- ○ No

If yes, please provide additional details on how you utilized the 2024 MRSE Scenario to meet other disaster management requirements.

_____

Q29 Did your organization apply lessons learned from the 2024 MRSE to refine and strengthen your current emergency management strategies and procedures?

- ○ Yes
- ○ No

End of Block: Disaster Preparedness Insights and Experiences

Start of Block: Compensation

Next Steps and Compensation Information

Q30 To show our appreciation for your time, we are offering $25 for completing the survey and an additional $50 for completing an interview. After the interview, compensation will be provided as a one-time gift card (estimated March 2025). **Would you like to accept this compensation?**

- ○ Yes, I would appreciate compensation.
- ○ No, I'm happy to participate without compensation.
- ○ No preference; I'm participating to support the study.

Q31 How would you prefer to receive your compensation? (Select one)

- ○ Electronic gift card - sent to an email
- ○ Physical gift card - sent to an address

Email
Please provide your preferred email address to the gift card.

_____

Address
Please provide the address where you would like the gift card to be mailed. (Please include the full address, including street address, city, state, and ZIP code.)
Street Address _____
City _____
State _____
Zip code _____

End of Block: Compensation

Appendix G

Aim 2 Interview Guide (Chapter 3)

Aim 2 – Understanding the Barriers and Facilitators in Conducting the MRSE in Healthcare Coalitions

Semi-Structured Interview Guide

Survey Tool: Zoom

This is a semi-structured interview, which allows for flexibility in conversation. Both the interviewer and interviewee may introduce new topics as they arise during the discussion. The primary purpose of this interview is to verify and expand upon the data collected from the "Enhancing Disaster Resilience: Insights from Healthcare Coalitions" survey. Specifically, we aim to confirm whether our understanding of the subject is complete and accurate. The MRSE CFIR Core Questions have been adapted from the CFIR Interview Guide Tool CFIR Interview Guide Tool. The interviews are estimated to take approximately 75-minutes.

Note: Interviews will be scheduled via a Calendly link and conducted on Zoom, which will be used to record audio, transcribe conversations, and take notes with the help of Zoom AI Companion and Otter.AI.

OPENING [5 MINUTES]

Interviewer:

Hello, [Interviewee Name]. Thank you for joining me today. My name is Azia Harris-Martin, and I'm a PhD candidate at the University of Michigan. I truly appreciate your time and insights.

Today, we'll discuss factors that influence the success of the MRSE and its role in strengthening organizational resilience and disaster preparedness. My goal is to understand your experiences and perspectives.

This is an open, judgment-free space—please share as much or as little as you're comfortable with.

Before we begin, I'd like to confirm that this conversation will be recorded for research accuracy. Your responses will remain confidential, and a pseudonym will be used in the transcript. I will update your screen name to your pseudonym now so that its is accurately reflected on the transcript. [Change screenname to pseudonym to initials]

As outlined in the consent form you previously signed, this interview will be audio-recorded via Zoom, and OtterAI will assist with transcription. Your responses will remain confidential.

Do you consent to the recording and AI transcription?

Interviewee: [Response]

Interviewer: [Starts Zoom Recording, Admit OtterAi] Please speak clearly for a quick microphone check. For the record, kindly state your pseudonym and the organization you represent.

Interviewee: [Response]

Interviewer: As we go through this interview, I when a question is asked referring to "your organization," please keep in mind the organization that you just mentioned. I also want to remind you that our primary focus today is the 2024 MRSE, but since the 2025 MRSE has taken place, feel free to share insights from that as well.

Before we jump in, do you have any questions?

Interviewee: [Response]

Interviewer: Great! In this interview, we'll start by discussing your background and experience in disaster management before diving into chatting more about the MRSE. We'll explore its goals, challenges, and outcomes, as well as how your organization engages with it—including implementation, external collaborations, and leadership support. Toward the end, we'll reflect on resilience and any areas for improvement. So, let's get started.

INTERVIEW QUESTIONS [45 MINUTES]
[Include Transition Phrases, Keep Log of All Questions]

Rapport Building (5 minutes)

1. Can you tell me a story about what inspired you to get involved in disaster management?
2. The FEMA model emphasizes 'Federally Supported, State Managed, and Locally Executed' disaster response. In your experience, how does this work in practice?
    a. How does the federal government **support** state and local disaster response, and where do gaps exisit?
    b. How do states **manage** disaster response between federal agencies and local governments?
    c. What enables local governments to **execute** disaster response effectively, and what support and or oversight do they need from state and federal agencies?
3. The FEMA Whole Community approach emphasizes engaging all sectors in disaster preparedness and response. How have you applied this model in your work to ensure essential services continue during disasters?
4. What role do you think academia should play in disaster management?
5. What do you see as the key benefits and challenges of Healthcare Coalitions (HCCs) in disaster response efforts?

