INSTITUTE FOR HOMELAND SECURITY

NETWORKS UNDER PRESSURE:

STRUCTURAL COHESION AND COLLAPSE IN CRITICAL INFRASTRUCTURE ORGANIZATIONS

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Introduction And Overview

When healthcare systems fail, they almost never fail all at once. Collapse is rarely dramatic. Instead, failure unfolds unevenly, as particular sectors lose capacity over time rather than breaking down immediately. Research in organizational sociology shows that these failures emerge through the erosion of coordination rather than the sudden depletion of resources (Perrow 1984; Vaughan 1997, 1999; Faraj and Xiao 2006). Studies of organizations under sustained stress demonstrate that work often continues even as capacity deteriorates and coordination weakens (Faraj and Xiao 2006; Vindrola-Padros et al. 2020). Although decisions continue to be made by leaders, their implementation becomes increasingly inconsistent as communication degrades and informal practices displace formal coordination, a pattern documented in empirical studies of healthcare organizations under pressure. During the COVID-19 pandemic, for example, qualitative research showed healthcare delivery persisting amid disruption, as teams adapted everyday practices to cope with unprecedented demands (Vindrola-Padros et al. 2020).

Under sustained strain, units within healthcare organizations often adapt to challenges to meet immediate demands. These adjustments can be effective in the short term but cannot be relied upon for formal organizations that demand accountable and standardized workflow. This paper argues that such breakdowns are best understood as network scenarios rather than simple losses of capacity, and that organizational network structure plays a role in shaping how disruption spreads once it enters healthcare systems. Here, my central claim is with regard to the social network analytical concept of “structural cohesion” (Moody and White 2003). Structural cohesion refers to the extent to which an organization remains connected when key people or positions are lost, emphasizing the depth and redundancy of coordination rather than surface-level ties. In network terms, it is defined by the smallest number of actors whose removal would break the network into disconnected parts, with higher values reflecting greater redundancy in communication and coordination pathways (Moody and White 2003). High-cohesion organizations have many routes to communication, while low-

cohesion organizations are sparse to the point that removing a few key nodes isolates the rest of the network.

Applied to healthcare settings, this perspective shifts attention away from leadership style or resources and toward how authority, information/knowledge, and responsibilities are distributed across roles and units. Building on this work, the paper uses structural cohesion to explain why similar types of disruptions can have markedly different system-level consequences across healthcare organizations. This paper proceeds in three analytic stages intended to clarify failure dynamics rather than predict outcomes for specific institutions:

First, I define “collapse” as the loss of coordinated operational capability and situates this definition within organizational scholarship that treats coordination as a precondition for collective action.

Second, I build on work in social network analysis to offer *structural cohesion* as an explanatory lens and uses it to interpret recurring patterns of degradation documented in empirical studies of hospitals and health systems under stress.

Third, I apply this framework to a set of exemplary healthcare coordination structures subjected to standardized stress scenarios. These are based on ideal types of leadership networks in organizations. This approach allows structural properties to be examined independently of case-specific particularities.

By isolating these mechanisms, the paper aligns with classic organizational analyses of failure that emphasize structure over individual error (Vaughan 1997, 1999). Together, these steps contribute to scholarly debates on organizational failure while providing a structural vocabulary applicable to healthcare resilience analysis.

Problem: Defining Collapse As Coordination Failure

As argued in the introduction, healthcare systems tend to fail in ways that are incremental rather than dramatic, even under conditions of severe strain – such as those when encountering natural disasters like hurricanes – a topic which I have written about previously. Broadly speaking, hospitals and health systems usually continue to operate while their ability to coordinate action across units steadily weakens. Empirical research across organizational sociology shows that staff remain present, infrastructure continues to function, and formal authority structures persist, even as collective performance becomes increasingly uneven (Okhuysen and Bechky 2009). Decisions continue to be made by leaders, but they are not carried out consistently across departments, and priorities become difficult to align across professional and administrative boundaries. In this sense, failure in healthcare is less often a matter of sudden capacity loss than of gradual erosion in coordination.

