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A conceptual mind genomics framework for understanding heterogeneity in post-ICU recovery support

Abstract

Post-Intensive Care Syndrome (PICS) represents a multidimensional and prolonged recovery challenge in which ICU survivors may experience physical, cognitive, and psychological impairments, with associated functional and quality-of-life difficulties, while also differing in their recovery priorities and support needs. Although existing literature identifies multiple components of post-ICU recovery, including rehabilitation, psychological support, recovery information, follow-up, goal setting, social support, and patient participation, it remains unclear whether survivors systematically differ in how they value combinations of these recovery-support features. This conceptual paper proposes a Mind Genomics framework for examining such heterogeneity. Drawing on the literature on PICS, patient recovery priorities, rehabilitation, psychological interventions, follow-up, and patient-centered care, the framework organizes post-ICU recovery support into four Story Questions addressing recovery goals, emotional recovery, physical recovery, and follow-up and participation. The Story Questions were refined using the Idea Coach function in BimiLeap, a Mind Genomics platform for designing and conducting structured vignette-based studies. The Idea Coach generated up to 15 candidate answers for each Story Question. Four elements were then selected and, where necessary, refined for each Story Question, resulting in 16 proposed elements that could be systematically combined into realistic vignettes in a future empirical Mind Genomics study. Respondents could evaluate the overall value of each vignette, with subsequent Mind Genomics analysis estimating element-level contributions and using clustering to determine whether reproducible response-based patterns emerge. Three illustrative mindsets are presented solely as hypothetical examples of how potential response heterogeneity might be interpreted; they are not empirical findings or predefined patient categories. The framework is intended as a hypothesis-generating approach rather than a clinical intervention or substitute for individualized assessment. Future empirical research could test and refine the proposed elements, examine the stability and generalizability of any emerging response patterns, and explore whether such patterns have relevance for patient-centered post-ICU communication and recovery support.

Keywords: post-intensive care syndrome, post-ICU recovery, mind genomics, patient-centered care, recovery support, patient preferences

Volume 10 Issue 4 - 2026

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Received: August 10, 2026 | **Published:** August 31, 2026

Introduction

Advances in intensive care have improved survival from life-threatening illness, yet survival from critical illness does not necessarily mark the completion of recovery. Patients may leave the intensive care unit (ICU) with new or worsening impairments involving physical function, cognition, and psychological health. These consequences are captured by the concept of Post-Intensive Care Syndrome (PICS), which encompasses impairments in one or more of these domains after critical illness. Consensus-based recommendations consistently identify physical function, cognition, and mental health as the principal domains requiring assessment, while also demonstrating substantial variation in the specific assessment instruments recommended across clinical settings.[1] PICS therefore represents a multidimensional recovery problem rather than an isolated psychological or physical complication.

The consequences of PICS may extend substantially beyond hospital discharge. PICS has been associated with persistent impairment in physical function, cognitive function, and mental health, with evidence indicating that impairments may remain present for prolonged periods following discharge.[2] In addition, post-ICU care may involve follow-up clinics, home-based assessment, telephone or mail contact, and telemedicine, reflecting the need to maintain attention to recovery after the acute hospitalization. The lack of consistent evidence regarding the effectiveness of particular follow-up approaches further indicates that the post-discharge period remains an important area for continued investigation. The Indian Society of Critical Care Medicine similarly emphasizes that critical care extends beyond the physical boundaries of the ICU and recommends continued follow-up after ICU and hospital transfer, with early identification of problems and multidisciplinary care planning.[3]

Cognitive impairment represents an important consideration in post-ICU recovery because it may persist well beyond hospital discharge and can affect multiple cognitive domains relevant to everyday functioning. A systematic review of ICU survivors reported cognitive impairment across follow-up periods ranging from 2 to 156 months, with memory, attention, verbal fluency, and executive functioning among the domains affected.[4] More recent meta-analytic evidence similarly indicates that cognitive impairment remains common after ICU discharge, with pooled prevalence estimates of 49.8% within one month and 30.4% beyond 12 months.[5] Such

difficulties may be relevant to recovery-related communication because information concerning rehabilitation, follow-up, expectations, and self-management may need to be understood, processed, and retained by survivors experiencing cognitive impairment.

The multidimensional burden of post-ICU survivorship is also evident in quality-of-life and psychological outcomes. A systematic review of 19 studies examining PICS and Family PICS (PICS-F) reported evidence concerning depression, anxiety, post-traumatic stress disorder (PTSD), and quality of life among ICU survivors, as well as quality-of-life and burden-related outcomes among their relatives.[6] Fourteen observational studies reported effects of PICS on depression, 12 reported effects on anxiety, nine examined post-traumatic stress disorder, and 10 assessed quality of life. Mobility, personal care, usual activities, and pain or discomfort were among the quality-of-life domains most affected by PICS. The review also identified a significant association between higher anxiety among ICU survivors and greater burden among their relatives, highlighting that the consequences of PICS may extend beyond the individual survivor to the family context. These findings reinforce the multidimensional nature of post-ICU recovery, encompassing physical, psychological, quality-of-life, and family-related concerns.

