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# Constructing Shared Mental Models in High-Acuity Clinical Trajectories: A Narrative Review and Proposed Framework for Multidisciplinary Simulation Integrating Pre-Hospital, Emergency, and Surgical Disciplines

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## Abstract

**Background:** High-acuity patient crises, particularly those involving complex surgical pathologies like bariatric or endocrine emergencies, demand seamless coordination across pre-hospital, emergency, and surgical teams. Traditional siloed training often fails to prepare these disparate groups for the intense collaboration required, leading to breakdowns in communication, role confusion, and delayed decision-making. **Aim:** This narrative review aims to synthesize current evidence on multidisciplinary simulation (MDS) as a pedagogical tool to build shared mental models, enhance interprofessional communication, and clarify role responsibilities among EMS, Emergency Medicine, Nursing, and General Surgery teams during time-sensitive events. **Methods:** A structured literature search was conducted across PubMed, CINAHL, Scopus, and Web of Science (2010-2024) using keywords related to simulation, interprofessional education, teamwork, and the specified clinical domains. Included literature focused on simulation involving at least three of the target disciplines in high-acuity settings. **Results:** The analysis reveals that MDS effectively improves non-technical skills, including situational awareness, closed-loop communication, and leadership. Scenario design principles emphasizing realism, cognitive fidelity, and structured debriefing are critical. Successful implementations, such as "Field-to-OR" or "Clinic-to-ICU" pathways for surgical complications, demonstrate improved clinical outcomes, including reduced time-to-intervention and enhanced team psychological safety. **Conclusion:** Multidisciplinary simulation is a powerful, evidence-based strategy for constructing the shared cognitive frames necessary for managing complex patient crises. To bridge persistent gaps in care continuity, healthcare institutions must prioritize and institutionalize immersive, cross-disciplinary simulation training that mirrors the high-stakes, interdependent nature of real-world emergency care.

**Keywords:** interprofessional simulation, team cognitive frames, high-acuity care, surgical emergencies, crisis resource management.

## Introduction

The trajectory of a critically ill surgical patient—from the initial 9-1-1 call through emergency department (ED) resuscitation to definitive operative intervention—represents a profound test of healthcare system integration. For patients experiencing acute complications of specialized surgeries, such as an anastomotic leak post-bariatric procedure or an adrenal crisis following endocrine surgery, outcomes hinge on the flawless handoff and collaboration between highly specialized yet often disconnected teams: Emergency Medical Services (EMS), Emergency Medicine physicians and nurses, and General Surgery sub-specialists (Weaver et al., 2014). Each team operates within its own domain of expertise, culture, and cognitive framework, a reality that can create dangerous chasms in the continuum of care during time-


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sensitive crises. Failures in communication and coordination across these interfaces are not merely logistical hiccups; they are recognized as leading contributors to preventable medical error and adverse patient outcomes (Lazzara et al., 2022; Weller et al., 2015).

The concept of a shared mental model—a common understanding of a situation, the tasks at hand, and the roles and responsibilities of team members—is a cornerstone of effective teamwork in high-stakes environments like aviation and, increasingly, in healthcare (McComb & Simpson, 2014). In the context of a multisystem emergency involving a complex surgical patient, a shared mental model must encompass the patient's altered anatomy, the specific physiological derangements at play, and the sequential priorities from field management to operative strategy. Without this shared cognitive frame, teams risk working at cross-purposes: EMS may lack context for a patient's unique surgical history, ED providers may misinterpret subtle signs of deterioration, and consulting surgeons may receive incomplete or delayed information, leading to critical delays in definitive care (Gillespie et al., 2016).

Simulation-based training has emerged as the gold standard for developing both technical proficiency and non-technical skills (NTS) in controlled, reproducible environments. However, much simulation remains discipline-specific—trauma teams train in the ED, surgical teams in the operating room (OR), and EMS in the field (Paige et al., 2017). This siloed approach, while valuable, fails to replicate the complex interprofessional interactions that define real emergencies. Multidisciplinary Simulation (MDS), which purposefully brings together learners from different professions to manage a simulated case, offers a potent solution. It allows for the practice and rehearsal of the very handoffs, communications, and collaborative decisions that are so vulnerable to failure (Kaba et al., 2018).