Studies of healthcare organizations operating under sustained stress repeatedly document this pattern. Research on emergency departments and acute care units shows that clinical work often continues through improvisation and local problem solving even as shared routines weaken over time (Kellogg et al. 2006; Allen 2016). From the perspective of activity alone, organizations may appear to be functioning at or near full capacity. Yet beneath this surface continuity, coordination becomes more fragile, increasingly dependent on ad hoc communication and local judgment, rather than on shared expectations or standardized processes. What deteriorates is not effort or commitment, but the organization's ability to function as a coherent whole.

For the purposes of this paper, collapse is defined as a continuous variable where the loss of coordinated operational capability happens gradually. Collapse occurs when a healthcare organization can no longer translate decisions into synchronized action across its internal boundaries with sufficient reliability to sustain core functions. This definition treats coordination as the central mechanism through which organizations achieve collective outcomes in settings characterized by task interdependence and specialization (Okhuysen and Bechky 2009). It distinguishes collapse from shutdown, abandonment, or total resource exhaustion, which are

relatively uncommon even during major crises. This definition is consistent with organizational research that treats coordination not as a fixed property of structure or leadership, but as an ongoing accomplishment (in the sense that it is a process) that must be continuously reproduced. Studies of complex organizations emphasize that coordination depends on interaction, shared understandings, and stable roles. This is particularly important in environments where tasks are tightly coupled with roles (for example, a job description that maps perfectly onto tasks) and time-sensitive (Bechky 2006). When these coordinating mechanisms weaken, organizations may continue operating for extended periods while losing their capacity to act in a synchronized and reliable manner. Failure, in this sense, emerges through misalignment and drift rather than sudden collapse.

Defining collapse in this way also helps clarify why external shocks alone are insufficient explanations for organizational failure – though research has done well to document how emergent crises (such as natural disasters) can put acute strain on institutions and their supply lines. Healthcare preparedness and resilience frameworks often emphasize patient surges, supply chain disruptions, or technological failures as primary sources of breakdown. While such stressors impose real constraints, they do not explain why organizations exposed to similar shocks experience markedly different trajectories over time. Why do some systems remain stable in the face of these shocks? Comparative research shows substantial variation in performance among hospitals facing comparable levels of demand and scarcity (Kuntz et al. 2007). These differences suggest that the consequences of shock are mediated by *internal* coordination arrangements rather than determined by *external* conditions alone.

By defining collapse as the loss of coordinated operational capability, this paper centers attention on the organizational processes through which systems succeed or fail under strain. This coordination-centered definition provides the foundation for the structural analysis that follows, allowing failure to be examined as a property of organizational design and interaction rather than as the result of individual error, insufficient effort, or unavoidable scarcity. It shifts the analytic focus from whether

organizations remain active to how reliably they are able to act together when coordination demands intensify.

Topic Discussion: Structural Cohesion And Coordination Under Disruption

The previous section defined collapse as the loss of coordinated operational capability and situated this definition within organizational scholarship that treats coordination as a precondition for collective action. This section advances a structural account of why similar disruptions can produce divergent coordination outcomes across healthcare organizations. Building on network and organizational research, I argue that these differences are shaped, at least in part by *structural cohesion*—that is, by the extent to which coordination pathways are redundant rather than concentrated in a narrow set of roles or channels (Moody and White 2003). Structural cohesion is not a feature of leadership style or organizational culture, nor does it describe efficiency under routine conditions. Instead, it captures a system's vulnerability to fragmentation once coordination demands intensify and losses accumulate. When cohesion is low, disruption tends to concentrate on a small number of coordination points, increasing the likelihood that overload or failure at those points will isolate units from one another. When cohesion is higher, coordination can be rerouted through alternative pathways, allowing systems to remain connected even as performance degrades.

