Flight Decks and Isolettes: High-Reliability Organizing (HRO) as Pragmatic Leadership Principles during Pandemic COVID-19

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Abstract

The COVID-19 crisis has created a physical environment where neonatologists and neonatal staff face exposure to an easily transmissible, potentially fatal infection in the course of their duties. Leaders cannot reject an assignment, such as a resuscitation of a newborn, because of risk. As in military operations, safety and capability cannot be separated from neonatal operations. Leadership models developed in stable environments do not fully translate to dynamic, uncertain situations where the leader and subordinates personally face threats; the type of environment from which the High-Reliability Organization (HRO) emerged. There must be a shift from the increasingly abstract, academic, and normative representation of HRO leadership to its original, more pragmatic frame that iteratively supports engagement. The purpose of this paper is to present HRO as leadership principles, bridging the gap between abstract theory and practice by bringing attention to HRO as a scientifically supported pragmatic leadership stance.

Keywords: None

Introduction

The uncertain and ambiguous behavior of COVID-19 taxed healthcare leaders who directed medical care, identified and treated the novel infection, and protected their staff while risking exposure to the potentially lethal virus themselves. During COVID-19, neonatologists faced the dual challenge of identifying and treating a previously unencountered disease while protecting themselves and others from contracting a highly infectious virus.

Leadership models developed by external observers bring clarity to leadership duties, introduce a macroscopic view, and assist in different levels of analysis. This approach directs leadership schemata toward organizational design and structure, maintains coherence with established leadership concepts, and ensures congruence with the organization's operations. Effective leadership buffers the organization from disruptions, yet cannot be tested until the rare, extreme situation. Leadership models do not incorporate the characteristics necessary for close in, quick identification and interpretation of weak signals, uncertainty, and ambiguous information. "A story always sounds clear enough at a distance, but the nearer you get to the scene of events the vaguer it becomes" (Orwell 2008 31).

Leadership models developed in safe, stable environments do not generalize well in circumstances where leaders and followers must personally face dynamic and unpredictable situations, actively avoid death, and consider outcomes that include life-threatening disease or psychological injury (Kolditz 2006; Campbell, Hannah, and Matthews 2010). Stress responses, fear reactions, and threat reflexes then easily become misinterpreted as personal failings or emotional responses developing into subtle or hidden decrements in human performance and organizational operations.

Leadership models meet the purposes of the leader and organization with less emphasis on the needs of subordinates. Leadership for dangerous situations, by necessity, encompasses the point of view of subordinates, such as mutual sense giving (Dixon et al. 2017) and survival (Dixon 2014; Kolditz 2006). Followers must believe the leader's intent and actions will influence their well-being (Kolditz 2006)

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Leadership found in dangerous environments is similar to leadership in the organizations from which academicians codified HRO (TAM) and dangerous public safety environments (DvS, SDM). The purpose of this article is to identify salient leadership characteristics for HRO that support neonatal care during pandemic COVID-19. Responding to the admixture of threat and duty necessitates values directed toward well-being. Acting under time compression limits ethics analysis. The pragmatic stance for leadership must be grounded in practical wisdom.

Appreciation of the pragmatic leadership stance as integral HRO will support neonatologists bringing the benefits of HRO to the neonatal intensive care unit (NICU) and to their academic research. In this article, we will describe 1) the emergence of HRO principles from aerial combat operations and nuclear engineering, 2) leadership ethics and practical wisdom, 3) the dynamics of leadership, 4) leadership in extremis, and 5) The nature of the problem and environment

The emergence of HRO: The duality of safety and leadership

During the roughly 30-year period from WWII through the Vietnam War, the Pacific Fleet had conducted most of the US Navy's combat operations, making death a part of operations and creating 'rules written in blood.' The exigencies of combat made it imperative for everyone to identify effective actions and retain what they learned. Aviation Safety is vital even during wartime, and operational accidents are thoroughly investigated. Safety in combat has an additional function; the avoidable operational loss causes shortages of men and planes one cannot afford and increases vulnerability to enemy activity. The pragmatic leader gives meaning to the adage "Safety through operations and operations through safety."

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After 1973, when the US Navy's involvement in the Vietnam War ended, the Navy established additional risk management and safety programs for greater attention to operational readiness. This included the development of what is now called HRO. A very significant decrease in aircraft and shipboard accident rates occurred over the next twenty years. Major aircraft accidents per 100,000 flight hours were reduced from seventeen to two. Nearly all accidents have some degree of aircrew or personnel error involved (the point where human intervention may prevent failure), contributing to the expansion of selection and training pipelines for all air wing and shipboard personnel, particularly in the top leadership positions.