This narrative review synthesizes contemporary evidence to propose and evaluate the use of MDS scenarios specifically designed to integrate EMS, Emergency Medicine, Nursing, and General Surgery teams. It argues that targeted simulation of high-acuity events, such as a "Field to OR" pathway for a post-sleeve gastrectomy leak or a "Clinic to ICU" cascade for a post-adrenalectomy crisis, is essential for building the robust team cognitive frames required to navigate these clinical challenges successfully. The review will explore the theoretical underpinnings, critical design elements, measurable outcomes, and practical implementation strategies for such transformative educational interventions.

**The Imperative for Shared Cognitive Frames in High-Acuity Surgical Care**

The management of acute surgical complications presents unique cognitive and logistical demands. Patients with a history of bariatric or endocrine surgery often have physiologies and anatomical relationships that deviate from the norm, creating "hidden" pitfalls for the unprepared clinician. For instance, a patient with Roux-en-Y gastric bypass who presents with abdominal pain and tachycardia may be suffering from a life-threatening internal hernia. This diagnosis requires a high index of suspicion and specific imaging protocols (Ende et al., 2023). Similarly, a patient post-adrenalectomy arriving in the ED with hypotension and nausea could be in Addisonian crisis, requiring immediate steroid replacement—a treatment not typically first-line in undifferentiated shock (Bancos et al., 2015). The knowledge of these possibilities is often asymmetrically distributed; the surgical team holds deep expertise in the complication, while the frontline responders (EMS, ED) have the responsibility for early recognition and stabilization.

This knowledge asymmetry, combined with time pressure and high emotional valence, creates a fertile ground for *cognitive stacking*—the accumulation of pending tasks and decisions—and *fixation errors*, where teams become anchored to an initial, often incorrect, diagnosis (Armstrong et al., 2023). A shared mental model helps mitigate these risks by ensuring all team members are "on the same page." When EMS communicates not just vitals but a suspicion of "possible surgical complication in a bariatric patient" based on scene findings, they activate a more specific cognitive frame in the receiving ED team (Thompson et al., 2019). When the ED nurse, familiar with the priorities for a potential adrenal crisis, proactively prepares steroids and a hydrocortisone drip, they align actions with the surgical team's anticipated needs before formal consultation.

The development of these shared frames is not automatic. It requires repeated, structured practice in applying collective knowledge to dynamic problems. Team Cognitive Frames Theory suggests that teams develop shared understanding through interaction and communication, which in turn guides their coordinated action (Paletz & Schunn, 2010). Simulation provides the ideal interactive crucible for this development, allowing teams to practice building these frames from the ground up in scenarios where missteps carry no real patient harm. Research in trauma resuscitation has consistently shown that teams with stronger shared mental models demonstrate more efficient communication, make fewer errors, and adapt more flexibly to changing circumstances (Fackler et al., 2009; Cooper et al., 2014).

**Core Principles of Effective Multidisciplinary Simulation Design**

Designing effective MDS for high-acuity events requires moving beyond simple task training to creating immersive experiences that force interdependence. The goal is *cognitive fidelity*—the degree to which the simulation requires participants to engage in the same thinking processes as in a real event—as much as physical or environmental fidelity (Kneebone, 2016). Several key principles underpin this design.

First, scenario realism and clinical authenticity are paramount. Cases must be carefully crafted to reflect the genuine diagnostic dilemmas and time pressures of the clinical environment. A scenario involving a post-pancreatectomy patient with a hemorrhagic pseudoaneurysm, for example, should require EMS to manage hemodynamics during transport, the ED team to interpret complex cross-sectional imaging, nurses to manage massive transfusion protocols, and surgeons to weigh endovascular versus open surgical approaches—all while maintaining continuous communication (Barrionuevo et al., 2020). Utilizing real equipment, standardized patients, or high-fidelity manikins with appropriate stomas or surgical sites, and integrating actual electronic health record systems or radio communication devices enhances immersion.