Figure 1: Visualizing Low V.S. High Structural Cohesion

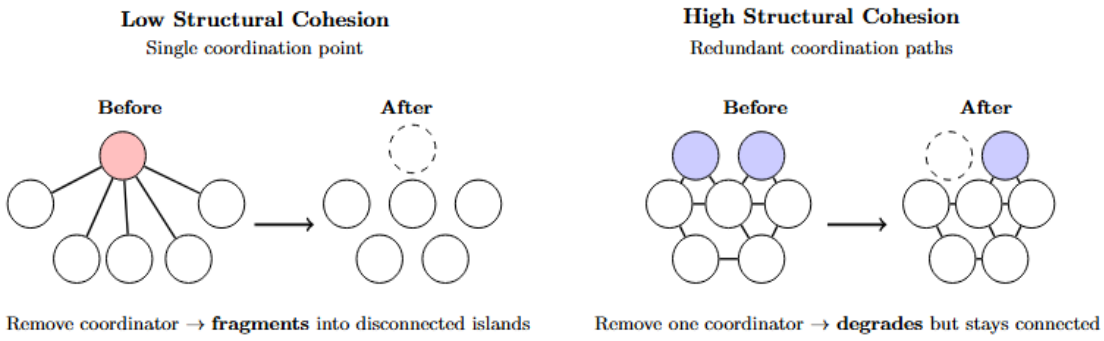

Figure 1 (above) illustrates this logic using an explicit before–after connectivity illustration. In the low-cohesion structure, coordination depends on a single central point linking otherwise weakly connected units. Removal of that coordinator, for whatever reason, fragments the organization into disconnected components. Units remain active, but they no longer share information, authority, or task alignment in ways that support collective action. In contrast, the high-cohesion structure contains multiple overlapping coordination paths. Removing one coordinator degrades performance but preserves connectivity, allowing coordination to continue through alternative routes. This contrast reflects the formal definition of structural cohesion as node connectivity: the minimum number of actors whose removal would disconnect the network (Moody and White 2003; White and Harary 2001). The analytic distinction is therefore not between functioning and non-functioning organizations, but between systems that fragment when coordination roles fail and those that remain connected while operating less efficiently.

While Figure 1 clarifies structural cohesion as a static property of organizational design, Figure 2 (below) traces how disruption propagates dynamically through systems with different levels of cohesion. The figure begins with a shock, such as the loss of key personnel or critical materials. Importantly, the shock itself does not directly produce collapse. Organizational research has repeatedly shown that healthcare systems often continue operating despite substantial personnel loss, material scarcity, or infrastructural disruption (Faraj and Xiao 2006; Vindrola-Padros et al. 2020). Instead, the effects of shock are mediated by coordination structure. In low-cohesion systems, disruption concentrates on narrow coordination pathways, producing bottlenecks as decision latency increases, tasks accumulate, and authority becomes increasingly centralized (Okhuysen and Bechky 2009). Supervisory or coordinating roles absorb additional work, visibility across units declines, and exceptions proliferate. As overload intensifies, informal bypasses emerge to keep work moving, but these workarounds further erode formal coordination. Collapse occurs when these bypassed authority structures can no longer reestablish synchronized action across units.

