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Title: Living with Embodied Uncertainty: A Phenomenological Study of Risk, Ethics, and Systemic Strain Among Iranian Helicopter Emergency Medical Services Providers

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Abstract

Background: Helicopter Emergency Medical Services (HEMS) in resource-limited settings represent critical but structurally constrained lifelines. While operational challenges are documented, a profound knowledge gap persists: the *lived phenomenological experience* of frontline providers navigating the intersection of acute clinical risk, chronic systemic strain, and embodied ethical decision-making remains unexplored. This study addresses this gap by investigating the essence of meaning-making among Iranian HEMS personnel operating under significant duress.

Methods: An interpretive phenomenological design was employed. Through purposive maximum-variation sampling, eleven HEMS providers from three Iranian bases participated in in-depth, semi-structured interviews. Data were analyzed using Reflexive Thematic Analysis (RTA) within a phenomenological framework. Rigor was ensured via a structured reflexivity protocol, consensus coding, member checking, and audit trail maintenance. The study received full ethical approval.

Results: The analysis crystallized in the core phenomenon of "Embodied Uncertainty" a pervasive state of being wherein professional agency is continuously negotiated within and against systemic constraints through bodily, cognitive, and moral dimensions. This essence is constituted by five interconnected themes: 1) Vocational Calling and Existential Sacrifice, 2) Operational Vigilance as a Habituated State, 3) Ethical Decision-Making Under Constraint as Moral Residue, 4) Training as a Ritual of Anticipatory Control, and 5) Systemic Pessimism as Crystallized Foresight. Crucially, the findings delineate a direct, lived pathway from operational friction and resource scarcity to tangible moral injury, where ethical dilemmas are not just cognitively processed but somatically retained ("engraved in muscle memory").

Conclusion: This study makes a seminal contribution by theorizing "Embodied Uncertainty" as a fundamental framework for understanding prehospital work in constrained systems. It moves beyond cataloging stressors to model the dynamic embodiment of systemic failure. The findings compel a paradigm shift from individual resilience narratives toward structural accountability. We propose three evidence-based, actionable pillars for reform: (1) Mandatory, psychologically-informed post-mission debriefing systems to process moral residue; (2) High-fidelity, interprofessional simulation training co-designed with crews to bridge preparedness gaps; and (3) National ethical guidelines for aeromedical retrieval co-created with frontline providers. Ultimately, this research posits that provider well-being is the foundational determinant of HEMS safety and sustainability a critical imperative for global prehospital systems facing analogous constraints.

Keywords: Emergency Medical Services, Air Ambulances, Clinical Decision-Making, Qualitative Research

Background

Helicopter Emergency Medical Services (HEMS) constitute a critical component of Iran's prehospital emergency care system, enabling rapid access to definitive treatment in geographically remote, mountainous, and disaster-prone regions where ground ambulance transport is frequently delayed or operationally unfeasible. In such contexts, HEMS often represents the sole viable means of timely life-saving intervention (1). Despite growing demand, HEMS operations remain constrained by structural challenges, including limited aviation infrastructure, shortages of specialized medical helicopters, prolonged mission activation times, and challenges related to interorganizational coordination across multiple emergency response and aviation stakeholders (2–5). These systemic constraints are not merely operational hurdles; they fundamentally shape the high-pressure, resource-limited context in which HEMS providers must make rapid, high-stakes decisions, thereby forming the essential backdrop to their lived experiences of risk, ethics, and strain (6).

Iranian HEMS teams are typically composed of paramedics and emergency nurses operating in small crews, often without physicians on board, a staffing model that places substantial clinical and ethical responsibility on non-physician providers (2,7,8). These providers navigate a complex operational environment requiring the simultaneous management of high-acuity patient care, flight safety, environmental hazards, and ethical decision-making, often under severe time pressure and with resource limitations, resulting in persistent cognitive and moral strain (5,6,9,10). Recurrent exposure to traumatic incidents and ethically ambiguous triage decisions can lead to moral distress, the psychological anguish of knowing the right action but being constrained from taking it and moral residue, the lingering emotional burden after such events (11–13).

While international research on HEMS has extensively examined stress, burnout, and operational outcomes, the majority of these studies employ quantitative methods that prioritize measurable indicators over lived experience (11,14). While a limited number of recent qualitative studies in high-resource settings have begun to explore aspects of HEMS providers' experiences, such as wellbeing in challenging contexts or ethical challenges, a focused phenomenological investigation into the nuanced, lived experience of meaning-making under systemic constraint remains scarce (6). In the Iranian context, prior research has predominantly focused on quantitative assessments of stress or job satisfaction (12,13), further highlighting the absence of in-depth qualitative inquiry into how HEMS providers subjectively interpret, negotiate, and give meaning to ethical dilemmas, emotional burden, and professional identity within this resource-constrained, high-stakes context.

Given the need to understand the depth and complexity of these experiences, a qualitative phenomenological approach, specifically informed by an interpretive phenomenological orientation, is employed (15). This approach is concerned with how individuals make sense of their lived world, making it ideal for exploring the intersubjective meanings of risk, responsibility, and ethical practice in HEMS. Data were analyzed using reflexive thematic analysis within this phenomenological framework (16). Theoretically, this study is situated at the intersection of phenomenology of practice and constructs related to moral distress and resilience, focusing on how providers make meaning of their experiences within a context of systemic constraint.

Therefore, this study aims to address the identified gap by posing the following research question: What are the lived experiences and shared meanings that Iranian HEMS providers ascribe to their professional practice within a context of operational constraint and high-stakes decision-making? Specifically, it explores how providers navigate professional motivation, operational and ethical challenges, coping and training strategies, and their outlook on the future. By centering the lived experiences of frontline providers, this research aims to generate contextually rich, theoretically informed insights that contribute to the phenomenology of prehospital care, while offering evidence-based guidance for policy, support systems, and sustainable HEMS operations in resource-limited settings, with findings from the Iranian context providing transferable insights.