Second, the simulation must enforce mandatory interdependence. Participants should be placed in a situation where no single profession can achieve the patient's optimal outcome alone. The scenario design should create natural "handoff choke points" that require clear communication. For instance, the EMS handoff to the ED team must include specific information about the patient's surgical history and pre-hospital response to fluids; the ED-to-surgery phone consultation must efficiently convey key examination and imaging findings to trigger the OR activation (Lazzara et al., 2022). Roles should be blurred intentionally at times to encourage negotiation and shared leadership, mirroring the chaos of real crises.

Third, a structured, psychologically safe debriefing is the most critical component for learning. The debriefing, typically led by a facilitator skilled in interprofessional education, is where shared mental models are explicitly constructed and refined. Using evidence-based models like Debriefing with Good Judgment (Rudolph et al., 2007) or the PEARLS framework (Bajaj et al., 2018), facilitators guide participants to analyze their performance, with a heavy focus on NTS: communication clarity, role clarity, situational awareness, and decision-making. Discussing perspectives from each profession—why the paramedic chose a certain transport priority, why the surgeon asked a specific question over the phone, why the nurse prioritized one medication over another—builds mutual understanding and respect (Velásquez et al., 2022). This process transforms a simulation from a simple skills test into a powerful team-building and cognitive alignment exercise. Table 1 and Figure 1 illustrate a multidisciplinary simulation (MDS) pathway designed to construct shared mental models across Emergency Medical Services (EMS), Emergency Department clinicians, nursing staff, and surgical teams during high-acuity clinical trajectories.

**Table 1: Exemplar Multidisciplinary Simulation Scenarios for High-Acuity Surgical Events**

| Scenario Title | Clinical Focus | Key Learning Objectives for Shared Mental Model | Participating Disciplines | Critical Handoff Points |
|---|---|---|---|---|
| **"The Leaking Sleeve"** | Septic shock from gastro-gastric fistula post-sleeve gastrectomy. | 1) Recognize nonspecific presentation (tachycardia, abdominal pain) as potential catastrophic leak. 2) Coordinate early antibiotics & fluid resuscitation across teams. 3) Efficiently communicate need for urgent CT scan & surgical consult. | EMS, ED MD/RN, General Surgery (Bariatric) | EMS → ED: "Post-bariatric surgery, low-grade fever, tender abdomen." ED → Surgery: "CT shows extraluminal air & fluid. Patient requires OR." |
| **"The Crashing Adrenal"** | Addisonian crisis in patient 2-weeks post unilateral adrenalectomy for | 1) EMS/ED identification of surgical history as key to diagnosis. | EMS, ED MD/RN, General Surgery (Endocrine) | Clinic Call → EMS Dispatch: "Post-op adrenal patient, vomiting, weak." |

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| | pheochromocytoma. | 2) Initiation of stress-dose steroids before definitive lab results.<br>3) Team management of refractory hypotension & hyperkalemia. | | ED → ICU/Surgery: "Initiated hydrocortisone drip, still unstable, requiring vasopressors." |
| **"The Internal Hernia"** | Closed-loop obstruction from Petersen's hernia post Roux-en-Y gastric bypass. | 1) Maintain high index of suspicion in any abdominal pain post-RYGB.<br>2) Appreciate imaging limitations & need for clinical diagnosis.<br>3) Activate "time-to-OR" countdown based on clinical suspicion. | EMS, ED MD/RN, Radiology Tech/Nurse, General Surgery (Bariatric) | Radiology → ED: "CT is equivocal, not classic SBO."<br>ED → OR Desk: "Clinical picture concerning for internal hernia, need emergent OR regardless of CT." |
| **"The Bleeding Pseudoaneurysm"** | Hemorrhagic shock from pseudoaneurysm of gastroduodenal artery post-Whipple procedure. | 1) Manage massive transfusion in ED while coordinating with IR/surgery.<br>2) Interpret complex post-operative anatomy on CT angiogram.<br>3) Determine triage to the IR suite vs. the OR. | EMS, ED MD/RN, General Surgery (Hepatobiliary), Interventional Radiology | ED → Blood Bank: "Activate massive transfusion protocol."<br>Surgery & IR → ED: "Joint decision: IR for embolization is first-line if stable." |