Interviewer: Thanks for sharing! It's great to learn more about your background in disaster management. Now, let's shift our focus to the MRSE.

MRSE Introduction (10 minutes)

1. How would you explain the purpose and key goals of the MRSE to someone unfamiliar with it?
2. How would you describe your role in the 2024 MRSE?
3. What was your overall experience with the MRSE?
    - What aspects of the MRSE went well?
    - What challenges did you face?
4. The MRSE Situation Manual outlines six objectives. Did your organization achieve all of them? (Interviewer shares screen)
    a. Why or why not?
5. The manual also outlines seven intended outcomes. Were these outcomes achieved? (Interviewer shares screen)
    a. Why or why not?
6. What were the key takeaways from the MRSE for your organization?

MRSE CFIR Core Questions (35 minutes)

1. **Innovation (5-7 minutes)**
    1.1. What other disaster management exercises have you participated in?
        1.1.1. In what ways is the MRSE similar to other preparedness exercises?
        1.1.2. How does the MRSE differ from those exercises?
    1.2. How complex is the MRSE in terms of duration, scope, and key steps?
    1.3. Has your organization adapted the MRSE to better fit local needs?
        1.3.1. If so, what changes did you make?
    1.4. What evidence (e.g., data, feedback, outcomes) demonstrates the effectiveness of the MRSE?
    1.5. What financial or non-financial costs did your organization incur while implementing the MRSE?

2. **Outer Setting (5-7 minutes)**
    2.1. How were the needs of those your organization serves considered in the decision to conduct the MRSE?
    2.2. What information do you share with external partners about the MRSE or disaster management in general?
    2.3. Do you collaborate with external organizations when conducting the MRSE? If so, how?
    2.4. Which local, state, or national performance measures, policies, or regulations influenced your decision to implement the MRSE?
    2.5. What financial or other incentives played a role in your organization's decision to implement the MRSE?
        2.5.1. Do you think financial incentives would encourage more HCC partner organizations to participate in the MRSE?
        2.5.2. If not, what other factors might increase engagement?

3. **Inner Setting (5-7 minutes)**
    3.1. How aware is your organization of the MRSE and its objectives?

3.2. What resources (e.g., financial, human, or material) does your organization allocate to support the MRSE?
3.3. How does your organization's culture influence MRSE planning and execution?
3.4. How receptive is your organization—and other HCC partners—to implementing the MRSE?
    3.4.1. What challenges affect engagement?
    3.4.2. What motivates organizations to engage in the MRSE?
3.5. Do you think disaster preparedness exercises like the MRSE are deprioritized in favor of other initiatives?
3.6. Has your organization set specific goals for implementing the MRSE or other disaster preparedness exercises? If so, what are they?

4. Individuals (5-7 minutes)

4.1. How do you define leadership within your organization?
4.2. How supportive has leadership been in implementing the MRSE?
4.3. Who is typically involved in planning the MRSE within your organization?
4.4. Who participates in the MRSE, and who finds it difficult to engage?
    4.4.1. What factors influence participants' involvement?
4.5. What information and materials are provided to participants before the MRSE?
4.6. What training is provided beforehand? Is it sufficient?

5. **Process (5-7 minutes)**

5.1. Can you walk me through the steps your organization takes to plan and implement the MRSE?
5.2. What challenges did your organization face during MRSE planning?
5.3. How does your organization use MRSE tools (e.g., Situation Manual, Evaluation Plan, Evaluation Excel Tool)?
    5.3.1. How useful are these tools?
    5.3.2. What challenges or limitations exist in using them?
    5.3.3. What improvements would make them more effective?
5.4. Which aspects of planning are most critical to MRSE success?
5.5. How is the MRSE conducted, and what challenges arise during execution?
5.6. How well did your organization meet MRSE evaluation measures (e.g., 20% surge demand, EMS coordination, bed capacity tracking, staffing, resource sharing, patient transfers)?
5.7. How was the After-Action Review used to improve disaster response plans and future exercises?