Importantly, recovery from critical illness may involve different priorities for different survivors. A secondary qualitative analysis of interviews with 39 community-dwelling adult critical illness survivors identified 12 core patient priorities across the course of recovery: feeling safe, being comfortable, engaging in mobility, participating in self-care, asserting personhood, connecting with people, ensuring family well-being, going home, restoring physical health, restoring psychological health, resuming normal roles and routines, and seeking new life experiences .[7] The relative importance of these priorities changed across stages of recovery, with concerns becoming broader and more aspirational later after discharge. This variation suggests that heterogeneity in post-ICU recovery may involve more than differences in clinical impairment; patients may also differ in what they regard as important, meaningful, or desirable during recovery.

Patient-reported recovery needs further indicate that post-ICU support consists of multiple potentially relevant components. O'Neill et al.[8] identified support and guidance from others, self-motivation and goal setting, mobility equipment, and technology as facilitators of recovery. At the same time, lack of follow-up services, exercise rehabilitation, peer support, and personal feedback were identified as barriers, while fragmented access to healthcare services was perceived as contributing to slower or poorer-quality recovery. The study further identified informational, emotional, instrumental, appraisal, and spiritual support as distinct categories of strategies that could address patients' recovery needs. These findings indicate that post-ICU recovery may involve multiple forms of support and rehabilitation that can be individualized to patient needs.

The complexity of these needs has been reflected in rehabilitation frameworks. A consensus framework for physical rehabilitation after hospital discharge identified functional exercise, endurance and strengthening activities, education regarding recovery, a nutritional component, and screening for impairments in other health domains as important components of rehabilitation.[9] The framework also recognized the importance of assessing outcomes such as exercise capacity, muscle strength, activities of daily living, mobility, quality of life, and pain, with referral to specialists when impairments in other health domains are identified. More recent multidisciplinary guidance characterizes PICS as a variable and complex syndrome requiring repeated assessment and individualized multidisciplinary and multiprofessional rehabilitation addressing motor, cognitive, and psychological impairments.[10]

Psychological recovery is an important component of this broader recovery problem. Anxiety, depression, and PTSD are recognized manifestations of the psychological dimension of PICS, but they occur within a wider context of physical and cognitive impairment.[10] The available evidence concerning psychological interventions also demonstrates considerable variation. An examination of 39 intervention studies found differences in intervention content, timing, intensity, delivery mode, and professional involvement, with heterogeneous and methodologically fragile evidence overall; 14 studies reported improvement in at least one psychological outcome, whereas 23 reported no benefit.[11] The findings therefore do not establish a single uniformly effective approach to psychological recovery. Instead, they indicate that the characteristics and combinations of recovery-support approaches may be important considerations for future investigation.

The potential importance of patient preferences provides another dimension to this problem. In a cross-sectional study of 403 adult inpatients at public hospitals in West Shoa, Ethiopia, 64.8% of participants preferred a collaborative role in shared decision making, whereas 35.2% preferred a passive role, leaving decisions to healthcare providers.[12] The preference for a collaborative role was significantly associated with age, marital status, and educational level. The study conceptualized patient preferences in relation to individuals' experiences, beliefs, and values and discussed patient participation and communication as important components of shared decision making. Although the study involved general adult inpatients rather than ICU survivors, its findings provide relevant patient-centered evidence that preferences for involvement in healthcare decision making may differ according to patients' sociodemographic characteristics.

This principle is consistent with the broader concept of patient-centered care. Patient-centered care requires healthcare organizations and professionals to understand what patients value and to treat patients as partners in their care. Patient experience is also influenced by whether information is actually understood and remembered, rather than simply by what healthcare professionals believe they have communicated.[13] For post-ICU recovery, this distinction is particularly relevant because patients may encounter substantial uncertainty about their illness, expected recovery, rehabilitation, and longer-term functioning after leaving the hospital.

Communication about post-ICU recovery may itself be challenging. Recent evidence involving ICU providers and patients suggests a gap between provider communication about PICS and patients' recall of having received such information. Potential barriers include difficulties in communicating long-term outcomes and prognostic uncertainty, while communication guidance for PICS also emphasizes the importance of avoiding unnecessary jargon and excessive information burden for patients and families. These challenges are particularly relevant to a recovery-support framework that relies on patients being able to understand and evaluate information about rehabilitation, follow-up, emotional recovery, and other aspects of post-ICU care.[14,15]

Taken together, the available evidence indicates that post-ICU recovery is multidimensional, prolonged, dynamic, and heterogeneous. Survivors may differ in the physical, cognitive, and psychological difficulties they experience, the priorities they attach to different aspects of recovery, the forms of support they find useful, and the degree of participation they prefer. The literature has established important domains of PICS, identified patient priorities, described rehabilitation and follow-up approaches, and evaluated psychological

interventions. However, these findings leave an important conceptual question insufficiently addressed: whether patients systematically differ in their responses to different combinations of recovery-related support and communication features.