During this time, the ten Nimitz-class nuclear aircraft carriers joined the fleet. Captains of a US Navy aircraft carrier are nuclear trained and, by an act of the US Congress, must be aviators. They now serve a three-year tour in carrier command after a nominal six years of prior qualifying assignments. In addition to the eighteen months of nuclear power and Naval Reactors training, the program includes a two-year tour as the Executive Officer of a nuclear carrier and command of a conventionally powered deep draft vessel. Thus, the nuclear aircraft carriers brought together three independent, otherwise disparate domains within a single individual: 1) aerial warfare experience with initiative, improvisation, and flexibility, 2) nuclear propulsion engineering experience with rigor, detail, and conformity to procedures; and 3) previous aircraft squadron and large ship command of complex organizations in demanding circumstances. This remains the standard.

Nuclear training in engineering and nuclear safety theory gave these Captains a greater appreciation of highly reliable operations and expanded their leadership capabilities. The training and professionalism of the nuclear propulsion engineers helped formed the basis for increased safety awareness and reliability of operations throughout the entire aircraft carrier and embarked air wing. HRO had emerged on the nuclear aircraft carrier by merging the emergency-type responses of aerial combat with the control-operator functions for a nuclear reactor. Diverse organizations adapted HRO to their specific environments. For example, wildland firefighting emphasized the emergency operations component, while civilian nuclear power programs emphasized the control operator style (Roe and Schulman 2015).

The USS Carl Vinson departed on a seven-month homeport change and around-the-world cruise less than a year after commissioning. As the first new carrier assigned to the Pacific Fleet in over twenty years, much of the pre-cruise aviation and ship logistic support was provided through the Pacific Fleet chain and awaited the ship in Diego Garcia, an island in the middle of the Indian Ocean. After a month of operational commitments in the Mediterranean Sea, and a port visit to the Ivory Coast in West Africa, Carl Vinson proceeded to the Indian Ocean. One of the authors, (TAM), reported as Captain to the ship in Perth, Australia, three months into the cruise. Over the next three years and two extended deployments, Carl Vinson operated free of aircraft accidents and major injuries, receiving significant aviation safety and operational readiness awards, including the Admiral Flatley Memorial Award for the best Navy-wide aircraft carrier and air wing safety record.

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Shortly after arrival in the ship's new homeport of Alameda, CA, RAdm Mercer invited the academicians from the University of California, Berkeley, onboard to research and evaluate the Navy's methods in ensuring safe and reliable aircraft and ship operations (Ford et al., 2003; van Stralen and Mercer 2015). The intense activity on the flight deck and in Air Operations during high tempo operations captured their attention. Navigation Bridge and Combat Information Center coordination in defending the ship and avoiding collisions and groundings were studied to a lesser extent. The academicians, therefore, had a somewhat restricted view of the hands-on leadership, including the Captain's presence throughout the ship, which made the complex organization function as a team. This led to a single level of analysis rather than a macroscopic view providing multiple levels of analysis. The initial data collection and research did not identify the effect of command and leadership on the organizational structure and culture of the carrier. The researchers focused on the flight deck and "experiences of not failing" ("error-free"), somewhat missing "the experiences of failing," resulting in the flight deck only level of analysis becoming codified as HRO.

Unconventional aspects of the pragmatic leadership stance, often misunderstood by outsiders, can hinder acceptance of HRO. For example, in the US Naval Special Warfare (NSW) community (aka Navy SEALs), enlisted (or relatively junior) personnel are often expected, and as necessitated by circumstances, to give commands to those senior to them, including officers, that must be followed. This may appear to negate the strong rules of relationships between officers and enlisted sailors, similar to the hierarchy in healthcare. But the behavior has a basis in experience. Because of the nature of their work, an enlisted sailor with proximity to the problem knows what needs to be done. They are often the individual that planned and was responsible for the success of one aspect of the operation. An officer on the mission, accountable for the overall operation, may not be in a position to act. Thus, a lower-ranking individual with local knowledge gives urgent commands or directions to a higher-ranking individual (personal communication, Raymond C. Smith, RAdm, USN, retired). This is also, to a lesser degree, the operational norm for firefighting operations and combined fire-rescue ambulance physical rescues (DvS, SDM) but not nearly as accepted in healthcare (DvS). This forms the basis for

training all members to be "leader-leaders," and is certainly one example of appropriate "deference to expertise."