Final Questions (3-5 minutes)

1. If you could change anything about the MRSE, what would it be and why?
2. How did you feel about the 2025 MRSE? How did it differ from 2024?
3. How do you define **disaster resilience** and **community resilience**?

4. What role do **HCCs** play in strengthening resilience?

WRAP-UP [5 minutes]
Interviewer: Thank you for your time and valuable insights. Before we close, is there anything else you'd like to add that we haven't covered?

Interviewee: [Response]

Interviewer: I truly appreciate your perspective. If anything else comes to mind, feel free to reach out. Your feedback will be incorporated into my data analysis to improve future disaster preparedness exercises.

- If you opted for compensation, you will receive communication about that soon.
- Once my analysis and write-up are complete, I will share a summary of the results with all participants**.**

Your responses will remain confidential and used solely for research purposes. If you have any questions, don't hesitate to reach out.

Interviewee: [Response]

Interviewer: I'm stopping the recording now. Thank you again! (Stop Recording and Transcribing)

Appendix H

Aim 3 Interview Guide and Activity (Chapter 4)

Aim 3 – Enhancing Disaster Resilience: Insights from Healthcare Coalitions

Semi-Structured Interview Guide

Additional Tools: PowerPoint (Sociotechnical Model Summary and Barrier/ Facilitator Outline)

This is a semi-structured interview, designed to allow flexibility and natural flow in the conversation. Both the interviewer and participant may introduce new topics as they come up during the discussion. The main goal of this interview is to verify and expand upon the data collected from the "Enhancing Disaster Resilience: Insights from Healthcare Coalitions" survey. Specifically, we aim to ensure that our understanding of the subject is both complete and accurate. The questions are intended to validate the findings from Aim 1 and further explore the insights from Aim 2, particularly regarding the implementation strategies and mechanisms participants would recommend. This interview uses a modified Think-Aloud approach, which helps gather real-time insights from participants that will inform the creation of a consolidated Implementation Research Logic Model (IRLM) for the MRSE project. (Reference: Ericsson, K. A., & Simon, H. A. (1998). How to study thinking in everyday life: Contrasting think-aloud protocols with descriptions and explanations of thinking. Mind, Culture, and Activity, 5(3), 178–186. https://doi.org/10.1207/s15327884mca0503_3)

Note: Interviews will be scheduled via a Calendly link and conducted on Zoom, which will be used to record audio, transcribe conversations, and take notes with the help of Zoom AI Companion and Otter.AI.

OPENING [5 MINUTES]

Interviewer: Thank you so much for taking the time to speak with me again today. I really appreciate your willingness to share your experiences in this follow-up interview.

Before we begin, I just want to confirm a few things:

- This interview will be audio recorded on Zoom and transcribed using OtterAI.
- You gave consent for recording and transcription when you signed the initial consent form in the survey.
- Your participation is voluntary, and your responses will remain confidential. Any recordings or transcripts will only be used for research as described in the consent form, and nothing will be shared without your approval.

- To protect your privacy, we'll continue using the same pseudonym as before: [blank]. Please update your screen name to match.

Do you have any questions before we start?
Interviewee: [Response]
Great! There are no right or wrong answers—this is your story. If you'd like to pause or take a break at any time, just let me know.

Do you consent to the recording and AI transcription as outlined in the consent form you signed earlier?

Interviewee: [Response]

Interviewer: [Starts recording] Please speak clearly so the transcription is accurate. Let's do a quick mic check. For the record, could you please state your pseudonym?
Interviewee: [Response]
Interviewer: During our first conversation, I wanted to better understand the barriers and supports you experienced when implementing the Medical Response Surge Exercise [MRSE] Since then, I've reviewed our discussion along with others and summarized the key barriers and enablers that came up most often. Just so we're on the same page: when I say **barriers**, I mean anything that gets in the way of successfully running the MRSE. **Enablers** are the supports, conditions, or actions that help make it work well.
The purpose of today's conversation is to confirm these findings with you, hear your thoughts on how to address these barriers and supports, and discuss practical ways your recommendations could be put into action.
Interviewee: [Response]

MRSE IRLM Core Questions [25 minutes]

Interviewee: Let's pivot a bit, keeping in mind the MRSE is a sociotechnical system in this part of the interview, we'll review key factors identified in earlier phases of the study—such as your survey responses and our first interview—that affect the success (or "enablers/facilitators") and challenges ("barriers") of implementing the MRSE. I'll share my screen and walk you through these factors.
As we talk, please feel free to share your thoughts on any actions, processes, or tools you think could address these areas. I'll take high-level notes, and the AI transcription will help capture your responses for later analysis.
Before we continue, here are a few quick instructions:

- **Speak freely:** Share any thoughts that come to mind, even if they feel unrelated.
- **No need to filter:** There's no need to justify or over-explain—just say what comes naturally.
- **Let thoughts flow:** Don't worry about having a "perfect" answer—speak as things come to you.
- **Keep talking:** If you're unsure, just keep sharing what you're thinking.