This question is important because post-ICU recovery support can contain multiple components. Information about expected recovery, psychological reassurance, rehabilitation guidance, goal setting, follow-up, family involvement, peer support, technology, and opportunities for patient participation may all represent potentially relevant features of the recovery experience. Existing evidence demonstrates that these elements can be relevant to patients, but it does not establish that all patients value them equally or that the same combination of elements will be meaningful across individuals. The documented variation in patient priorities, recovery facilitators, and intervention evidence therefore provides a rationale for examining combinations of recovery-support features rather than considering each component only in isolation.

The present paper therefore proposes a conceptual Mind Genomics framework for post-ICU recovery, designed to organize clinically relevant recovery-support features into experimentally testable combinations. Future empirical research could test whether systematic response patterns emerge and whether such patterns may inform more patient-centered approaches to post-discharge communication, rehabilitation support, and recovery planning.

Conceptual mind genomics framework

Post-ICU recovery is conceptualized in this paper as a multidimensional process extending beyond the resolution of acute critical illness. The framework focuses not only on clinical impairment, but also on how ICU survivors may perceive, prioritize, and respond to different aspects of the recovery experience.

Mind Genomics has been applied in healthcare to examine heterogeneity in responses to health-related messages and experiences, with response-based mindsets emerging from patterns in how individuals evaluate systematically varied elements. In a study of diabetes communication, for example, distinct mindsets emerged around managing the condition independently, relying on the physician as a source of knowledge, and managing diabetes with the help of others; the study further demonstrated how a Personal Viewpoint Identifier could be used to assign individuals to these empirically derived mindsets and support more appropriately matched messaging.[16] Similar response-based heterogeneity has been demonstrated in other healthcare settings, including hospitalized teens aged 13–18, in whom three mindsets reflecting different preferences for professional conduct and communication were identified,[17] as well as among hemodialysis patients, in whom three mindsets reflecting different patterns of perceived wellbeing were identified.[18]

Mind Genomics has also been used to examine how different communication elements resonate with different groups and to inform more individualized communication. In a study of communication concerning patients' experiences with COVID-19, two distinct mindsets emerged, characterized by greater responsiveness to factual information versus emotional support, illustrating how communication preferences can vary within a healthcare population.19 Earlier work in diabetes similarly showed that different message elements resonated with different mindsets and that a Personal Viewpoint Identifier could be used to support individualized message selection.[16] Related work applying Mind Genomics to medical communication has likewise emphasized the need to fine-tune communication to individual response patterns rather than assuming that a single approach will suit everyone.[20] More recently, a conceptual Mind Genomics framework for palliative care has specifically extended this logic to serious illness communication, organizing difficult-news delivery, emotional responses, future-care discussions, and subsequent decision-making into experimentally testable communication elements and proposing empirically derived communication mindsets as a basis for more personalized communication. The palliative-care framework is particularly relevant to the present proposal because serious illness communication occurs within a patient- and family-centred context involving prognosis, goals of care, preferences, and shared decision-making.[21]

Mind Genomics has additionally been applied directly to family contexts. Peer et al.[22] used systematically varied descriptions of family situations to examine responses to family stress and identified distinct response-based mindsets through individual-level modelling and clustering. The study demonstrates how family situations and interpersonal interactions can be incorporated into a Mind Genomics framework and evaluated through systematic variation in experimental elements. Similarly, the diabetes study explicitly incorporated family support, learning from others, patient workshops, and community support as elements of health management, with family support showing particularly strong responses within the mindset focused on managing diabetes with the help of others.[16] Together, these applications indicate that Mind Genomics can accommodate family involvement and social support as measurable components of health-related experience and can potentially inform more responsive, family-sensitive approaches to care.

Rather than treating post-ICU recovery support as a single intervention, the framework therefore conceptualizes it as a combination of potentially distinct features. These may include information about expected recovery, psychological and emotional support, rehabilitation guidance, goal setting, follow-up, family involvement, technology, and opportunities for patient participation. The purpose is not to assume that any particular feature is universally preferred or effective, but to provide a structured basis for examining how different recovery-support features may be valued by ICU survivors.

A central feature of the framework is therefore heterogeneity as an empirical question. The present paper does not assume that ICU survivors can be divided in advance into predefined psychological or clinical categories. Any response patterns or mindsets identified in a future study would need to emerge from the empirical analysis rather than being imposed beforehand.

Canonical design for post-ICU recovery

The present framework follows the canonical Mind Genomics approach by translating the problem of heterogeneous post-ICU recovery into a structured set of questions and recovery-support features. The behavioral problem addressed by the framework is:

How do ICU survivors value different forms of post-ICU recovery support?