Materials and Methods

Study Design

This study was guided by an interpretive phenomenological philosophy to explore the lived experiences of Iranian HEMS providers (17). Within this philosophical framework, we employed a qualitative design utilizing Reflexive Thematic Analysis (RTA) as our analytical method (16,18). This approach was chosen because its flexible, systematic process for identifying themes is compatible with phenomenological inquiry when applied with a focus on *experiential meaning* rather than mere frequency of data segments (16,17). Its core emphasis on researcher reflexivity also aligns with the interpretive, co-constructed understanding central to phenomenology (19). While our focus was on elucidating shared patterns of meaning across participants a strength of RTA for generating insights relevant to health services and policy, we remained grounded in the idiographic, lived detail of individual accounts through close engagement with each transcript, ensuring our themes captured the essence of the phenomenon as experienced (15,17).

Sampling and Participants

Setting and Recruitment

Participants were recruited from three HEMS bases in Tehran and Qom provinces, Iran. We employed a purposive sampling strategy aiming for maximum variation (20,21) across key dimensions: professional role (paramedic vs. nurse), years of HEMS experience (from 1 to over 10), estimated mission volume, and base operational environment. To operationalize this, research team members reviewed anonymized staff lists (provided by base management after institutional approvals) and actively selected potential participants to create a demographically and professionally diverse sample pool.

Eligible individuals were contacted directly by a member of the research team (who held no supervisory authority) via phone or in person. They received comprehensive verbal and written information about the study's aims, procedures, confidentiality, and their right to withdraw. Written informed consent was obtained from all participants prior to scheduling the interview.

Participants

Eleven HEMS providers participated (see Table 1 for full demographics). The all-male sample reflects the current gender composition of Iran's operational clinical HEMS workforce (8), a contextual factor discussed as a study limitation. Participants' ages ranged from 29 to 52 years (mean ~43 years), with HEMS-specific experience ranging from 1 to 10 years (mean ~6 years). All met the following inclusion criteria: (1) current clinical practice as a HEMS nurse or paramedic; (2) at least one year of full-time HEMS experience; (3) involvement in a minimum of 30 air medical missions; and (4) willingness to provide informed consent and participate in a recorded interview.

Sample Size and Saturation

Data collection and preliminary analysis occurred concurrently. Thematic saturation was operationally defined as the point where two consecutive interviews yielded no new thematic insights but only reinforced the depth and boundaries of the existing thematic framework (22). This point was reached after nine interviews. Two additional interviews were conducted to confirm the robustness and stability of the findings, resulting in the final sample of eleven.

Data Collection

Data were collected via semi-structured, in-depth interviews between May and June 2024. The interview guide (see Supplementary File 1) was developed from a literature review on prehospital stress and ethics, and refined through pilot testing with two experienced HEMS providers (not part of the main sample), which led to clarifications in question phrasing (23,24).

Interviews were conducted in Persian by two authors (M.A. and M.P.M.), both male clinicians with over a decade of emergency care experience. This shared background aided rapport but required active bracketing of preconceptions. We employed strategies such as maintaining a reflexive journal, using open-ended probes (e.g., "Can you tell me more about that moment?"), and holding debriefing sessions after each interview to discuss and set aside our initial reactions (25).

Interviews lasted 53–78 minutes (mean: 58). Seven were conducted in-person at HEMS bases, and four online via a secure, encrypted platform (Zoom). All interviews were audio-recorded with consent, transcribed verbatim in Persian by a professional transcriptionist, and anonymized (participant codes P1–P11). Transcripts were not returned for correction to preserve narrative spontaneity and the emotional authenticity of the accounts. However, key interpretive summaries were later shared with five participants for member checking; all confirmed the accuracy of the interpretations, with two offering minor contextual clarifications that were incorporated (26). Post-interview field notes documented contextual observations and reflexive thoughts.

Researcher Reflexivity and Positionality

Researcher positionality was actively managed throughout the study using a structured, collaborative approach. The primary interviewers and analysts (M.A., M.P.M.) are male clinicians with over a decade of experience in Iranian prehospital emergency care. This insider status was instrumental in building rapport, understanding technical jargon, and probing clinical nuances (27). However, we recognized it risked analytic complacency (e.g., overlooking taken-for-granted assumptions about systemic inefficiency) and emotional over-identification with participants' frustrations.

To bracket these preconceptions and enhance interpretive rigor, we employed multiple strategies:

Maintaining a Collaborative Reflexive Journal: All researchers contributed to a shared digital journal documenting pre-interview assumptions, emotional reactions post-interview, and analytic hunches (25). For example, after interviewing several participants who expressed deep pessimism, we documented our own concern about system sustainability to separate our emotional response from the analytic task of understanding the meaning of that pessimism.

Engaging a Critical Friend: A third researcher (M.G.), a female academic in public health without frontline EMS experience, acted as a "critical friend" throughout the analysis. She regularly challenged clinical assumptions, asked for evidence for interpretations, and ensured themes were grounded in the data rather than in the clinicians' professional worldview (28).

Structured Team Debriefings: We held regular analytic meetings where journal entries were discussed. Disagreements in coding (e.g., whether a narrative primarily illustrated "operational challenge" or

"ethical distress") were resolved by returning to the transcripts and the reflexive notes, ensuring the final analysis represented a negotiated, consensus-based interpretation aligned with the principles of Reflexive Thematic Analysis (16).

This iterative process ensured that our interpretations were continually questioned and refined, moving from initial personal reactions to critically examined, shared thematic understanding.