Do you have any questions before we start?
Interviewee: Response

Interviewer: Great – let's get started. [Interviewer Shares Screen – Complete list of Barriers/Facilitators].

On the screen, you'll see a list of the main factors identified so far, grouped into broad themes. Take a moment to look through them.

1. What are your first thoughts when you see this list?
2. Do you agree these factors can hinder MRSE implementation?
3. Are there any major barriers you expected to see but don't?
4. Do you agree these factors can support MRSE implementation?
5. Are there any supports or enablers missing from this list that help in your organization?

Interviewer: Thank you. Now, let's go through each of these factors—starting with the enablers that help make MRSE implementation successful. [Interviewer Shares Screen – Enablers/ Facilitators list, one slide at a slide] Read the factor for the transcription

1. *Context Check:* Does this factor apply to your organization by contributing to the successful implementation of the MRSE?
2. *Implementation Strategy:* What do you do to put this enabler into practice?
3. *Mechanism:* How does this factor support the implementation of the MRSE in practice?

Interviewer: Thank you for your insights about enablers. Now, let's review the barriers. [Interviewer Shares Screen – List Barriers, one slide at a slide] Read the factor for the transcription

1. *Context Check:* Is this barrier relevant in your organization?
2. *Context Check:* How does this barrier get in the way of a successful MRSE? Any examples?
3. *Implementation Strategy:* What solutions or strategies would help overcome this challenge?
4. *Mechanism:* What steps would you take to put that solution in place?
5. *Mechanism Resources:* What tools or resources would help you implement this solution effectively?

WRAP-UP [5 minutes]
Interviewer: Thank you for sharing your insights today. You've provided very valuable information about what affects the success of the MRSE.

- Is there anything else you'd like to add about your experience with the MRSE?
- Are there any points you'd like to clarify or expand on?
- Do you have any feedback on this interview process, or suggestions for how I can improve it in the future?

Interviewee: [Response]
Interviewer: Thank you again for your time and valuable insights. I will carefully review your input to strengthen my analysis and contribute to improving future disaster preparedness exercises. In the next few

weeks, I may follow up with you to validate a model I'm developing based on the MRSE manual and to get your feedback on how it can be adapted for local needs.
If you opted to receive compensation, you'll get details about that soon. I'll also share a summary of the results once the study is complete.
Please remember your responses are confidential and will be used only for this research. If you have any questions after today, don't hesitate to reach out. Your input is truly appreciated and will help make future exercises more effective.

Interviewee: [Response]

Interviewer: I'm stopping the recording now. Thank you again for your time and insight! (Stop Recording and Transcribing]

Modified Think-Aloud Activity

Summary of MRSE Enablers

Rank	Theme	Short Description
1	**Strong Collaboration & Coalition Engagement**	Trusted relationships and regular teamwork across partners drive seamless planning, participation, and resource sharing.
2	**Realistic, Clear, Manageable Exercise Design**	Exercises are straightforward, practical, and relevant, with scenarios and tools that make participation easy and meaningful.
3	**Robust Communication & Information Sharing**	Timely, multi-channel communication and regular updates foster transparency and collaboration.
4	**Education, Training, Experience Sharing**	Ongoing training and shared lessons keep partners informed, capable, and prepared.
5	**Inclusive Stakeholder Involvement**	Broad engagement across EMS, hospitals, LTC, and others ensures relevance and widespread support.
6	**Regulatory/Accreditation/Funding Motivation**	Mandates and funding requirements drive and sustain participation.
7	**Efficient Planning & Administrative Simplicity**	Minimal paperwork and use of familiar processes make exercises simple and sustainable.
8	**Continuous Improvement/AARs**	Ongoing feedback and after-action reviews drive year-to-year progress.
9	**Supportive Leadership, Championing Culture**	Strong leaders and a preparedness-focused culture encourage participation and improvement.
10	**Flexibility/Local Adaptation**	Exercises can be tailored to local needs, hazards, and capacities for greater relevance.