The literature reviewed in this paper identifies several recurring themes relevant to this question, including recovery priorities and goals, psychological and emotional recovery, physical rehabilitation, continuing follow-up, patient participation, and different forms of practical and social support. PICS encompasses physical, cognitive, and psychological impairments, with evidence of adverse effects on quality of life and particular difficulties involving mobility, personal care, usual activities, and pain or discomfort.[6] Patient priorities include

safety, comfort, mobility, self-care, psychological and physical health, family well-being, returning home, resuming previous roles, and pursuing new life experiences[7] Recovery facilitators and unmet needs include guidance, goal setting, mobility equipment, technology, follow-up, exercise rehabilitation, peer support, and personal feedback.[8] Rehabilitation frameworks emphasize functional exercise, strengthening, recovery education, and assessment across multiple domains,[9] while multidisciplinary guidance addresses physical, cognitive, and psychological recovery.[10] Continuing follow-up and different modes of post-ICU contact are also relevant to recovery,[2] while patient participation and individual preferences provide an additional patient-centered dimension of recovery-related care.[12]

Based on the themes identified in the reviewed literature, four Story Questions were developed to structure the post-ICU recovery problem. The Story Questions were then refined using the Idea Coach function in BimiLeap (https://www.bimileap.com), a platform developed for the design, administration, and analysis of Mind Genomics studies. For each Story Question, Idea Coach generated up to 15 candidate answers. From these candidate answers, four elements were selected for each Story Question and, where necessary, refined for inclusion in the conceptual framework, resulting in a total of 16 proposed elements.

The elements presented in Table 1 are intended to represent alternative features of post-ICU recovery support for subsequent combination into realistic vignettes in a future empirical Mind Genomics study. They are not presented as validated clinical interventions or as recommendations for individual patient care, but as experimentally testable representations of different aspects of post-ICU recovery support.

Table 1 Story Questions and Elements for the Conceptual Mind Genomics Design

Story Question	Elements
Q1. What recovery goals matter after ICU?	**A1.** Regaining independence in everyday activities after ICU discharge.
	A2. Returning to previous work, family, and social roles.
	A3. Feeling safe during recovery after ICU discharge.
	A4. Setting personal recovery goals during recovery.
Q2. What helps emotional recovery after ICU?	**B1.** Having access to psychological support during recovery.
	B2. Receiving clear information about recovery and emotional changes after critical illness.
	B3. Talking with others who have experienced ICU recovery.
	B4. Receiving guided psychological or emotional support during recovery.
Q3. What helps physical recovery after ICU?	**C1.** Starting individualized physical rehabilitation based on the survivor's abilities.
	C2. Gradually increasing mobility, strength, and physical activity.
	C3. Receiving practical guidance and equipment to support mobility at home.
	C4. Combining physical rehabilitation with support for cognitive and psychological recovery.
Q4. What matters in post-ICU follow-up?	**D1.** Having regular follow-up to identify problems that continue after discharge.
	D2. Receiving coordinated care from a multidisciplinary team.
	D3. Having follow-up available through telephone, telemedicine, or home-based care when appropriate.
	D4. Being involved in decisions about recovery goals and the type of support received.

Proposed mind genomics study design

In a future empirical investigation, the 16 proposed elements could be incorporated into the BimiLeap platform. BimiLeap would use the experimental design to automatically combine the proposed elements into multi-element vignettes. Respondents would evaluate these vignettes rather than the individual elements separately, allowing different combinations of post-ICU recovery features to be examined within realistic recovery scenarios.

Each vignette would contain a different combination of the proposed elements. The combinations would be systematically varied according to the experimental design, allowing respondents to evaluate the overall recovery approach represented by each vignette.

Respondents could evaluate each vignette using the following researcher-defined rating question:

"Based on what you just read, how valuable would this post-ICU recovery approach be for you?".

Because vignette evaluation requires sufficient comprehension of the information presented, cognitive status will be an important consideration in a future empirical implementation. Post-ICU cognitive impairment may affect memory, attention, verbal fluency, and executive functioning; in one study included in the systematic review, 27 patients were excluded because they could not complete cognitive testing, highlighting the potential for cognitive impairment to create challenges for reliable assessment.[4] Participants with profound cognitive impairment or other conditions that prevent

Citation: Paul D, Moskowitz H, Badreddine H. A conceptual mind genomics framework for understanding heterogeneity in post-ICU recovery support. *Int J Fam Commun Med.* 2026;10(4):125–132. DOI: 10.15406/ijfcm.2026.10.00427

reliable comprehension and completion of the study tasks may therefore require exclusion, adapted procedures, or alternative approaches to participation, depending on cognitive status, decision-making capacity, and study objectives. Such eligibility decisions should be established prospectively rather than assumed in the present conceptual framework.

Responses could be recorded using a five-point scale:

1 = Not at all valuable

2 = Slightly valuable

3 = Moderately valuable

4 = Very valuable

5 = Extremely valuable

The rating question and response scale are proposed for future empirical testing and could be adapted according to the study population and objectives. The same rating question would be applied to each BimiLeap-generated vignette, allowing the respondent to evaluate the overall combination of recovery-support features presented in that vignette.