Data Analysis and Rigor

Analytic Framework and Process

Data were analyzed iteratively using Reflexive Thematic Analysis (RTA) within a phenomenological framework, guided by the six-phase approach of Braun and Clarke (16). This method was chosen for its theoretical flexibility and systematic process for identifying themes, which is compatible with phenomenological inquiry when applied with a focus on experiential meaning over frequency (16,17). Its core emphasis on researcher reflexivity also aligns with the interpretive, co-constructed understanding central to our phenomenological philosophy (19). While RTA facilitates the identification of shared patterns across participants suitable for generating health services insights, we remained grounded in the idiographic detail of individual accounts. The analysis was conducted manually (without software) to facilitate deeper, immersive engagement with the data and allow for greater flexibility during the recursive, reflective coding process (29).

The process was collaborative and iterative:

Familiarization: Transcripts were read and re-read multiple times alongside audio recordings, and initial analytical and reflexive notes were recorded.

Generating Initial Codes: Two researchers (M.A. and M.P.M.) independently coded the first three transcripts line-by-line to generate an initial codebook (see Supplementary File 2 for an excerpt).

Coding discrepancies (approximately 15% of initial codes) were resolved through discussion and consensus in the presence of the third researcher (M.G.), leading to a refined, shared codebook (30).

Constructing Initial Themes: Using the shared codebook, codes from all transcripts were collated. Through constant comparison (31), codes were clustered into potential themes using visual thematic maps, resulting in 12 candidate themes.

Reviewing and Refining Themes: Candidate themes were rigorously reviewed against the entire dataset and for internal coherence during weekly team meetings. For instance, an initial descriptive theme "Frustration with Equipment" was subsumed under the broader, more conceptual theme of "Operational Vigilance" after discussion about its underlying experiential meaning. Our critical friend

(M.G.) consistently challenged interpretations to ensure they remained data-driven. Thematic saturation was confirmed when no new thematic insights emerged from subsequent interviews (22).
Defining and Naming Themes: The final five overarching themes were clearly defined and named to capture their experiential essence. A thematic map was developed to visualize their connections (Figure 1).

Producing the Report: The final analytic narrative was written in the original Persian language to preserve experiential meaning, and later translated for publication. It is supported by verbatim participant quotations and the conceptual thematic map (Figure 1).

Trustworthiness

We adhered to established criteria for ensuring trustworthiness in qualitative research (32).

Credibility was enhanced through prolonged engagement, member checking (where summaries were shared with five participants for confirmation and refinement) (26), and peer debriefing with the critical friend.

Dependability was established by maintaining a comprehensive audit trail (including raw data, reflexive journals, codebook iterations, and analytic meeting notes).

Confirmability was achieved through triangulation among researchers, reflexive journaling, and consensus-based analysis, ensuring findings were grounded in the data.

Transferability is enabled by the thick descriptions of context, participants, and methods provided herein, allowing readers to assess applicability to other settings.

Ethical Considerations

Ethical approval was granted by the Ethics Committee of Qom University of Medical Sciences (IR.MUQ.REC.1399.067). All procedures adhered to the principles of the Declaration of Helsinki (33). Written informed consent was obtained prior to each interview. Participants were assured of confidentiality and their right to withdraw without consequence. All transcripts were anonymized (using codes P1–P11) and stripped of identifying details. Digital audio files and transcripts are stored on a password-protected, encrypted institutional server accessible only to the core research team. Data will be retained in accordance with institutional policy until December 2030, after which they will be securely deleted. Anonymized interview transcripts can be made available by the corresponding author upon reasonable request for academic purposes, subject to a formal data-sharing agreement.

Results

Participant Characteristics

Eleven HEMS providers participated (Table 1). Participants' ages ranged from 29 to 52 years (mean: 43.3). The sample included paramedics (n=7) and nurses (n=4), with HEMS experience ranging from 1 to 10 years (mean: 6.1 years). This variation in professional roles and experience enhanced the breadth of perspectives captured. All participants were male, reflecting the gender composition of Iran's clinical HEMS workforce.

Overview of Findings

Interpretive analysis yielded five interconnected themes, visualized in a conceptual map (Figure 1). These themes coalesce around a core phenomenological essence: "Embodied Uncertainty." This essence captures the participants' fundamental state of being a continuous, bodily-felt negotiation with unpredictability, limited resources, and high-stakes responsibility, where clinicians' sense of professional agency is constantly tempered by systemic constraints. The themes are not discrete but fluid, each reflecting a different facet of this overarching experience of operating in a space of inherent indeterminacy.

The interrelationships among the five themes are depicted in a conceptual map (Figure 1), demonstrating how systemic strain permeates clinical practice, intensifies ethical distress, and shapes participants' future outlook. The thematic structure and illustrative data excerpts are summarized in Table 2.

Table 1. Table 1. Demographic and professional characteristics of Iranian HEMS providers (N=11).

Participant ID	Age (Years)	Gender	Profession	HEMS Experience (Years)	Academic Degree
P1	29	Male	Paramedic	1	BSc
P2	36	Male	Paramedic	4	BSc
P3	39	Male	Nurse	8	BSc
P4	40	Male	Paramedic	8	BSc
P5	43	Male	Paramedic	6	BSc
P6	44	Male	Nurse	3	MSc
P7	46	Male	Nurse	8	MSc
P8	47	Male	Nurse	2	BSc
P9	50	Male	Paramedic	8	BSc
P10	51	Male	Paramedic	10	BSc
P11	52	Male	Paramedic	10	BSc
Mean (SD)	43.3 (7.2)			6.1 (3.2)	

The table presents participant age, gender, professional role, years of HEMS-specific experience, and highest academic degree. The sample reflects the current gender composition of the operational HEMS workforce in Iran.