Figure 2. Path toward collapse in two organizations

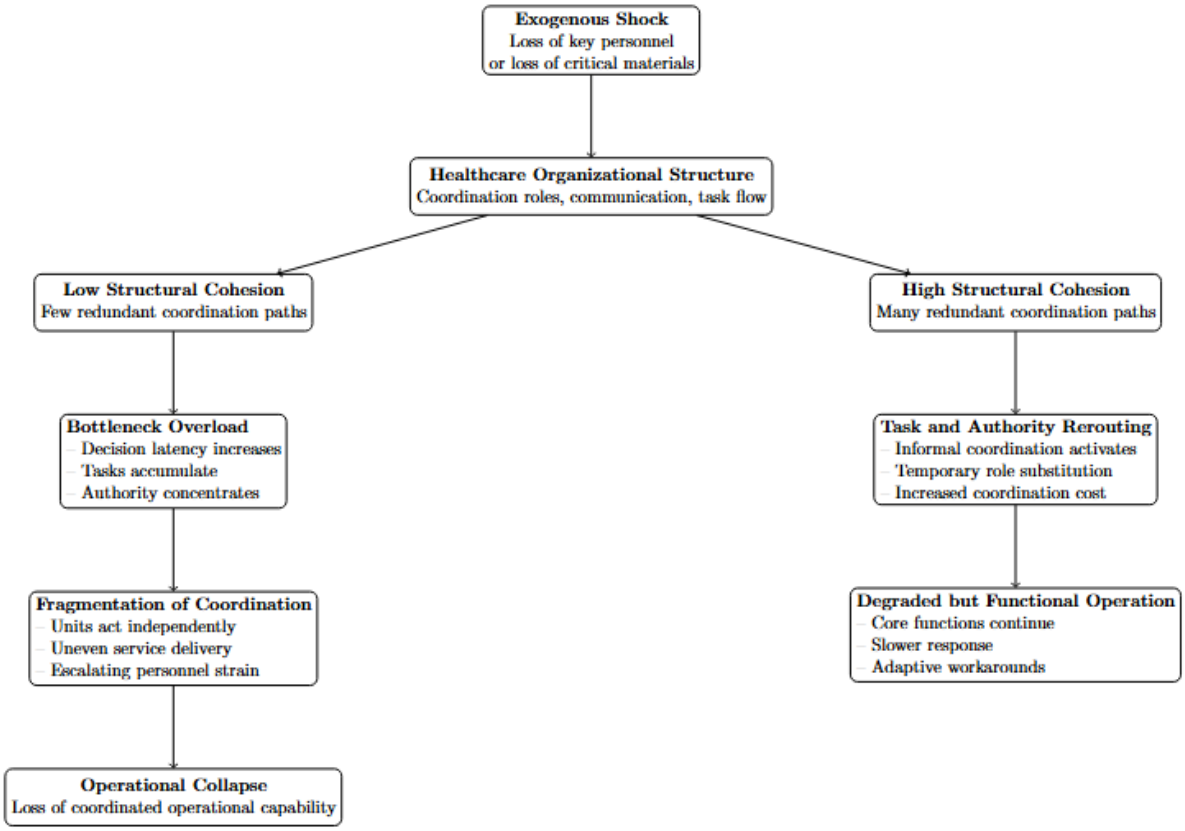

Figure 2: Shock propagation and structural cohesion in healthcare organizations. Identical disruptions, such as the loss of key personnel or critical materials, do not directly produce collapse. Instead, their effects are mediated by organizational coordination structure. Low-cohesion systems concentrate disruption on narrow pathways, producing bottlenecks and fragmentation, while higher-cohesion systems enable rerouting and degraded but coherent operation under stress.

In higher-cohesion systems, the same disruption follows a different trajectory. Because coordination pathways are redundant, tasks and authority can be redistributed when familiar roles or channels are strained. Informal coordination activates, temporary substitutions emerge, and coordination costs rise, but connectivity is preserved. Empirical studies of healthcare teamwork and cross-boundary coordination show that such rerouting allows organizations to sustain collective action under pressure, even

while efficiency declines and responses slow (Kellogg et al. 2006; Allen 2016). The result is not immediate fragmentation, but a period of degraded yet coherent operation in which core functions continue despite mounting strain. Structural cohesion does not prevent degradation, but it delays fragmentation by keeping coordination pathways open.

Taken together, Figures 1 and 2 clarify two recurring features of organizational collapse. First, collapse is rarely instantaneous. It is typically preceded by a period of degraded but ongoing operation in which activity remains high while coordination weakens, a pattern documented across studies of organizational adaptation and crisis response (Christianson et al. 2011). Second, the stability of this degraded state varies systematically with structural cohesion. In low-cohesion systems, degradation tends to accelerate into fragmentation because coordination cannot be rerouted once key junctions fail. In higher-cohesion systems, degradation is more often contained, preserving time and options for adaptation or intervention (Sutcliffe and Vogus 2003; Leveson 2016). These differences help explain why organizations exposed to similar disruptions may experience markedly different coordination outcomes without invoking differences in effort, commitment, or leadership quality.

The stress-test approach developed here does not aim to predict outcomes for specific hospitals. Rather, it clarifies how coordination behaves under controlled disruption by isolating structural properties that shape failure dynamics. By holding task demand constant and varying coordination structure, the analysis makes visible how disruption accumulates, reroutes, or fragments within organizations. The next section applies this framework by subjecting the exemplar coordination structures illustrated in Figures 1 and 2 to standardized stress scenarios, allowing coordination degradation and collapse pathways to be examined comparatively.