Following completion of data collection, BimiLeap would process the vignette ratings using the standard Mind Genomics analytical workflow. Ordinary least-squares (OLS) regression would estimate the independent contribution of individual elements to the observed vignette ratings, while clustering procedures, including K-means clustering, would identify groups of respondents with similar response patterns.[23,24] These analyses would be generated as part of the BimiLeap study workflow rather than being manually performed or determined by the researchers. Because the present article is conceptual, the resulting coefficients, clusters, and mindsets are not reported as findings of the present paper.

The resulting BimiLeap outputs would provide information on the overall response pattern and the estimated contribution of individual recovery-support elements. The analysis would also identify whether distinct response-based mindsets emerge among ICU survivors. These outputs could provide an empirical basis for examining which features of Recovery Goals, Emotional Recovery, Physical Recovery, and Follow-up and Participation are more strongly associated with respondents' evaluations.

Depending on the findings of a future empirical study, the identified mindsets could also provide a basis for developing a Personal Viewpoint Identifier (PVI). A future PVI could potentially help identify an individual's response pattern or recovery-support mindset and inform more appropriately tailored communication about post-ICU recovery. The development and validation of such a PVI would constitute a separate empirical step and is not an outcome established by the present conceptual paper.

Because the present article is conceptual, no BimiLeap-generated results, element-level coefficients, or empirical mindsets are reported as findings of the present paper. The number, composition, and characteristics of any future mindsets would depend on the response patterns generated in an empirical implementation.

The overall conceptual workflow is therefore:

4 Story Questions → 16 Proposed Elements → BimiLeap Experimental Design → BimiLeap-Generated Vignettes → Respondent Ratings → BimiLeap OLS Regression & K-Means Clustering → Element-Level Contributions → Empirical Mindsets → Potentially Tailored Post-ICU Communication/Recovery Support → Future PVI Development

Illustrative conceptual mindsets

The following mindsets are illustrative and hypothetical profiles intended to demonstrate how response-based heterogeneity might be interpreted in a future empirical Mind Genomics study. They are not empirical findings of the present conceptual paper, nor do they represent predefined patient segments or clinical categories. The 16 proposed elements constitute the experimental input set; their individual contributions to observed response patterns, and their relationship to any empirically derived mindsets, would be determined in a future empirical study.

Mindset 1 — Independence and emotional security responder

A hypothetical response pattern in which ICU survivors show relatively greater positive responses to vignettes emphasizing restoration of independence, personal recovery priorities, safety, and psychological or emotional support.

Mindset 2 — Rehabilitation and continuity responder

A hypothetical response pattern in which ICU survivors show relatively greater positive responses to vignettes emphasizing structured physical rehabilitation, practical recovery support, multidisciplinary care, and continued follow-up after discharge.

Mindset 3 — Socially supported recovery responder

A hypothetical response pattern in which ICU survivors show relatively greater positive responses to vignettes emphasizing social connection, return to valued roles, accessible follow-up, and participation in recovery-related decisions.

Important methodological distinction

These three profiles are conceptual examples only. They are intended to illustrate how qualitatively different vignette-response patterns might be interpreted in a future empirical Mind Genomics study. The profiles are not derived from the 16 elements individually and do not constitute a predefined assignment of elements to patient groups.

In a future empirical study, participants would rate systematically varied vignettes containing combinations of the proposed elements. The resulting vignette-rating data would then be analyzed to identify response patterns and empirically derived mindsets. Thus, the number, composition, and characteristics of any future mindsets would emerge from the observed response data rather than being specified in advance.

Accordingly, the three profiles presented here should be understood solely as illustrative hypotheses about possible response patterns. A future empirical study could identify fewer, more numerous, or substantially different mindsets, and the elements contributing to each mindset would be determined empirically from the observed vignette-rating data.

Discussion and conceptual implications for post-ICU recovery

The proposed Mind Genomics framework has several conceptual implications for understanding post-ICU recovery. First, it shifts attention from recovery as a single clinical outcome toward recovery as a multidimensional experience involving different priorities and

aspects of recovery. The literature identifies diverse patient priorities, including safety, mobility, self-care, psychological and physical health, family well-being, and resumption of previous roles and routines.[7] The proposed framework extends this literature by treating variation in the importance of recovery-related features as an empirical question that could be examined through systematic evaluation of combinations of features.

Second, the framework suggests that recovery-support features may be examined in combination rather than only as isolated services. Post-ICU recovery encompasses multiple forms of support, including psychological and emotional support, physical rehabilitation, information, goal setting, follow-up, peer support, and patient-directed strategies. O'Neill et al.[8] identified support and guidance, goal setting, mobility equipment, technology, exercise rehabilitation, peer support, and follow-up among patient-reported facilitators or gaps in recovery support. At the same time, the evidence concerning psychological interventions remains heterogeneous, with substantial variation in intervention characteristics and reported outcomes.[11] A Mind Genomics approach could therefore provide a structured way to examine responses to combinations of such features.