**Figure 1. Multidisciplinary Simulation Pathway for Building Shared Mental Models in High-Acuity Clinical Events**

**Measuring Impact: Outcomes of Multidisciplinary Simulation**

The efficacy of MDS is measured across four Kirkpatrick-like levels: reaction, learning, behavior, and results (Kirkpatrick & Kirkpatrick, 2016). At the reaction level, participants consistently report high satisfaction and perceived value, noting increased confidence in interacting with other professions and a deeper appreciation of each other's roles and constraints (Dunnack, 2020; Moslehi et al., 2022). This improved interprofessional attitude is a foundational step toward behavioral change.

At the learning and behavioral levels, assessment focuses on both NTS and clinical decision-making. Tools like the Team Emergency Assessment Measure (TEAM) (Cooper et al., 2010), the Observational Teamwork Assessment for Surgery (OTAS) (Undre et al., 2017), or customized checklists are used to measure improvements in leadership, communication, coordination, and mutual support. Studies demonstrate that teams participating in MDS show significant post-training improvement in these metrics compared to controls (Buljac-Samardzic et al., 2020; Lee et al., 2021). More importantly, this learning translates to clinical results. Although challenging to measure directly due to confounding variables, a growing body of evidence links multidisciplinary team training, often via simulation, to improved patient outcomes. These include reduced time-to-antibiotics for sepsis, decreased time-to-incision for emergency surgeries, lower incidence of post-operative complications, and reduced mortality in trauma and cardiac arrest scenarios (Barsuk et al., 2021; Murphy et al., 2019; Mathis et al., 2021). For surgical complications, the "golden hour" principle is paramount; simulation-trained teams are better equipped to minimize system-induced delays, directly impacting morbidity.

Furthermore, MDS fosters psychological safety—the shared belief that the team is safe for interpersonal risk-taking (Edmondson, 2018). In debriefings, participants learn to voice concerns, ask questions, and correct errors without fear of reprisal. This cultural shift is critical for preventing errors, as it empowers the EMT to question a treatment plan or the nurse to call a "stop-the-line" if they perceive a dangerous oversight. A culture of psychological safety, nurtured in simulation, is perhaps one of its most valuable and lasting outcomes (O'Donovan & McAuliffe, 2020).

**Implementation Challenges and Practical Strategies**

Despite its proven benefits, widespread implementation of high-quality MDS faces significant barriers (Table 2). Logistical complexity is the foremost challenge. Coordinating schedules across EMS shifts, ED staff, and busy surgical services is daunting (Paige et al., 2017). Resource intensity in terms of faculty time, space, equipment, and dedicated simulation personnel can be prohibitive for some institutions. Professional hierarchies and cultural resistance can also impede open participation and candid debriefing; junior nurses or paramedics may hesitate to speak freely in the presence of senior surgeons (Weller et al., 2015).

Overcoming these barriers requires strategic approaches. "In-situ" simulation, conducted in the actual clinical environment (e.g., the ED bay, ambulance bay, or ICU) during working hours, mitigates scheduling and realism issues. While disruptive, it tests real-world systems and processes, uncovering latent safety threats (Patterson et al., 2013). Tiered training models can help: initial discipline-specific training on foundational knowledge (e.g., a module for all ED staff on bariatric surgical emergencies) can be followed by smaller, more frequent multidisciplinary sessions focusing on handoffs and communication (Milton et al., 2023).