MRSE Enabler - #3

Enabler	Strategy	Mechanism	Additional Notes
Does this factor apply to your organization by contributing to the successful implementation of the MRSE?	*What do you do to put this enabler into practice?*	*How does this factor support the implementation of the MRSE in practice?*	
Robust Communication & Information Sharing: *Effective communication infrastructure (e.g., MIHAN, EMTrack, EMResource, email, radio) ensures timely alerts, real-time updates, and redundancy. Regular information sharing before, during, and after exercises fosters transparency, situational awareness, and a collaborative response environment.*			

Summary of MRSE Barriers

Rank	Theme	Short Description
1	**Staffing Shortages & High Turnover**	Not enough or constantly changing staff; excessive multitasking.
2	**Competing Priorities & Time Constraints**	Other urgent clinical/administrative demands crowd out exercises.
3	**Administrative Burden & Complex Tools**	MRSE tools create reporting frustration, errors, wasted time.
4	**Low Executive/Leadership Engagement**	C-suite rarely involved; low buy-in from top levels.
5	**Low/Inconsistent Partner Participation**	Sectors like EMS/LTC/home care are hard to engage.
6	**Data Collection Challenges**	Hard to get timely/accurate data from all partners; data quality varies.
7	**Communication Gaps & Breakdown**	Inconsistent, unclear, or too-late messaging; virtual engagement weakens participation.
8	**Overly Complex/Unrealistic Exercise Design**	Exercises not relevant/localized or too burdensome to implement.
9	**Limited Funding & Resources**	Declining/additional funding makes engagement difficult; little financial incentive to participate.
10	**Scheduling & Logistical Barriers**	Hard to find a time for all; real-world events disrupt participation.
11	**Low Perceived Value ("Check the Box")**	Some participate only for compliance, not meaningful improvement.
12	**Lack of Jurisdictional Authority**	Coalitions lack power to require or enforce participation.

MRSE Barrier – #1

Enabler	Strategy	Mechanism	Additional Notes
Is this barrier relevant in your organization? *How does this barrier get in the way of a successful MRSE? Any examples?*	*What solutions or strategies would help overcome this challenge?*	*What steps would you take to put that solution in place?* *What tools or resources would help you implement this solution effectively?*	
Staffing Shortages & High Turnover: Chronic understaffing in hospitals, EMS, and public health, combined with frequent turnover (especially post-pandemic), means constant onboarding and loss of institutional knowledge. Many staff wear multiple hats, reducing time and bandwidth for preparedness activities.			

MRSE Barrier – #2

Enabler	Strategy	Mechanism	Additional Notes
Is this barrier relevant in your organization? *How does this barrier get in the way of a successful MRSE? Any examples?*	*What solutions or strategies would help overcome this challenge?*	*What steps would you take to put that solution in place?* *What tools or resources would help you implement this solution effectively?*	
Competing Priorities & Time Constraints: *Clinical and administrative staff juggle many urgent demands. Preparedness can be deprioritized in favor of clinical care, reporting, or other critical tasks, especially when exercises are not seen as directly beneficial ("just another chore").*			

MRSE Barrier – #3

Enabler	Strategy	Mechanism	Additional Notes
Is this barrier relevant in your organization? *How does this barrier get in the way of a successful MRSE? Any examples?*	*What solutions or strategies would help overcome this challenge?*	*What steps would you take to put that solution in place?* *What tools or resources would help you implement this solution effectively?*	
Administrative Burden & Complex Tools: *Bulky, confusing MRSE reporting tools (especially those with macros or complex drop-downs) create frustration and take significant time to complete. Cybersecurity concerns block tool use, and complicated documentation leads to errors or incomplete reports.*			

MRSE Barrier – #4

Enabler	Strategy	Mechanism	Additional Notes
Is this barrier relevant in your organization? *How does this barrier get in the way of a successful MRSE? Any examples?*	*What solutions or strategies would help overcome this challenge?*	*What steps would you take to put that solution in place?* *What tools or resources would help you implement this solution effectively?*	
Low Executive/Leadership Engagement: *Executive (C-suite) involvement is difficult to obtain—leaders often see preparedness as a low priority, may lack understanding of its value, or are simply stretched thin. Their absence makes sustainable change and high-level buy-in hard to achieve.*			

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