The military is viewed as hierarchal, but, for example, the Army's philosophy of 'mission command' empowers subordinates within the intent of the mission. The key point to understand is who has authority and responsibility. Regardless of their branch of service, whether Special Operations Forces (SOF) or conventional forces, a commander can delegate authority but not responsibility. Operators are expected to speak up and provide immediate directions or commands based on the circumstances, which aren't orders. Actual orders are legally binding

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In a recently opened pediatric intensive care unit (PICU), "First do no harm," the classical safety dictum in healthcare, initiated a cortisol stress cascade in bedside staff during abrupt patient deteriorations, interfering with care. Executive functions, cognition, working memory, and declarative memory became impaired. Resident physicians and staff, with little or no experience in a PICU or with unanticipated patient deteriorations, hesitated to make decisions or take actions, other than known protocols. Unrecognized fear caused defensive and offensive protective behaviors. Sustained threat reflexes such as fight, flight, and (hypervigilant) freeze interfered with team formation. The problem was present, staff were present, residents were present, but the intensivist was not, a recurring situation experienced by one of the authors (DvS). To address these impairments, the two PICU attendings (one a former fire department paramedic and the other a former US Navy aviator and Vietnam War veteran) focused on decision-making and modulating the stress responses, fear reactions, and threat reflexes that inhibited engagement.

Professionals have requested information from the authors to "convince" their leaders to accept various safety models, including HRO. Misunderstanding HRO's leadership dimension contributes to conflict with existing leadership beliefs and subsequent rejection of portions, if not the entirety, of HRO. Not recognizing the leadership dimension obscures the qualities of HRO that extend leadership into the situation. Viewed as a leadership stance, HRO methods naturally integrate into the organization's structure, and leadership approaches. "Conversion" without the inherent leadership dimension, as with other reliability and safety models, and HRO becomes a market commodity rather than a readily attained, pragmatic leadership stance.

We also find leaders will profess their organization's HRO characteristics. Pragmatic leadership, derived from in extremis situations, has positive influences on subordinates when the leader is absent. From the perspective of HRO comprising attributes, each attribute necessitates a sort of melding of subordinates and leaders in various circumstances independent of the proximity of the leader. Interactions with these subordinates, far from the organization's central leaders, reveals the operational presence of pragmatic leadership.

Leadership Ethics, Practical Wisdom, Phronesis

During a week of training for a select group of US Special Operations Command (USSOCOM) personnel, one of the first questions the medics asked one of the authors (DvS) was, "Do you have a relationship with your people?" People trust themselves to the leader who develops relationships with subordinates, genuinely cares about their welfare, is honest, and possesses integrity (Sweeney, Matthews, and Lester 2011). Threat and time compression generate unrecognized fear behaviors directed toward self-protection, making these actions appear prudent in the moment. These are situations where subordinates look to the leader for decisions ensuring their welfare and the public good.

Subordinates will take a far harder path than imagined when they believe in the character and integrity of the leader, the reason we find these leader traits in Aristotle's Nicomachean Ethics (1140b5-7), public safety training ((Palmer, Hannah, and Sosnowik 2011), and American military colleges and universities (Palmer, Hannah, and Sosnowik 2011; Sweeney, Matthews, and Lester 2011; Olsen, Eid, and Larsson 2020). Phronesis – prudence or practical wisdom – is situational wisdom for contextual circumstances, context-dependent information, and the particulars of a situation. Phronesis guides rule selection appropriate for the situation at the moment of action. We are more familiar with rule-based knowledge independent of context: epistêmê (epistemology) and technê (technology).

Phronesis, adaptive and pragmatic toward the greater good, has three elements: (1) the person who possesses character; (2) the particular situation in context; (3) values for the community good. In Aristotle's words, phronesis is an intellectual virtue or characteristic "bound up with action, accompanied by reason, and concerned with things good and bad for a human being" (Nicomachean Ethics 1140b5-7). Phronesis, also called prudence, is the first of Aristotle's four Cardinal Virtues (Prudence, Justice, Temperance, and Fortitude).

The leader in dangerous contexts influences subordinates by modeling attitudes, values, and behaviors. While beliefs have a stronger influence on behavior, their greater specificity limits adaptability to uncertainty and ambiguity. Values have a stronger, more consistent effect on behaviors with less context-dependence. Attitudes influence behavior and are less specific, making them adaptive to varying contexts. Attitudes predispose us toward favor or disfavor (Banaji and Heiphetz 2010, 350), the notion of evaluation at their core (Petty, Wegener, and Fabrigar 1997, 611). Attitudes summarize and integrate cognitive and affective reactions (Crano and Prislin 2006).