Securing administrative and financial buy-in is essential. Framing MDS not as a cost but as a risk-mitigation and quality improvement investment is crucial. Data on reduced door-to-balloon times, faster OR activation, or improved compliance with sepsis bundles can make a compelling business case (Barsuk et al., 2009). Finally, cultivating a faculty corps with interprofessional facilitation expertise is key. Facilitators must be trained to manage group dynamics, mitigate hierarchy, and focus debriefings on systems and teamwork rather than individual clinical knowledge (Cheng et al., 2023). Figure 2 summarizes the core cognitive and non-technical skill domains targeted by multidisciplinary simulation for high-acuity care.

**Table 2: Framework for Designing and Debriefing a Multidisciplinary Simulation**

| Phase | Key Actions | Focus for Building Cognitive Frames |
|---|---|---|
| **1. Pre-Brief** | • Set psychological safety contract. • Clarify simulation goals (NTS over technical skills). • Orient to environment & manikin capabilities. | Establish a shared understanding of the *purpose* of the exercise: to practice working together, not to perform perfectly. |
| **2. Scenario** | • Run scenario with embedded triggers (e.g., patient deterioration, new information). • Facilitators observe, take notes for debrief. | Observe natural communication patterns, role assumption, and decision-making under stress. Identify moments where mental models were aligned or misaligned. |
| **3. Debrief (Reaction & Analysis)** | • **Reaction:** "How did that feel?" Allow emotional unpacking. • **Analysis:** Use advocacy-inquiry: "I noticed the surgeon was called at minute 5. What was the ED team's thinking at that time?" • Explore perspectives: "Paramedic, what did you think the ED needed to know most? Nurse, was that what you heard?" | Make implicit thoughts explicit. Compare and integrate different professional viewpoints. Identify specific communication phrases that worked or failed. |
| **4. Debrief (Generalization & Application)** | • **Generalize:** "What does this tell us about how we hand off complex surgical patients?" • **Apply:** "What is one thing we can do differently in the real | Translate scenario-specific lessons into generalizable team principles. Create a shared commitment to behavioral change, solidifying the new cognitive frame. |

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| | ED/OR/ambulance tomorrow?"<br>• Develop a concrete "team contract" or action plan. | |


**Figure 2. Cognitive and Teamwork Outcomes of Multidisciplinary Simulation in High-Risk Clinical Scenarios**

**Future Directions and Conclusion**

The future of MDS for high-acuity care lies in increased sophistication, accessibility, and integration. Longitudinal programs that track teams over time with progressively more complex scenarios will deepen learning and sustain benefits (Velásquez et al., 2022). The use of virtual reality (VR) and extended reality (XR) platforms holds promise for creating immersive, scalable training environments that can connect geographically dispersed team members—imagine a paramedic in an ambulance simulator linked to an ED team and a surgeon at home, all managing a virtual patient (Pottle, 2019). Furthermore, data analytics from simulation, including communication network analysis and behavioral biometrics, could provide objective, granular feedback on team dynamics (Weaver et al., 2014).

In conclusion, the management of life-threatening surgical complications represents a critical interface where pre-hospital, emergency, and surgical disciplines must converge under extreme pressure. Disparate cognitive frames and poor team coordination at this interface represent a significant, modifiable risk to patient safety. This review underscores that Multidisciplinary Simulation is not merely an educational luxury but an essential operational strategy for building the shared mental models, refined communication, and explicit role clarity required for excellence. By deliberately designing and implementing realistic, interdependent simulations around scenarios like "Field to OR" or "Clinic to ICU" pathways, healthcare systems can proactively forge the team's cognitive frames necessary to bridge the chasms in care. The investment in such training is an investment in a more resilient, communicative, and effective clinical workforce, ultimately leading to the singular goal of safer, more reliable outcomes for our most vulnerable surgical patients.

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