Structural Conditions of Coordination and Collapse

This section uses analytic scenarios (that I'm terming "conditions" here) to examine how structural cohesion shapes the trajectory of coordination degradation under disruption. As previously described, structural cohesion, following Moody and White, refers to the minimum number of nodes whose removal disconnects a network and thus captures the depth and redundancy of coordination pathways. In organizational terms, it describes how many independent routes exist for authority, information, and task coordination once key roles or capabilities are lost. The stress tests reported here vary coordination structure in order to generate systematically different levels of structural cohesion, then observe how disruption propagates as cohesion is progressively reduced.

It is crucial to note that these tests are not designed to estimate performance, predict institutional outcomes, or reproduce specific empirical cases from existing research. Instead, they function as controlled analytic exercises that expose how coordination behaves as connectivity is degraded. In a sense, these may take the form of propositions that could be tested in future empirical research. Across all tests, task demand is held constant and stress is introduced incrementally by overloading or removing key coordinating roles or disabling capabilities that support coordination. Collapse is defined consistently as the loss of coordinated operational capability, operationalized as the point at which coordination pathways no longer sustain synchronized action across units. What differs across tests is the cohesion threshold at which this loss occurs.

Condition 1: Hierarchical Coordination (Low Structural Cohesion, $k = 1$)

The first condition examines a hierarchical coordination structure characterized by *low structural cohesion*. In this structure, coordination pathways are routed through a small number of supervisory roles that function as articulation points. From a network perspective, the removal or overload of a single coordinating role is sufficient to disconnect large portions of the organization, corresponding to a cohesion level of approximately $k = 1$. There are few independent pathways for maintaining alignment once these roles are removed.

Under low stress, coordination remains intact because the supervisory chain continues to integrate information and transmit decisions. As stress accumulates, coordination loading concentrates on supervisory nodes, producing increasing delays and reduced throughput. Structural indicators show that while the network remains nominally connected, effective connectivity narrows around these cut points. Once supervisory overload reaches a threshold, operational units begin bypassing formal coordination pathways to sustain local activity. Collapse occurs when these bypasses become irreversible. At that point, the removal or functional failure of a single coordinating role is sufficient to fragment the organization into disconnected units. This abrupt transition reflects the low cohesion of the structure: once the single articulation point fails, no alternative coordination pathways remain. The failure trajectory is therefore sharp rather than gradual, consistent with expectations for networks with minimal redundancy. I depict this dynamic in Figure 3 below.

Figure 3. Low Cohesion organizational structure

Figure 3: Condition 1 (hierarchical coordination; low structural cohesion). The hierarchy relies on a single coordinating role that serves as an articulation point. When that role is removed or functionally lost, coordination pathways split into disconnected substructures, consistent with minimal node connectivity ($k = 1$).

Condition 2: Hub-and-Spoke Coordination (Low Structural Cohesion, Central Cut Node)

The second condition examines a hub-and-spoke coordination structure (depicted below in Figure 4), which also exhibits low structural cohesion but with a different topology. Coordination is centralized in a single hub that mediates information and allocation across multiple peripheral units. Although the network contains many nodes, its cohesion remains low because the hub functions as a dominant cut node. Removal or overload of this node disconnects the system into isolated spokes.

Figure 4. Hub and Spoke style organizational network.

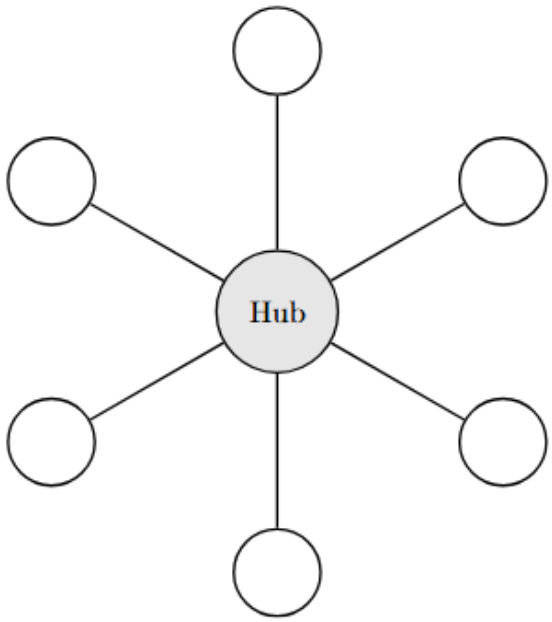

Figure 4: Hub-and-spoke coordination structure. Peripheral units coordinate exclusively through a central hub, producing low structural cohesion and vulnerability to fragmentation.