Leaders stimulate people to act on their own at the interface with the problem. Compared to fixed administrative control leadership, flexible distributed leadership generates knowledge-creation. The pragmatic leader recognizes context, defers to expertise, and accepts local knowledge. Practical wisdom is the capacity to choose appropriate goals and successfully devise means to reach those goals (Halverson 2004). Phronesis leaders view the problems of the organizations as being solvable within local constraints.

Engagement combines theory and practice, while leadership translates theory to practice. Phronesis, as a leadership-engagement characteristic, imbues practice with ethics while closing the theory-practice gap. Phronesis, to Aristotle, is an embodied quality to one who instructs the novice, a leadership quality, and the greatest of his Cardinal Virtues.

The dynamics of leadership

In the neonatal world, "resuscitation" evokes procedures, protocols, teamwork, and actions directed to correct the baby's physiological dysfunction. The neonatologist considers the cause, initiating event, complications of therapies, sequelae, and optimal means to lead the team toward success. Although leadership and bringing order to these contingencies go hand-in-hand, this views leadership from the leader's perspective rather than of the subordinate and resuscitation as a relatively linear activity from alarm to resolution. The 'dangerous context,' imminent and personal threat to the individual, can destabilize leadership.

Resuscitation is a series of overlapping and sequential contingencies that can be simple or complex. Team members work independently and interdependently as decisions migrate to the person with the necessary information and capability to act. The neonatologist leads from a position somewhere between a dispassionate observer and an active participant. For example, during a tense resuscitation, someone states, "I need help." Does that remark reflect a subordinate's performance or a leader's ability or both? It depends on whether it is top-down or bottom-up and on whether it is made from an observer outside the problem space or an active team member working within the problem space.

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From a pragmatic stance, it makes little difference because the leader and subordinate experience the same threats and constraints. Making sense of their continuously changing perceptions, participants have only discrete concepts to rely on (Weick 2011). Both leader and subordinates experience the gap between how they practice in the moment and the theories and concepts they use (Zundel and Kokkalis 2010). Together, the leader and subordinate engage the uncertainty and ambiguity, experience the restrictions and threats, struggle with the gaps between discrete concepts and continuous perceptions, and make and remake a team in a continuously adaptive, iterative process. Collaboration makes the team and the HRO stronger when leader and subordinates face the situation together with shared strengths and inadequacies.

The sense of uncontrollability and existential threat results in stress responses and fear reactions that go unrecognized, impairing human performance and interaction (van Stralen, Byrum, Inozu 2017 269-73). Increasing stress capacity, a distinct yet inadequately developed leadership dimension in civilian leadership models, is fundamental to pragmatic HRO leadership.

Healthcare adopted HRO theory as codified by academicians from studying aviation operations on US Navy nuclear aircraft carriers (Rochlin, La Porte, and Roberts 1987; Chassin and Loeb 2013). The absence of the leadership domain in the body of HRO literature appears to be due in part to early HRO studies' focus on the visible 'flight deck' embodiment of high reliability achieved on the nuclear aircraft carrier USS Carl Vinson (TAM) as opposed to the inherent leadership skills that enabled it. As HROs organize to detect and respond to subtle and nuanced shifts and variance in contexts, it would appear reasonable that a leader's intentions and commands, or an executive's directives, could organize a system or situation from the outside. The leadership dimension of HRO, particularly in the dangerous context, is part and parcel of every interaction comprising the five (5) characteristics of HRO.

Leadership in extremis

The neonatologist often leads by entering the situation, sharing the same demands and threats as the team, characteristics of leadership in extremis (Kolditz 2006; Hannah et al. 2009; Campbell, Hannah, and Matthews 2010; Ramthun and Matkin 2014; Dixon et al. 2017). In this article, we will adapt the leadership characteristics missed by the early HRO researchers into leadership for routine operations. Combined, they produce a pragmatic leadership stance available for routine care yet capable of rapid expansion with an evolving emergency. Jim Denney, Capt., LAFD, a veteran of two Vietnam combat tours, stating "What you do in an emergency is what you do every day," had integrated into routine work the leadership stance he learned from combat and emergency operations. People will then coalesce into an emergency team without fear of labels such as "crying wolf." The pragmatic leadership stance makes leaders available to the team, though the formal leader is absent.