This combined perspective is particularly relevant because post-ICU recovery is not organized into neatly separated clinical domains. Post-ICU impairments may span physical, cognitive, and psychological domains, with impairment in one domain potentially affecting another.[10] Physical problems such as weakness, pain, fatigue, and reduced physical functioning may coexist with anxiety, depression, post-traumatic stress, or other psychological difficulties, making it difficult to view physical and psychological recovery as entirely independent processes.[6,8,10] The priorities that patients attach to different aspects of recovery may also change across stages of recovery.[7] This complexity is important for recovery-support planning because a survivor's need for information, rehabilitation, psychological support, or follow-up may not remain constant over time. The proposed Mind Genomics framework therefore treats recovery-support features as potentially interacting components of a broader recovery experience rather than as isolated clinical domains.

The complexity of post-ICU recovery also extends beyond symptoms to the organization of care itself. Post-ICU recovery may involve multiple forms and settings of follow-up, including dedicated follow-up clinics, home-based care, telephone or online follow-up, and multidisciplinary rehabilitation and support.[2,3] At the same time, patients have reported gaps in follow-up, exercise rehabilitation, peer support, personal feedback, and transitions between services, with access to specific healthcare services sometimes experienced as fragmented.[8] This fragmentation is relevant to patient-centred recovery because patient-centred care emphasizes understanding what patients value and coordinating care around their needs and preferences.[13] The proposed framework does not seek to reorganize this care ecosystem; rather, it provides a potential experimental approach for examining how survivors value combinations of recovery-support features that may span different components of post-ICU care.

Third, the framework provides a potential experimental perspective on patient-centeredness. Patient-centered care emphasizes understanding what patients value and treating patients as partners in their care.[13] Similarly, research on shared decision making indicates that patients may differ in their preferred level of participation, with collaborative decision making being preferred by a substantial proportion of respondents.[12] Within the proposed framework, these principles could be explored experimentally by examining how ICU survivors respond to systematically varied combinations of recovery-related features.

Fourth, the framework may provide a conceptual bridge between post-ICU rehabilitation and recovery-related communication. Existing rehabilitation frameworks address multiple dimensions of recovery, including physical function, mobility, activities of daily living, and recovery education.[9] More recent guidance similarly describes PICS rehabilitation as requiring an individual multidisciplinary and multiprofessional approach addressing motor, cognitive, and psychological impairments.[10] The proposed framework does not replace these clinical approaches. Rather, it introduces a way to examine whether different combinations and presentations of recovery-related features may receive different responses from ICU survivors.

Finally, the framework positions heterogeneity as an empirical question rather than a predefined segmentation. The illustrative mindsets presented in the preceding section are not intended to classify ICU survivors in advance. If a future empirical Mind Genomics study identifies reproducible response patterns, these patterns could provide additional insight into how different survivors value combinations of recovery-support features. Such findings could inform future research on patient-centered post-discharge communication and recovery support, while remaining complementary to individualized clinical assessment and professional decision making.

Overall, the conceptual contribution of the framework is not the identification of new clinical interventions, but the proposal of an experimental approach for studying variation in how ICU survivors respond to combinations of recovery-support features. In this way, Mind Genomics provides a potential methodological link between the documented multidimensional nature of post-ICU recovery and the empirical investigation of response-based patterns.

Limitations and future research

This paper is conceptual and does not provide empirical evidence from ICU survivors. Accordingly, no patient-level data are available in the present study to determine how cognitive impairment, communication difficulties, severity of illness, or other individual characteristics might influence participants' ability to understand, evaluate, or respond to the proposed vignettes. The 16 proposed elements, Story Questions, rating approach, and vignette structure have not yet been tested with patients. Their clarity, relevance, and contribution to evaluations of post-ICU recovery support therefore remain to be established empirically.

Cognitive impairment may also introduce important eligibility and measurement considerations in a future Mind Genomics study. Post-ICU cognitive impairment can affect memory, attention, verbal fluency, and executive functioning, and some ICU survivors in previous studies have been unable to complete cognitive testing.[4] Because vignette-based evaluation requires participants to understand study instructions and evaluate the presented information, individuals with profound cognitive impairment may require exclusion, adapted procedures, or alternative approaches to participation, depending on cognitive status, decision-making capacity, and study objectives. Such criteria should be established prospectively and reported transparently. Excluding individuals with substantial cognitive impairment could also limit generalizability because those with greater cognitive difficulties may represent an important subgroup of the post-ICU population.

A further limitation concerns the population and context of some of the evidence informing the framework. Not all supporting studies were conducted specifically among ICU survivors or examined post-ICU recovery. For example, Gurmu[12] examined preferences for participation in shared decision making among 403 adult patients

admitted to medical and surgical wards at four public hospitals in West Shoa, Ethiopia, rather than among ICU survivors or patients receiving post-ICU recovery support. The study found that 64.8% of participants preferred a collaborative role and 35.2% preferred a passive role, with a preference for a collaborative role associated with age, marital status, and educational level. Thus, Gurmu[12] provides evidence that preferences for participation in shared decision making may differ among adult inpatients, but it should not be interpreted as direct evidence of how ICU survivors value post-ICU recovery-support features.