At low stress levels, the hub maintains connectivity and situational awareness, and coordination remains effective. As stress increases, the hub absorbs an increasing volume of coordination work, producing rapid saturation. Structural indicators show that while the network remains technically connected, effective communication between

peripheral units depends entirely on the hub. Once the hub becomes saturated or unavailable, peripheral units lose visibility into one another and coordination fragments.

Collapse in this structure is driven by isolation rather than delay. Unlike hierarchical systems, where overload produces cascading latency, hub-and-spoke systems fail when the central node ceases to function as an integrator. From a cohesion perspective, the outcome is identical: a single node failure disconnects the network. The difference lies in how disconnection manifests operationally, but in both cases low cohesion produces a low collapse threshold.

Condition 3: Decentralized Coordination (Moderate Structural Cohesion, $k > 1$)

The third stress test examines a decentralized coordination structure with moderate structural cohesion. Coordination pathways are distributed across lateral ties rather than concentrated in a small number of roles. No single node functions as a cut point, and the removal or overload of individual roles does not immediately disconnect the network. From a network perspective, cohesion exceeds one ($k > 1$), as multiple node removals are required to fragment the system. I depict this dynamic below in *Figure 5*.

Figure 5: Moderate Structural Cohesion condition

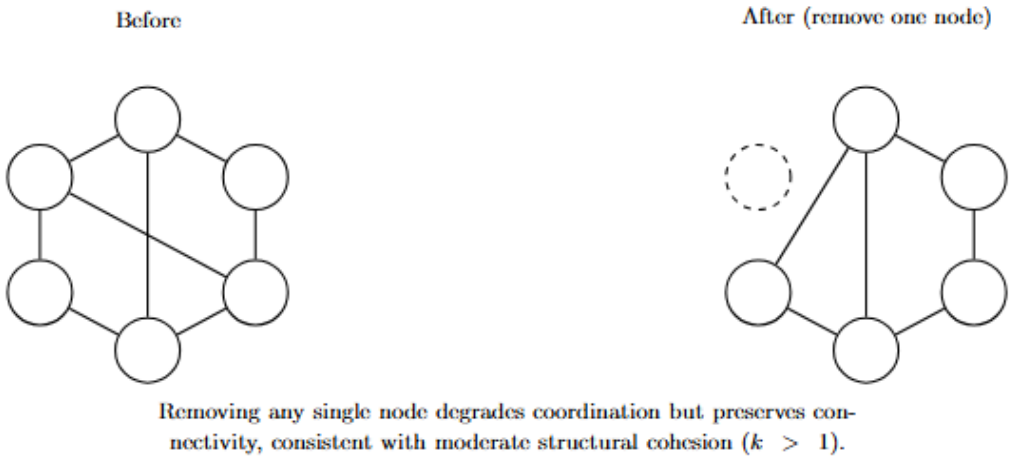

Figure 5: Condition 3 (decentralized coordination; moderate structural cohesion). Coordination is distributed across ties rather than through a single articulation point. Removing one actor does not fragment the network, preserving connectivity while allowing coordination quality to degrade.

Under increasing stress, coordination demands are redistributed across peer relationships. Tasks and authority are rerouted through alternative pathways, preserving connectivity even as individual roles are lost or overloaded. Structural indicators show that the network remains connected over a wider range of stress conditions than in low-cohesion structures. However, the absence of centralized integrative roles produces increasing variation in local practices over time. Collapse, if it occurs, emerges through cumulative misalignment rather than abrupt disconnection. Connectivity persists, but coherence degrades as coordination pathways become noisier and less reliable. From a cohesion standpoint, the system resists fragmentation because redundancy exists, but higher cohesion does not guarantee sustained alignment. The failure trajectory is therefore gradual, reflecting the distinction between connectivity and coordination quality.