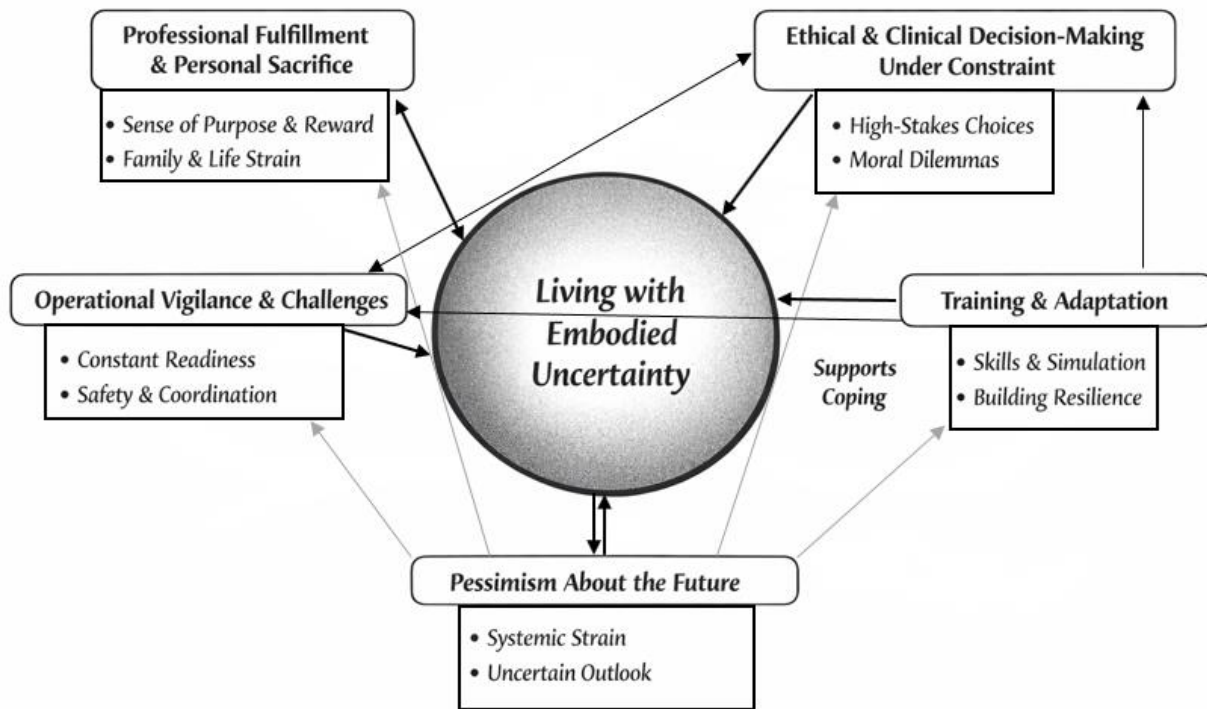


Figure 1. Conceptual map illustrating the lived experiences of Iranian HEMS providers.

The core phenomenological essence, 'Embodied Uncertainty,' captures the participants' ongoing bodily and cognitive negotiation with systemic constraints, operational risk, and ethical responsibility. The map depicts the dynamic interrelationships among the five central themes and how systemic strain shapes ethical distress, professional agency, coping strategies, and future outlook.

Table 2. Thematic structure of Iranian HEMS providers' lived experiences with illustrative verbatim quotations.

Overarching Theme & Core Description	Sub-Theme	Illustrative Verbatim Quotation (Participant ID, Role, Experience)
<p>1. Professional Fulfillment Intertwined with Personal Sacrifice</p> <p>Captures the central paradox of finding profound purpose in work that incurs chronic personal costs.</p>	<p>1a. Intrinsic Motivation & Existential Meaning</p>	<p><i>"What compels me is not adrenaline, but the absolute solitude of responsibility... That pressure... it clarifies you. It tells you who you are."</i> (P3, Nurse, 8 years)</p>
<p>2. Operational Vigilance as a Lived State of Being</p> <p>Characterizes readiness not as a task but as a permanent mode of being, shaped by embodied habits and systemic friction.</p>	<p>1b. Relational Costs & Dislocation</p>	<p><i>"My children have grown up with a father who is physically present but perpetually mentally on the edge... You carry the gratitude of strangers and the quiet resentment of your own family."</i> (P7, Nurse, 8 years)</p>
<p>2. Operational Vigilance as a Lived State of Being</p> <p>Characterizes readiness not as a task but as a permanent mode of being, shaped by embodied habits and systemic friction.</p>	<p>2a. Safety as Embodied Practice</p>	<p><i>"Flight safety is not something you think about; it is something you feel in your gut... A slight vibration... your body registers it before your mind can label it."</i> (P2, Paramedic, 4 years)</p>
<p>2. Operational Vigilance as a Lived State of Being</p> <p>Characterizes readiness not as a task but as a permanent mode of being, shaped by embodied habits and systemic friction.</p>	<p>2b. Systemic Friction & Coordinative Fatigue</p>	<p><i>"The deepest fatigue comes from these voids of accountability... You are trained for medical crisis, but you spend your energy in bureaucratic limbo."</i> (P6, Nurse, 3 years)</p>
<p>3. Ethical Decision-Making Under Constraint as Moral Weight</p> <p>Represents clinical judgments as ethical dilemmas under duress, often leaving moral residue.</p>	<p>3a. In-Flight Triage & Moral Residue</p>	<p><i>"We flew him. He died in the cabin... The protocol was right. But was I? Now... my hand hesitates. That child's face is engraved in my muscle memory."</i> (P4, Paramedic, 8 years)</p>
<p>3. Ethical Decision-Making Under Constraint as Moral Weight</p> <p>Represents clinical judgments as ethical dilemmas under duress, often leaving moral residue.</p>	<p>3b. Resource Limits as an Ethical Frontier</p>	<p><i>"You deliver suboptimal care by design... You become an agent of a system that has already decided some lives are less savable."</i> (P9, Paramedic, 8 years)</p>
<p>4. Training as a Ritual of Preparedness</p> <p>Positions training as a</p>	<p>4a. The Ritual of Simulation</p>	<p><i>"The simulation drills are where we reclaim the narrative... It creates a cognitive blueprint of order we try to overlay onto disordered reality."</i> (P8, Nurse, 2 years)</p>