The proposed framework also has important methodological limitations. Mind Genomics relies on structured vignette ratings to estimate the relative contribution of individual elements and to identify response-based patterns. These patterns should not be interpreted as clinical phenotypes or biological subphenotypes without independent clinical validation. More broadly, precision approaches in critical care face challenges related to reproducibility, external validation, prospective evaluation, and clinical applicability of identified subgroups.[25] The proposed framework therefore represents an initial behavioral-response approach rather than a validated precision-recovery model. Findings from a future empirical implementation would require replication across populations and healthcare settings, together with evaluation of whether identified response patterns are stable and clinically meaningful.

The proposed 16 elements also represent a structured simplification of a complex recovery experience. Post-ICU recovery may involve overlapping and changing somatic, cognitive, and psychological symptoms, as well as interactions with multiple healthcare providers and services. These features of the broader care delivery ecosystem are not fully represented in the proposed design. The framework is therefore not intended to capture every determinant of recovery or to replace comprehensive clinical, rehabilitation, or psychological assessment.

The need for a more individualized approach is supported by the broader development of precision critical care. Critical illness is characterized by substantial heterogeneity, and manifestations of critical illness may fluctuate over relatively short periods, such that a "one size fits all" approach can produce divergent results.[26] Recent consensus work further emphasizes that clinically useful precision approaches should identify reproducible subpopulations, examine differential responses, and undergo prospective evaluation and external validation before translation into clinical practice.[25] In post-ICU recovery, this principle may be particularly relevant because survivors can experience different combinations of physical, cognitive, psychological, and functional difficulties and may value different forms of recovery support. A precision-oriented recovery approach could therefore complement conventional clinical assessment by examining whether reproducible differences exist in how survivors respond to combinations of recovery-support features. The present Mind Genomics framework is proposed as one potential behavioral method for investigating this question, rather than as a substitute for established precision-medicine or clinical approaches.

The illustrative mindsets presented in this paper are hypothetical examples of possible response patterns. They are not empirical patient segments, clinical categories, or established characteristics of ICU survivors. A future study could identify fewer, more numerous, or substantially different mindsets, and the elements associated with each mindset would need to be determined from observed vignette-rating data rather than specified in advance.

Future research should first evaluate the proposed framework empirically among ICU survivors. Such studies could assess the clarity and relevance of the 16 elements, systematically combine them into vignettes, and examine how survivors evaluate different combinations of recovery-support features. The resulting data could then be analyzed using the Mind Genomics workflow to estimate element-level contributions and determine whether reproducible response-based mindsets emerge.

Subsequent research could examine the stability and generalizability of any identified response patterns across different ICU populations, healthcare settings, demographic groups, and stages of post-ICU recovery. Future studies could also refine the Story Questions, elements, rating scale, and vignette structure on the basis of empirical findings and patient feedback.

If reproducible response-based mindsets are identified, a subsequent research stage could investigate whether these patterns can support development of a Personal Viewpoint Identifier (PVI). Such a tool would require separate development and validation and should be evaluated independently before any consideration of practical use. Any future application of Mind Genomics-derived outputs should complement, rather than replace, individualized clinical assessment and professional decision making.

Future research could also examine whether response patterns identified through Mind Genomics are associated with meaningful recovery-related outcomes, such as perceived usefulness of recovery information, engagement with rehabilitation, satisfaction with post-discharge support, or understanding of recovery recommendations. Such work would help determine whether response-based heterogeneity has practical relevance beyond preference measurement.

Conclusion

Post-ICU recovery is a multidimensional and heterogeneous process involving physical, cognitive, and psychological impairments, with associated functional, quality-of-life, and patient-centered concerns.This paper proposes a conceptual Mind Genomics framework that organizes these recovery-related concerns into four Story Questions and 16 proposed elements for future empirical testing. Rather than assuming predefined patient mindsets or a universally preferred recovery pathway, the framework proposes that differences in responses to combinations of recovery-support features should be examined empirically. Future Mind Genomics research could therefore provide a structured approach to identifying response-based patterns that may contribute to more patient-centered post-ICU communication and recovery support.

Acknowledgements

None.

Conflicts of interest

The authors declare that they have no conflicts of interest.

References

1. Bornemann-Cimenti H, Lang J, Hammer S, et al. Consensus-based recommendations for assessing post-intensive care syndrome: a systematic review. *J Clin Med*. 2025;14(10):3595.
2. Nakanishi N, Liu K, Hatakeyama J, et al. Post-intensive care syndrome follow-up system after hospital discharge: a narrative review. *J Intensive Care*. 2024;12(1):2.