Condition 4: Hybrid Coordination (High Structural Cohesion, Overlapping Paths)

The final stress test examines a hybrid coordination structure with high structural cohesion. What distinguishes this structure is not simply the coexistence of formal authority and informal ties, but the fact that these coordination mechanisms overlap in ways that create independent and substitutable pathways for alignment. Formal supervisory roles and lateral relationships are interlinked such that coordination can be rerouted across role types when either channel is strained. From a network perspective, cohesion is high because no single role or category of role is necessary for maintaining connectivity across units. Removing or overloading any single coordinating position degrades performance but does not disconnect the system; fragmentation requires the concurrent degradation of multiple coordination pathways. I depict this dynamic below in Figure 6.

Figure 6. Hybrid Coordination

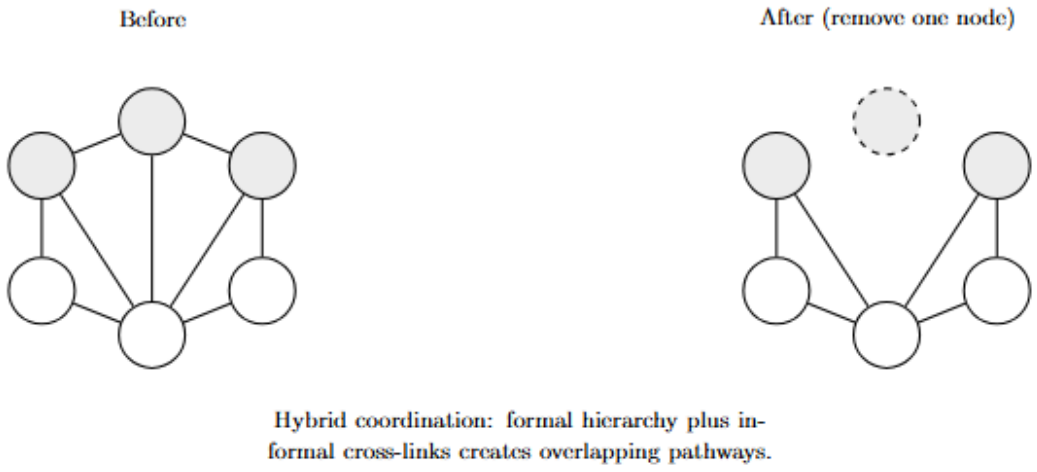

Figure 6: Condition 4 (hybrid coordination; high structural cohesion). Formal authority links coexist with cross-boundary ties, producing overlapping coordination pathways. The loss of a single coordinating role degrades performance but does not disconnect the system.

As stress accumulates, coordination in this structure is redistributed rather than concentrated. Informal ties absorb coordination work when formal roles become overloaded, while formal authority provides periodic re-synchronization when local adaptations begin to diverge. This interplay slows the erosion of both connectivity and alignment relative to lower-cohesion structures. Collapse therefore does not occur at a single cut point, but only after redundancy across both formal and informal pathways is exhausted. The result is delayed fragmentation: performance declines under strain, but coordinated operational capability is preserved longer, extending the window for adaptation or intervention.

Comparative Implications Of Structural Cohesion

Across all stress tests, variation in collapse trajectories is theoretically explained by differences in structural cohesion rather than by differences in task demand or shock magnitude. Low-cohesion structures fail when a small number of coordinating roles are lost or overloaded. Moderate-cohesion structures degrade gradually but remain connected longer. High-cohesion structures resist fragmentation until multiple pathways are compromised. These propositions add theoretical clarity the analytic role of structural cohesion in healthcare resilience. Structural cohesion does not eliminate failure, but it raises the threshold at which coordination collapse occurs and shapes how failure unfolds. By treating cohesion as a property of coordination pathways rather than individual roles or leadership quality, the stress tests provide a structural explanation for why similar disruptions produce sharply different outcomes across healthcare organizations.

Conclusion And Way Forward

This paper advances structural cohesion as a practical way to think about how healthcare organizations fail under sustained strain. Rather than treating resilience as an outcome to be measured or an aspiration to be achieved, the analysis centers on the internal structure of coordination itself: how authority, information, and task execution are connected across roles and units. The core claim is that many healthcare failures happen not because organizations simply run out of people or supplies, but because the coordination structures that link those resources lose connectivity. When coordination collapses, systems may continue operating, yet they no longer act coherently as organizations. This pattern has long been noted in studies of complex organizational failure (Perrow 1984; Vaughan 1997, 1999).