psychological practice to manage uncertainty, both imposing order and highlighting system gaps.	4b. The Gap Between Simulated & Real	<i>"We train with advanced equipment, but then fly with monitors that fail... This gap is demoralizing." (P5, Paramedic, 6 years)</i>
5. Pessimism as Crystallization of Systemic Strain	5a. Foreseeable Collapse	<i>"My pessimism isn't a mood; it's a forecast... I foresee a point where the service will simply be unable to function safely." (P9, Paramedic, 8 years)</i>
Reveals a collective, reasoned despair about system sustainability, emerging from prolonged neglect.	5b. Erosion of Advocacy	<i>"The ritual of ignored feedback is more exhausting... You realize you are a component reporting its own wear and tear. This silence is the dissipation of hope." (P11, Paramedic, 10 years)</i>

The table presents five overarching themes and associated sub-themes derived from reflexive thematic analysis within a phenomenological framework. Each sub-theme is illustrated by verbatim participant quotations, providing rich contextual insight into the experiential essence of professional practice, ethical challenges, operational vigilance, training, and perceptions of systemic strain. Themes reflect the dynamic interplay of embodied, cognitive, and ethical dimensions that constitute the core phenomenological essence of 'Embodied Uncertainty.'

Theme 1: Vocational Fulfillment Intertwined with Personal Sacrifice

This foundational theme captures the central paradox of HEMS work: a profound, identity-conferring sense of purpose inextricably bound to chronic personal costs. This duality forms a core tension within the experience of "embodied uncertainty."

Subtheme 1.1: Intrinsic Motivation and Existential Meaning: Participants described their work as a vocation providing unique existential meaning. As one nurse reflected: "What compels me is not adrenaline, but the absolute solitude of responsibility... In that moment, all your training condenses into a single point: 'You must save this person.' That pressure... it clarifies you. It tells you who you are." (P3, Nurse, 8 years). Participants described how this profound sense of duty manifests physically,

affecting sleep, attention, and overall bodily alertness, reinforcing the embodied nature of professional responsibility.

Subtheme 1.2: Relational Costs and Dislocation: This commitment incurred significant personal tolls. A participant shared: "My children have grown up with a father who is physically present but perpetually mentally on the edge... You carry the gratitude of strangers and the quiet resentment of your own family. It is a guilt that becomes part of your bones." (P7, Nurse, 8 years).

Notable Divergent Perspective: One participant (P2, Paramedic, 4 years) expressed a more integrated view, stating his family saw his duty as a source of pride, highlighting the role of individual support systems.

Connection to Other Themes: This deep-seated vocational fulfillment provides the psychological fuel that sustains the constant state of vigilance required in Theme 2. Conversely, the strain from subsequent themes can erode this foundational sense of purpose, feeding into systemic pessimism (Theme 5).

Theme 2: Operational Vigilance as a Lived State of Being

Operational readiness was not a task but a permanent mode of being a background state of alertness that shaped all other experiences.

Subtheme 2.1: Safety as Embodied Practice: Safety protocols were internalized to the point of becoming reflexive, physical responses. A paramedic described: "Flight safety is not something you think about; it is something you feel in your gut... Your body registers a change before your mind can label it. That constant, low-level scanning is fatiguing, but its absence would be terrifying." (P2, Paramedic, 4 years). This constant bodily attunement not only maintains operational readiness but also channels the systemic pressures into a continuous, physically-felt state of cognitive and emotional vigilance.

Subtheme 2.2: Systemic Friction and Coordinative Fatigue: Often, the greatest drain came from navigating systemic inefficiencies. A nurse explained: "The deepest fatigue comes from these voids of accountability, where you are suspended, waiting for others to play their part. You are trained for medical crisis, but you spend your energy in bureaucratic limbo." (P6, Nurse, 3 years).

Connection to Other Themes: This unrelenting state of vigilance forms the immediate, fatiguing backdrop against which the weighty ethical decisions of Theme 3 are made, amplifying their moral

difficulty. Thus, the 'lived state' of operational vigilance is a primary channel through which systemic constraints become embodied and transmuted into personal, cognitive, and ethical strain.

Theme 3: Ethical Decision-Making Under Constraint as Moral Weight

Clinical judgments were often profound ethical dilemmas performed under duress, representing the crystallization of "embodied uncertainty" into critical choice.

Subtheme 3.1: In-Flight Triage and Moral Residue: Decisions to transport unstable patients against protocol could lead to lasting moral injury. A paramedic recounted: "We flew a critically injured child. He died in the cabin. The protocol was right. But was I? Now, every time I see a pediatric case, my hand hesitates. That child's face is engraved in my muscle memory." (P4, Paramedic, 8 years).

These ethical dilemmas are not only cognitive challenges but are physically and emotionally embodied, leaving a lasting imprint on the providers' sense of agency and bodily awareness.

Subtheme 3.2: Resource Constraints as an Ethical Frontier: Moral suffering also stemmed from systemic limitations that dictated suboptimal care. Another participant stated: "You deliver suboptimal care by design, and you have to justify it to yourself each time. You become an agent of a system that has already decided some lives are less savable." (P9, Paramedic, 8 years).

Notable Divergent Perspective: One early-career paramedic (P1, Paramedic, 1 year) emphasized strict protocol adherence as an ethical shield, stating, "You follow the protocol. The ethics are built into the checklist," illustrating a cognitive coping strategy of relying on protocol objectivity.

Connection to Other Themes: This moral weight was experienced as being intensified within a state of constant operational vigilance, while simultaneously shaping how participants made sense of their vocational role and the future of the system. This heavy moral burden directly erodes the vocational fulfillment of Theme 1, is a direct product of the constrained operational environment in Theme 2, and serves as a primary feedstock for the systemic pessimism that crystallizes in Theme 5.