The pragmatic leadership stance takes place within the situation, taking advantage of natural internal processes that self-organize people and situations. Self-organization with intention creates adaptive improvisation and immediate responsiveness, driving engagement and action. Individuals sense and respond to weak signals, subtle and nuanced feedback, and misinterpreted noise to bring order and generate the structure. As a stance, pragmatic leadership demonstrates leadership in the world of practice, a mental position, and attitudes. HRO and leadership as abstract representations of work that is done "out there," a representation by academics, is the very object that has been turned into a normative frame that must be returned to its more pragmatic frame. Pragmatic leadership, iterative across levels of analysis and hierarchy, supports engagement, bridges the gap between theory and practice (Zundel and Kokkalis 2010; van Stralen 2020), entwines individuals into teams through heedful interrelating (Weick and Roberts 1993), and from teams to groups to the larger organization from which emerges the HRO. Reliance on leadership models developed in relatively stable systems, the use of a normative stance, and top-down implementation has restricted the extension of HRO into healthcare, as well as into any organization where the environment can abruptly change.

"I see HRO more as mitigating, getting through, lessening the impact of disruptive interruptions. What's failing, am I oversimplifying this, what am I doing, what do I have to work with, and who knows more than I do, all seem to me to be working to restore a workable cosmos," Karl Weick, personal communication.

The nature of the problem and environment

We work with the embedded problem, an ill-structured or ill-defined problem (Simon 1973) embedded in the environment (van Stralen 2020). Leadership in dangerous contexts occurs where the environment contains or influences information (Maitlis and

Christianson 2014; Dixon et al. 2017; van Stralen, Byrum, and Inozu 2017 page 396) and objectives compete or conflict (Vogelaar, Van den Berg, and Kolditz, 2010). Such problems have no clear problem definition, their goal state is not defined clearly, and the means of moving towards the (diffusely described) goal state are not clear (Dörner and Funke 2017).

In a natural system, problems embed into the environment to disrupt structures and distort the system's internal logic. As the environment gains influence, the immediate world becomes nonlinear and indeterminate, well thought out plans begin to fail, and the problem becomes a High-Reliability Situation (HRS) (van Stralen, Byrum, and Inozu 2017 122-3). Because the system can compensate for disruptions before they become consequential, HROs imagine disruptions as an early herald of a process. People maintain vigilance to intervene for these early heralds of failure. Small or frequent errors easily appear as patterns, mistaken for legitimate processes, which then become normative.

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In linear terms, an error or nonconformance results from clearly identifiable root causes to create a consequence. When we include time and the environment, the geometry is more like two cones joined at their apexes. Contingent elements, inconsequential by themselves, interact synergistically, obscuring root causes, some of which may provide contingent benefits. They begin to form a final common pathway at the apex, then expand into a subsequent cone of consequences with varying severity due to other contingent elements. Pragmatic leadership prepares subordinates for these situations:

- A system disruption obscures antecedent events, misleading leaders into thinking only a few variables have meaning or relevance, thus directing their focus on human action as the cause.

- Categorizing failures, by consequence, decreases their visibility and significance when different organizational programs conduct the investigation. A US Navy aviator described this decreased visibility for a single bearing failure: If caught during production, it is a process quality control problem. If returned to the machine shop, it is a production problem. If it leads to damage to a plane, it is a reliability problem. If it causes harm to a person, it is a safety issue. The organization would then study the same error but in different systems.

We speak of contingencies for precipitating events, but we rely on universal, context-free principles for a response. That is, the normative stance teaches and plans for a context-dependent event and relies on context-independent responses. Contingent information and contingent principles are less convenient to discuss. During an event, information may represent events for only a short time period, and principles may only apply or be contraindicated, for certain circumstances, for example, treatment of oxygen desaturation in a premature infant. The identification and use of contingent information and principles make HRO implementation difficult and HRO leadership important.

Acute respiratory failure gives contingent information that may necessitate mechanical ventilation. Stabilization produces new contingent information, yet when asked why the infant is receiving mechanical ventilation, staff often describe the initial information. Mechanical ventilation becomes a context-free principle rather than a treatment we modify for evolving contingencies. This scenario is a rough description of contingent information and contingent principles; it also manifests in the rigorous application of clinical pathways and protocols.

On the strategic level, objectives have a different meaning and longer time horizons. The cells and tissues of an adult change very little over weeks, yet the neonate's cells and tissues have a trajectory, actually, a dividing trajectory, to create different cells and tissues. The outcome of an action today does not fully appear for months or years.