3. Ramakrishnan N, Abraham BK, Barokar R, et al. Post-ICU care: why, what, when and how? ISCCM position statement. *Indian J Crit Care Med*. 2024;28(Suppl 2):S279–S287.
4. Wolters AE, Slooter AJC, van der Kooi AW, et al. Cognitive impairment after intensive care unit admission: a systematic review. *Intensive Care Med*. 2013;39(3):376–386.
5. Ho MH, Lee YW, Wang L. Estimated prevalence of post-intensive care cognitive impairment at short-term and long-term follow-ups: a proportional meta-analysis of observational studies. *Ann Intensive Care*. 2025;15(1):3.
6. Gravante F, Trotta F, Latina S, et al. Quality of life in ICU survivors and their relatives with post-intensive care syndrome: a systematic review. *Nurs Crit Care*. 2024;29(4):807–823.
7. Scheunemann LP, White JS, Prinjha S, et al. Post-intensive care unit care: a qualitative analysis of patient priorities and implications for redesign. *Ann Am Thorac Soc*. 2020;17(2):221–228.
8. O'Neill B, Green N, Blackwood B, et al. Recovery following discharge from intensive care: what do patients think is helpful and what services are missing? *PLoS One*. 2024;19(3):e0297012.
9. Major ME, Kwakman R, Kho ME, et al. Surviving critical illness: what is next? An expert consensus statement on physical rehabilitation after hospital discharge. *Crit Care*. 2016;20(1):354.
10. Renner C, Jeitziner MM, Albert M, et al. Guideline on multimodal rehabilitation for patients with post-intensive care syndrome. *Crit Care*. 2023;27(1):301.
11. Cesari J, Poujol AL, Guinot PG, et al. Impact of ICU and post-ICU interventions on the psychological dimensions of patients' PICS: a systematic review with narrative synthesis. *J Crit Care*. 2026;95:155658.
12. Gurmu Y. Patient preferences in shared decision making during healthcare and associated factors among adult admitted patients at public hospitals of West Shoa Oromia, Ethiopia. *Patient Prefer Adherence*. 2022;16:1781–1786.
13. Edgman-Levitan S, Schoenbaum SC. Patient-centered care: achieving higher quality by designing care through the patient's eyes. *Isr J Health Policy Res*. 2021;10(1):21.
14. Rolfsen ML, Wilcox ME, Mart MF, et al. Communicating to patients and families about post-intensive care syndrome. *Chest*. 2025;168(4):924–931.
15. Rolfsen ML, Mart MF, Kieffer H, et al. Post-intensive care syndrome awareness and communication: surveys of ICU providers and patients. *Chest*. 2026;169(2):486–495.
16. Gabay G, Gere A, Zemel G, et al. Messages about diabetes: a Mind Genomics exploration of communicating for medicine & public health. *Endocrinol Diabetes Metab J*. 2019;3(5):1–13.
17. Gabay G, Moskowitz HR. Mind Genomics: what professional conduct enhances the emotional wellbeing of teens at the hospital? *J Psychol Abnorm Child*. 2015;4(3):147.
18. Jahja E, Papajorgji P, Moskowitz H, et al. Measuring the perceived wellbeing of hemodialysis patients: a Mind Genomics cartography. *PLoS One*. 2024;19(5):e0302526.
19. Javed M, Saharan S, Wingert S, et al. Talking to patients: Part 2 - Mind Genomics cartography of reactions to messages pertaining to patient experience with COVID-19. *Mind Genom Stud Psychol Exp*. 2025;5(2):1–10.
20. Saharan S, Peart SA, Rappaport S, et al. Combining AI, Mind Genomics, and young medical minds to address communication: diabetes patients and their desire for herbal remedies. *Mind Genom Stud Psychol Exp*. 2023;3(1):1–20.
21. Paul D, Moskowitz H, Badreddine H. Delivering hard truths: a conceptual Mind Genomics framework for empathetic communication in palliative care. *J Case Rep Rev Med*. 2026;2(3):1–7.
22. Peer C, Rodriguez LE, Harizi A, et al. Family stress, responses, and mindsets: an exploratory Mind Genomics cartography. *Psychol J Res Open*. 2021;3(4):1–10.
23. Moskowitz HR, Gofman A, Beckley J, et al. Founding a new science: Mind Genomics. *J Sens Stud*. 2006;21(3):266–307.
24. Kornstein B, Rappaport S, Moskowitz H. Communication styles regarding child obesity: investigation of a health and communication issue by a high school student researcher, using Mind Genomics and artificial intelligence. *Mind Genom Stud Psychol Exp*. 2023;3(1):1–14.
25. Gordon AC, Alipanah-Lechner N, Bos LD, et al. From ICU syndromes to ICU subphenotypes: consensus report and recommendations for developing precision medicine in the ICU. *Am J Respir Crit Care Med*. 2024;210(2):155–166.
26. Maslove DM, Lamontagne F, Marshall JC, et al. A path to precision in the ICU. *Crit Care*. 2017;21(1):79.

Citation: Paul D, Moskowitz H, Badreddine H. A conceptual mind genomics framework for understanding heterogeneity in post-ICU recovery support. *Int J Fam Commun Med*. 2026;10(4):125–132. DOI: 10.15406/ijfcm.2026.10.00427