Theme 4: Training as a Ritual of Preparedness and a Shield Against Uncertainty

This theme captures how training transcended skill acquisition to become a psychologically essential practice for managing pervasive uncertainty. It functioned as both a ritual of preparedness to impose order on chaos and a symbolic shield against the emotional toll of constrained agency.

Subtheme 4.1: The Ritual of Simulation – Rehearsing Control: Scenario-based training was described as an active rehearsal of control. A nurse explained: "In the simulator, we get to dissect the chaos..."

We repeat procedures until our hands perform them without thought. That muscle memory creates a cognitive blueprint of order that we try to overlay onto the disordered reality of a mission." (P8, Nurse, 2 years). Through repetitive simulation, both cognitive and bodily schemas are internalized, allowing providers to 'pre-embodiment' procedural and ethical responses before confronting real missions.

Subtheme 4.2: The Gap Between Simulated and Real – A Source of Frustration: Paradoxically, training highlighted systemic shortcomings. A paramedic noted: "We train with advanced equipment, but then fly with monitors that fail. This gap is demoralizing. It makes training feel like a performance of an ideal that doesn't exist." (P5, Paramedic, 6 years).

Notable Divergent Perspective: One veteran participant (P10) focused solely on technical utility, viewing training primarily as a technical, skill-focused practice, deliberately separating procedural proficiency from its psychological and existential dimensions.

Connection to Other Themes: The "cognitive blueprint" from training aims to reduce the cognitive load of constant vigilance (Theme 2). Its failure due to systemic gaps fuels the pessimism of Theme 5. Thus, training represents the struggle to institutionally pre-script the body and mind against 'embodied uncertainty,' a struggle that often founders on the rocks of systemic reality.

Theme 5: Pessimism About the Future as the Crystallization of Systemic Strain

This theme reveals a collective, reasoned despair about system sustainability, representing the final internalization of "embodied uncertainty." Participants described feeling this pessimism not only cognitively but also physically, manifesting as chronic tension, anticipatory fatigue, and a pervasive sense of bodily vigilance.

Subtheme 5.1: Foreseeable Collapse – The Rationalization of Despair: Pessimism was framed as a logical forecast. A participant stated: "My pessimism isn't a mood; it's a forecast. We fly machines at their limits. Our most experienced colleagues leave. I foresee a point where the service will be unable to function safely." (P9, Paramedic, 8 years).

Subtheme 5.2: The Erosion of Advocacy – From Voice to Resignation: A poignant sub-theme was the transition to resigned silence. A participant shared: "Now, I am silent. The ritual of ignored feedback is exhausting. You realize you are a component reporting its own wear and tear. This silence is the real pessimism the dissipation of hope." (P11, Paramedic, 10 years).

A Notable Divergent Perspective: One early-career participant (P1) expressed optimism about new technology and advocacy, reflecting how early-career perspectives and optimism may temporarily buffer against systemic pessimism.

Connection to Other Themes: This theme is the synthetic outcome of all others. The sacrifices (Theme 1), strain (Theme 2), moral injuries (Theme 3), and inadequate training buffers (Theme 4) crystallize into this systemic pessimism. Thus, 'embodied uncertainty' initially encountered as vocational challenges (Theme 1), lived daily through operational vigilance (Theme 2) and moral dilemmas (Theme 3), and only partially mitigated by training (Theme 4) culminates in systemic pessimism about the future, completing a phenomenological cycle from immediate lived experience to anticipatory projection.

Phenomenological Essence: Embodied Uncertainty

The analysis converges on a core phenomenological essence: Embodied Uncertainty. This is a profound mode of being characterized by the continuous negotiation of agency within a structure of constraint. This embodied uncertainty is experienced not only cognitively but also somatically, manifesting as heightened alertness, fatigue, and the visceral weight of moral responsibility.

This uncertainty is embodied in two ways: 1) felt physically in heightened sensory awareness, vigilance fatigue, and the visceral weight of moral distress; and 2) enacted through adapted bodily habits (safety checks, rehearsed protocols) that attempt to impose order on chaos. Professional mastery is thus perpetually exercised within a limited field of possibility.

"Embodied Uncertainty" encapsulates the condition of acting with decisive purpose amid pervasive indeterminacy. Vocational fulfillment (Theme 1) provides the impetus to enter this space; operational vigilance (Theme 2) is the required stance within it; ethical decision-making under constraint (Theme 3) is its acute crisis point; training (Theme 4) is the struggle to build resilience against it; and systemic pessimism (Theme 5) is the foreshadowed future if the structural foundations remain unaltered. Thus, 'Embodied Uncertainty' is not merely a descriptor of stress but the fundamental structure of the lifeworld for Iranian HEMS providers a context in which professional competence, ethical responsibility, and systemic vulnerability are inextricably and bodily intertwined.

Discussion

Synthesized Interpretation: "Embodied Uncertainty" as the Core of HEMS Praxis

This interpretive phenomenological study advances an integrative understanding of Iranian Helicopter Emergency Medical Services (HEMS) providers' experiences, crystallized in the core essence of

"Embodied Uncertainty." This construct moves beyond cataloging discrete stressors, framing their reality as an existential praxis of care: a lived, embodied enactment of professional judgment under constraint, defined by the continuous negotiation of professional agency within a system of multifaceted limitations. The findings reveal that providers navigate a world where vocational meaning, operational vigilance, morally weighted decisions, preparatory rituals, and foresight of systemic decline are inextricably linked, forming both embodied and relational dimensions of their professional practice. This model synthesizes personal and systemic dimensions by explicating the dynamic interactions that constitute the taxing lifeworld of prehospital care in resource-limited settings, extending prior descriptive and survey-based studies in Iran and aligning with international qualitative research on HEMS well-being and operational stressors which highlight the unique patterns of stress, coping, and organizational influences in these settings (9). Moreover, the observed moral and operational strain resonates with broader literature on moral distress and ethical decision-making within emergency and critical care contexts, where systemic constraints and prolonged exposure to ethical challenges shape provider experiences, professional identity, and future outlooks (11,34).