We see this in the nature of the meaning we give feedback loops. We attribute greater importance to short feedback loops with their greater visibility and immediate appearance, common in the disciplines using procedures. The length of time for long feedback loops is affected by memory deficits, confound cause-and-effect interpretations, and are susceptible to later contingencies. Indirect feedback loops require experience, wisdom, and trust because of the vulnerability to new forces and uncertainty of outcome. Contingent feedback loops require monitoring as the feedback may not appear unless underlying conditions are met. And delayed feedback, more common in neonatology, reflects the results years later following actions today. Because a premature infant's tissues have not fully developed, the damage is not to a single cell line but potentially tissues, and damage to a few cells is damage to all the cells that would have developed. Feedback loops in neonatology, though immediate or short during a resuscitation, are generally delayed and indirect, making it difficult for observers to measure success.

Words as lexical elements

The pragmatic leader knows that the types of "words" used to communicate – lexical elements – influence thinking and action. Neonatologists use "diagnosis words," and nurses use "treatment words." Businesses use rules and protocols as words. Academicians, operating in a stable environment, use concepts as words, connecting concept words to construct theories and ideas. SOF units, operating in unstable, hostile, denied, or discrete environments, use descriptions, contingents, and responses as their words, supporting accurate communication of information. The SALUTE Report (US Marine Corps Section 4, Pages 228-229), must be factual, based on actual observations, distinguishing between facts and opinions. The use of different lexical elements, the types of words used, can impede communication and change a concept. This is quite common between physician and nurse urgently presenting new information.

During an emergency, mild, uncontrollable stress impairs the use of abstractions for thought (Arnsten 2009), communication, and

problem-solving. The pragmatic leadership stance thinks in abstract concepts but speaks with concrete terms to overcome this impairment. Leadership from a distance readily excludes the environment, enabling misplaced emphasis on abstract concepts. Concepts are images of reality, but we must not mistake concepts for reality. Alfred North Whitehead (1926/1967 64) warns against this "fallacy of misplaced concreteness," mistaking the abstract for the concrete, accepting abstractions as the most concrete rendering of fact. Discrete, abstract concepts, in a reality of continuous perceptions, creates gaps subject to misspecification, misidentification, and misunderstanding (Weick 2011), gaps the pragmatic leadership stance works to close.

The change in lexical elements, from concrete descriptions of an aircraft carrier's flight deck to abstract representations and business words, changed the frame of HRO from an operational frame to a normative, business frame. "Work done out there" became a normative frame of HRO principles, transforming the meaning and use of significant lexical elements. Threat and capability became risk and risk management using the standards for risk developed by the International Organization for Standardization (ISO) (2009). (The following terms in quotations come from ISO 31000:2009).

- Plans and planning to prepare for contingencies became protocols and algorithms restricting operations.

- Assessing capabilities needed for a mission, an assignment that cannot be refused, became "risk" ("effect of uncertainty on objectives") and "risk-benefit assessment" ("decision-aiding techniques that weigh advantages against disadvantages in numerical terms").

- Increasing capabilities for mission requirements (training and materiel) became "risk management" ("coordinated activities to direct and control an organization with regard to risk").

- Safety, as an operational element, became a distinct element and cost within risk management.

Called to a resuscitation, does the neonatologist determine and manage risk, sacrificing safety to reduce work? We do not deny the inherent dangers of resuscitating. We want to draw attention to the dynamics of "what helps now, hurts later; what hurts before, helps now." That is, we use contingent principles that apply in specific situations. When we consider HRO to be a method for risk management and safety, we wash out the value that HRO brings to extend teams and organizations against adversity and into hostile situations.

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The choice of lexical elements creates a structural change in thought and action. Leonhard Euler described how we gain knowledge from observation through the use of inductive processes (Pólya, 1954 3). Inductive processes require descriptive words in order to translate observations into thought, prompt intellectual synthesis, and extend thought and action into the environment. Calling this induction, even though accurate, brings to mind "generalizing" and the use of specific observation to make broad

generalizations. Observations, through inductive reasoning with caveats as introduced by Euler, "lead us continually to new properties which we all endeavor to prove afterward…We should take care not to accept as true, such properties (Euler 1915 459)" in (Pólya, 1954 3). Lexical elements supporting description, reliability, and "contingent facts" will prompt staff toward induction and the iterative proof and disproof necessary for accurate observation. Lexical elements supporting facts, concepts, and true-false statements will more likely prompt staff toward deduction and acceptance of information that has been "proved." The pragmatic stance of HRO builds on inductive processes, maintains vigilance, and follows Euler's dictum regarding the false character of observed novel properties. The lexical elements the leader uses and accepts determine whether subordinates search for new properties and evaluate whether concepts are able to support perceptions. The unease of induction drives the team to engage the problem while the security of certainty can slow, if not redirect, action.