Structural cohesion offers a concrete lens for understanding this process. In network terms, it captures how many independent pathways exist for coordinating

action and how vulnerable those pathways are to disruption (Moody and White 2003). In organizational terms, it describes how coordination is distributed across roles rather than concentrated in a small number of junctions. Systems with low cohesion rely heavily on a few key roles or channels to integrate action; when those roles are overloaded or removed, coordination deteriorates quickly and unevenly. Systems with higher cohesion distribute coordination across overlapping pathways, allowing authority and information to be rerouted when disruption occurs. This does not prevent strain, but it fundamentally alters how failure unfolds (Okhuysen and Bechky 2009).

The analytic stress tests developed in this paper illustrate how structural cohesion shapes collapse trajectories across different coordination arrangements. Hierarchical and hub-based structures exhibit low cohesion and tend to fragment abruptly once critical coordination points are compromised. Decentralized structures preserve connectivity longer, but often at the cost of growing divergence as local adaptations accumulate. Hybrid structures, in which formal authority overlaps with informal coordination ties, maintain the highest cohesion and resist fragmentation until multiple pathways are simultaneously degraded. Across these cases, the same disruptions produce different outcomes because coordination is organized differently, consistent with organizational research emphasizing structure over individual error (Vaughan 1997; Sutcliffe and Vogus 2003).

For practitioners, the value of structural cohesion lies in how it reframes diagnosis. Instead of asking whether a system has sufficient capacity or whether leaders made the right decisions, a cohesion-based perspective directs attention to how coordination is routed. Which roles function as critical junctions? How many alternative paths exist if those roles fail or are overwhelmed? Where does coordination narrow under stress? These questions help explain why early warning signs of failure often appear as delays, inconsistencies, and improvised workarounds long before visible breakdown occurs (Bechky 2006).

Structural cohesion also clarifies why external shocks can produce cascading internal failures even when local capacity appears intact. Prior work on disasters and

supply chains shows that shocks such as hurricanes can disable upstream production or transportation nodes, producing logjams that propagate far beyond the affected region (Sheffi and Rice 2005; Ivanov and Dolgui 2020). In healthcare, similar dynamics occur when the loss of a small number of enabling materials or systems—often sourced through geographically or institutionally fragile supply chains—places disproportionate strain on coordination roles responsible for allocation and substitution. These failures are not simply supply problems; they are coordination problems triggered by structural vulnerability.

The contribution of this paper is not to prescribe a single organizational design or offer a checklist for resilience. Instead, it provides a vocabulary for reasoning about coordination under stress. Structural cohesion shifts attention away from individual performance and isolated resource shortages and toward how organizations are wired to absorb disruption. It highlights that collapse is often a structural outcome rather than a failure of effort, intent, or leadership.

In practice, strengthening healthcare systems may therefore require protecting redundancy in coordination, supporting overlapping roles, and preserving informal ties that allow work to be rerouted when formal channels are strained. These features are rarely visible in organizational charts or emergency plans, yet they play a decisive role in how disruption propagates through complex systems. By making structural cohesion visible, this paper aims to equip practitioners and scholars with a clearer framework for anticipating failure, interpreting early warning signs, and understanding why similar disruptions (such as those presented in the case of supply chains in the wake of natural disasters) can produce sharply different consequences across healthcare organizations.

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Author Biography

Andrew Davis received his PhD in 2019 in Sociology from the University of Arizona. His research sits at the intersection of political sociology, law and society, and organizational analysis. His work examines how institutional cohesion and breakdown shape governance, academic freedom, and knowledge production, with a particular focus on repression, charismatic leadership, and cross-national variation in state capacity. He has published more than two dozen peer-reviewed articles and currently serves as Co-Editor-in-Chief of *Social Currents*. Drawing on comparative datasets, network analysis, and organizational theory, his scholarship links micro-level coordination failures to macro-level institutional outcomes. Network tools and theories such as structural cohesion are central analytic lenses across his research and applied policy work.

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