The Dual-Edged Sword of Vocational Fulfillment in a Constrained System

Consistent with international research on compassion satisfaction (35), participants derived a deep, identity-conferring purpose from their work. This study critically extends this concept within Iran's specific socio-cultural and operational milieu. We found that this vocational fulfillment functions as a potent yet paradoxical force. While it is the primary psychological engine sustaining engagement, it also becomes the implicit resource the system exploits to function despite its deficits. This creates a cycle where the altruism central to professional identity increases susceptibility to internalizing systemic failures as personal or ethical shortcomings, a process that aligns with the broader conceptualization of moral injury (36). This finding illustrates how resilience and vulnerability are co-constituted (37) within this context; the very source of meaning (vocational commitment) becomes the vector through which systemic strain is personally embodied and amplified, underscoring the dual nature of profound purpose as both a sustainer and a risk factor in constrained healthcare systems (38).

Operational Strain as the Phenomenological Ground of Ethical Distress

A pivotal contribution of this study is delineating the direct, lived pathway from chronic operational friction to acute moral injury. While prior literature documents operational challenges in EMS and in HEMS systems specifically, our analysis reveals that in Iranian HEMS, these are not mere logistical

hurdles but the constitutive fabric of the ethical landscape. The unceasing vigilance against equipment failures and coordination breakdowns ("Systemic Friction") depletes the cognitive and emotional reserves necessary for nuanced ethical reasoning, a form of allostatic load that erodes moral agency (39). This depletion was captured by one participant who noted, 'When you are exhausted from fighting the system, you lose your ethical clarity—your decisions become mechanical' (P6). Consequently, clinical decisions are transformed into sources of moral residue (40), as vividly illustrated in accounts of in-flight triage. This explicit linkage demonstrates that ethical distress is not an isolated psychological phenomenon but a direct systemic outcome, arguing that effective ethics support must integrally address its operational roots and be informed by practice-based models of prehospital ethical challenges (10).

Training as Ritual and the Foresight of Systemic Decline

Our findings reconceptualize training from a domain of technical skill acquisition to a psychologically essential ritual of preparedness. Training functioned as a structured space in which participants could rehearse control, stabilize professional identity, and temporarily suspend pervasive uncertainty aligning with contemporary evidence that simulation-based training enhances not only technical competence but also psychological preparedness and cognitive readiness in high-stakes clinical environments (41,42). In this sense, training operated as an embodied practice through which providers sought to impose order on an inherently unpredictable operational reality.

However, the analysis also reveals a critical paradox. When simulation-based training repeatedly foregrounds ideals of care and technological adequacy that are unattainable in everyday missions due to systemic constraints, it may paradoxically intensify frustration rather than alleviate it. This disjunction between simulated competence and real-world limitation undermines the preparatory ethos of training and contributes to moral and emotional strain, a phenomenon also noted in qualitative studies of healthcare professionals operating in resource-constrained systems (41).

More significantly, the theme of Pessimism as Crystallized Strain represents a novel contribution to the HEMS workforce literature, which has predominantly focused on individual-level outcomes such as burnout, compassion fatigue, or turnover intention (38,43). In contrast, the pessimism articulated by participants in this study was neither transient nor affective in nature; rather, it emerged as a rational, collective foresight derived from prolonged exposure to systemic erosion. Participants described this pessimism as an anticipatory awareness of organizational decline, reflecting a form of

organizational cynicism rooted in repeatedly violated psychological contracts between frontline providers and governing systems (36).

This crystallized pessimism marks the point at which the embodied uncertainty of daily clinical practice is projected forward onto the temporal horizon of the organization itself. It signals a shift from concerns about individual coping or resilience toward questions of structural responsibility, ethical governance, and system sustainability. In this way, pessimism functions not as a personal deficit but as an ethically and experientially grounded diagnostic signal of systemic failure—representing the ultimate internalization and temporal extension of embodied uncertainty within Iranian HEMS practice.

Implications for Policy, Management, and Practice

The phenomenological model of Embodied Uncertainty compels a fundamental paradigm shift from managing individual symptoms toward restructuring the systemic conditions that continuously produce this pervasive state. Rather than emphasizing individual resilience alone, these findings highlight the ethical and organizational responsibility to redesign the environments in which HEMS professionals operate. Accordingly, we propose targeted, actionable interventions across three interconnected levels, prioritized to first mitigate acute harm and subsequently build sustainable systemic resilience.

1. Policy and Systemic Reform: Integrating Standards and Ethics

Operational Integration.

National health authorities should mandate and sustainably fund the development of interoperable communication protocols and joint operational training involving HEMS, ground emergency medical services (GEMS), dispatch centers, and receiving hospitals. Such integration directly addresses the systemic friction identified in this study as a primary generator of embodied uncertainty, and is consistent with World Health Organization frameworks for emergency care system strengthening and recent evidence on multiteam coordination in crisis response (44,45).

Ethical Guidance.

National ethical guidelines for prehospital and aeromedical care should be co-created with frontline HEMS providers to address dilemmas unique to air medical transport, such as in-flight triage under severe resource constraints. Participatory guideline development validates providers' moral agency and reduces ethical isolation, aligning with best practices for context-sensitive clinical ethics support in complex healthcare environments (46–48).

2. Managerial and Organizational Action: Building Supportive Structures

Structured Psychological Support.

The implementation of mandatory, psychologically safe post-mission clinical debriefings and team reflections is an urgent organizational priority. Structured debriefing sessions after critical events or challenging clinical situations have been associated with positive psychological and emotional outcomes for healthcare providers, including enhanced emotional processing, improved team communication, and supportive reflection on difficult experiences. Scoping reviews of debriefing practices indicate that such sessions can give healthcare workers a voice to discuss stressful or morally distressing events and contribute to improvements in their emotional well-being and psychological experience at work (49).