We can paraphrase Weick's quote into induction or deduction:

- What's failing? Where do I need to look? versus "What did I (or someone) do wrong?"

- Am I oversimplifying this? "What direction can this go?" versus "Am I missing facts?"

- "What am I doing?" "Have my actions caused a response?" versus "Are we following the algorithm?"

- What do I have to work with? "How can we adapt our staff and resources?" versus "Do we have the right tools?"

- Who knows more than I do? "Who hasn't spoken up?" versus "Can we call a consultant?"

The Problem

Organizations seeking to increase reliability and decrease error, look to cognitive processes, and classical problem solving that utilize deductive analysis, scientific logic, and critical thinking. Unintentionally, this supports certainty, disregards ambiguity, and supports deterministic, linear problem solving, more like puzzle-solving, where knowable information fits together to produce the right answer (Heuer 1999 62; Wolfberg 2006). The belief that knowable information enhances decision-making, rather than iterated hypothesis testing, contributes to the collection of more information and increased feeling of confidence but with little change in accuracy, a problem recognized in intelligence analysis. Here, the pragmatic leader models methods of rapid hypothesis testing to quickly gain accuracy (Heuer 1999 51-53).

Leadership can unintentionally become limited to ensuring compliance to standards, appropriate response, and the completion of work with loss of functional authority over subordinates. The idea of followership then makes sense. When this becomes the core support for performance, we lose the ability to respond to unexpected, uncertain, and ambiguous events. The inclusion of uncertainty widens the operational environment making available a fuller spectrum of analysis and pursuit of weak but salient signals. Problem-solving becomes a mystery-solving rather than puzzle-solving (Wolfberg 2006).

Approaching the problem as a mystery promotes engaging an undefined problem (Deiterly 1980) before the situation is fully identifiable or the ill-structured problem that is not defined, poorly structured, requires information in the environment not readily available, uncertainty regarding allowable operations, and does not have a clear goal (Simon and Newell 1958; Simon 1973; Pretz et al. 2003). Well-structured and defined problems, independent of context, are amenable to computational algorithms with allow-

able operations (Simon and Newell 1958; Pretz et al. 2003), commonly used for education and planning. The ill-structured problem relies on heuristics, a practical process to move toward a solution (Newell, Shaw, Simon 1957). Algorithms are for the amount of processing; heuristics are for complexity (Newell, Shaw, Simon 1957). Heuristics have now become linked to error, cognitive biases, and biased decision-making (Tversky and Kahneman 1974), yet error, as the "experience of failing," is instrumental in achieving safety. Short, negative feedback, sometimes called an error, denotes the boundary of performance, knowledge, and operations. Error corrects heuristic bias.

Pragmatic leadership takes responsibility to guide and support the engagement of the undefined or ill-structured problem. The act of engagement generates information, while the direction of engagement generates structures. Simplification to make the situation a well-structured problem obscures information, the reason for the "reluctance to simplify" in HRO. In fact, HROs are disposed to "complexify the problem" to aid the search for information within the environment. The pragmatic leadership stance, through engagement and judgment, guides the resolution of undefined or ill-structured problems.

When the problem "embeds into time," compensating for the perturbation, it becomes covert, identifiable only from weak signals. The pragmatic leader, cognizant of the importance of weak but salient signals, encourages reporting, aware that subtle expressions from the leader easily extinguish communication. In this covert, compensated phase, a focus area for safety, the problem is ambiguous, yet interventions are more effective, and complications, less likely. The overt, decompensated phase, the focus for "error" surveys, is readily categorized, but internal, invisible processes continue to penetrate and spread.

The nature of an evolving embedded problem does not lend itself to most leadership models. Leadership, from a distance, shifts thinking to decontextualized abstractions, focuses on principles, and reliance on discrete concepts. The pragmatic leadership stance of HRO engages the embedded problem, accepts the influence of the environment, monitors the performance of individuals and the team, and supports leader-leader actions.

The Environment

The HRO operates within an open system where energy and resources exchange between the organization, the problem, and the environment. Knowledge and concepts developed in controlled research environments do not reliably support operations during the HRS. The environment affects the performance and capabilities of the leader and subordinates. Acknowledging the open environment and its increased interactions promote scalability within the organization from NICU to levels of administration.