A comprehensive scoping review found that debriefing following critical clinical events can promote positive psychological outcomes and support emotional processing in healthcare providers, particularly when the debriefing focuses on team reflection and emotional responses rather than merely procedural review (50).

Investment in High-Fidelity, Interprofessional Training

Training budgets should explicitly recognize simulation as a critical ritual not only for technical skill acquisition but also for psychological safety, identity stabilization, and systems learning. Evidence shows that repetitive, high-fidelity simulation improves team performance in emergency prehospital settings by enhancing psychomotor skills, decision-making under stress, and interprofessional coordination (51,52). Simulations must involve pilots, dispatchers, and hospital teams to rehearse coordination under constraints and address the simulation–reality gap identified in Theme 4 (53,54). Structured debriefing further supports emotional processing and psychological safety during learning

(55). This approach aligns with contemporary principles of distributed simulation for complex sociotechnical systems (56).

3. Clinical Practice and Workforce Support: Sustaining the Provider

Moral Distress Recognition

Routine moral distress check-ins and structured peer-support mechanisms should be embedded into everyday clinical practice. Formalizing these processes acknowledges the moral weight inherent in HEMS work (Theme 3) and supports the development of a sustainable moral community, as advocated in recent moral distress frameworks (48,57).

Career Development and Retention Pathways

Clear pathways for professional advancement, role diversification, and skills development are essential to counteract the sense of stagnation and anticipated system collapse described in Theme 5. Such investments reinvigorate vocational fulfillment (Theme 1) and directly address known determinants of retention and workforce sustainability in high-risk, high-attrition healthcare sectors (58,59).

Limitations

The trustworthiness and transferability of these findings must be contextualized within the following boundaries, which also delineate constructive pathways for future research.

1. Methodological Boundaries

As a qualitative phenomenological study, this research prioritizes idiographic depth and contextual understanding over statistical generalizability. The findings are analytically transferable to similar contexts of high-stakes, resource-constrained prehospital care. The reliance on retrospective interviews, while essential to access lived experience, carries an inherent risk of recall bias. This risk was mitigated by prompting detailed narratives and member checking but remains a consideration in qualitative retrospective inquiry. Voluntary participation may also introduce self-selection bias, as more engaged individuals might have been inclined to participate.

2. Sample Composition and Context

The purposive sample, while achieving robust thematic saturation, presents specific contours. First, the all-male participant group accurately reflects the current gender demographics of Iran's clinical HEMS workforce but precludes exploration of how gender might intersect with experiences of vulnerability, emotional labor, or professional identity—a critical avenue for future studies. Second, the study was conducted within three bases in two Iranian provinces. While capturing important variations, operational culture and resource availability in other regions may yield additional nuances. The core phenomenon of "embodied uncertainty" is presented as a transferable concept, but its specific manifestations may vary across contexts.

3. Researcher Positionality and Reflexivity

The insider status of the primary researchers who possess extensive backgrounds in Iranian prehospital care was instrumental for rapport and depth of inquiry. However, this shared professional worldview risked interpretive bias, where shared assumptions might remain unexamined. We implemented a structured, multi-layered reflexive strategy to bracket preconceptions, including maintaining collaborative reflexive journals, independent coding, and regular consensus meetings with a critical friend. While these steps enhance confirmability, the analysis remains fundamentally interpretive. Future studies could strengthen this further by involving an external auditor or employing methodological triangulation.

4. Scope of Analysis and Focus

The study focused on elucidating shared experiential patterns across participants rather than conducting a full, idiographic Interpretive Phenomenological Analysis (IPA) for each individual. This choice, aligned with our aim to generate insights relevant to health services and policy, centered on convergent themes over unique personal trajectories. A fully idiographic approach could yield additional depth at the level of individual lived worlds.

Conclusion

This interpretive phenomenological study has elucidated the lived reality of Iranian Helicopter Emergency Medical Services (HEMS) providers as a state of "embodied uncertainty" an existential praxis of care defined by the continuous negotiation of professional agency within a system of structural constraint. By moving beyond a descriptive catalog of challenges to model the dynamic interplay between vocational fulfillment, operational vigilance, moral weight, and systemic foresight, this research provides a coherent, contextually grounded framework for understanding the unique pressures of high-stakes prehospital work in resource-limited environments.

The primary contributions of this study are threefold. First, it advances the phenomenological understanding of emergency care by identifying "embodied uncertainty" as a core, transferable essence, shifting the focus from individual stressors to the systemic conditions that produce them. Second, it delineates a critical causal pathway demonstrating how chronic operational friction directly fuels ethical distress and moral residue, arguing that moral injury is often a symptom of systemic failure. Third, it recasts provider pessimism as rational, crystallized foresight a vital indicator of systemic risk that demands managerial and policy attention.

These insights compel a paradigm shift in supporting the HEMS workforce. Sustainability must be addressed holistically, recognizing that individual resilience is inextricably linked to structural support. Therefore, actionable progress requires integrated interventions: the implementation of mandatory, psychologically safe debriefing protocols; investment in interprofessional simulation that bridges coordination gaps; and the development of national ethical guidelines co-created with frontline providers. Ultimately, provider well-being must be reframed not as a peripheral concern but as the fundamental cornerstone of operational safety and system effectiveness.

Future research should build upon these contextual findings by empirically evaluating the proposed interventions and exploring the transferability of the 'embodied uncertainty' model across diverse cultural settings, healthcare systems, and with more gender-diverse samples. By continuing to center they lived, gendered, and contextually situated experiences of those who work at the clinical frontier, we can foster emergency care systems that are not only medically effective but also equitable, resilient, and sustainably human.

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