Problem Dynamics

Within a system, elements continuously and actively self-organize from local, nonlinear interactions. "Natural systems become structured by their own internal processes," and "the emergence of order within them is a complex phenomenon" F. Eugene Yates (Yates 2012 p xi). Energy and infectious agents enter or leave, and energy transforms into other forms, confounding our efforts to impose structure and stability. Novel properties, emerging from self-organization, are produced by interactions of the properties of the parts of the system. We cannot deduce these properties from observation of the individual units, making them unpredictable and unexpected (Salt 1979; Edson, Foin, and Knapp 1981). Rather, novel properties are discovered through direct observation. Engagement and inductive processes then identify and give meaning to the discovered novel or unexpected properties which

the pragmatic leader further interprets for salience, relevance, and meaning.

Dynamic problems and "deference to expertise" demonstrate how leadership occurs long before it is needed. Confusion between "deferring" versus "delegating" expertise interfered with early acceptance of HRO by physicians (personal communication from a physician executive with a national patient safety organization). In the US Navy, command consists of those duties the Captain cannot legally delegate. In healthcare, the physician cannot delegate diagnosis, prescriptive authority, or surgical procedures (there are exceptions). The pragmatic leadership stance acts as a mentoring system during routine operations, preparing members to assist the neonatologist during an emergency or to assume responsibility. That is, the physician mentors the expert that the physician will later defer to. For example, veteran leaders can readily manage the acceleration of activity in a linear system. A surge of critical patients, however, bifurcates the linear system, predictability is lost, and the leader can manage one or none of the patients. Subordinate "experts," developed by the pragmatic leader, are now available to extend the neonatologist's leadership to each critically ill neonate. Pragmatic leadership has elastic deformation compared to yielding (plastic) deformation of normative leadership stances. The physician leader has increased the distance from which we can enact change by using the organic energy of the NICU through this model (Jason Amerson, MSG, USASOC, personal communication). The pragmatic leadership stance is constant "on-the-job-training" supporting staff to recognize and engage problems early.

Bronchopulmonary Dysplasia as HRO

Bronchopulmonary dysplasia (BPD) emerged as a novel property (disease) from complex, nonlinear interactions between the elements of preterm birth, growth and development, pathology, treatment, and healing. Treatments influenced various contributing factors, with the caveat that treatment for one element exacerbated other factors, interfering with success and creating other novel pathologies (Northway, Rosan, and Porter 1967; Abman, Bancalari, and Jobe 2017). Success led to the intact survival of more infants at an earlier stage of gestation. Despite 50 years of knowledge and experience, the definition of the disease continues to be treatment rather than pathology, radiology, or injury markers (Jobe, 2016; Voynow 2017).

Weick's quotation in the introduction illustrates the elements of HRO in the progress of BPD and could also be applied to a dangerous context:

- What's failing? Premature babies are dying from lung disease.

- Am I oversimplifying this? BPD results from complex interactions of disease, health, treatment, and development.

- What am I doing? Treatments help or hurt or both.

- What do I have to work with? Improved use of, and alternatives to, mechanical ventilation. Identification of medications.

- Who knows more than I do? Chemists, physicists, surgeons, physiologists, engineers, nurses, dietitians, social workers, ethicists, and anyone with knowledge that extends effective care to the premature infant.

- All seem to work to restore a workable cosmos. Increased intact survival and extension of this success to smaller babies, restoring young families.

Over a 50-year period, infants live rather than die; without intellectual disability, they graduate from school; compete athletically

without physical disability, and children love and are loved instead of life-long mourning. HRO extends leadership, healthcare, and meaning into diseases once seemingly hopeless.

Elements of pragmatic leadership

The pragmatic stance is not about the leader entering a difficult environment, but how the leader's behavior influences the well-being of subordinates, so they not only enter the environment but effectively perform (Kolditz 2006). Working the problem from within the situation, sharing threats and uncertainty as a participant, defines the pragmatic leadership stance. The ill-structured problem is a natural system that becomes ordered from internal processes, a self-organizing system. The team, and leader, must enter the system, becoming part of the internal processes that generate order. We cannot organize the situation and use commands and rules to resolve ill-structured problems from the outside like is possible with context-independent, well-structured problems.

"The neonatologist, using the pragmatic leadership stance, can improve performance and effective operations while reducing uncontrollable stress in the NICU for the benefit of the babies, families, and staff."

Conclusion

HRO, as synthesized from aerial combat, nuclear engineering, and US Navy leadership, becomes a pragmatic stance to balance between emergency response and emergency prevention. HRO, as a pragmatic leadership stance, increases the mental and psychological capabilities of staff. It is the qualities of the HRO pragmatic leadership stance that enables the smooth implementation of HRO and supports identification and engagement of early heralds of failure. The neonatologist, using the pragmatic leadership stance, can improve performance and effective operations while reducing uncontrollable stress in the NICU for the benefit of the babies, families, and staff.

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