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Assessment of Risks Arising from Neuropsychological Crises in Cardiac Patients Using FMEA

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ABSTRACT

Neuropsychological crises such as panic attacks, anxiety, and acute emotional distress are common yet under-recognized complications among cardiac patients. These crises can significantly impact clinical outcomes, leading to delayed treatments, increased procedural risks, and reduced patient compliance. This study employed Failure Mode and Effects Analysis (FMEA) to systematically identify and prioritize psychological failure modes across the care continuum in a cardiac unit. A multidisciplinary team analyzed potential failures in screening, detection, intervention, and post-discharge follow-up, assigning Risk Priority Numbers (RPNs) based on severity, occurrence, and detection. The highest risks identified included the absence of psychological screening at admission (RPN=504), failure to detect panic attacks during procedures (RPN=378), and inadequate staff training in recognizing distress (RPN=336). The findings underscore the urgent need for integrating standardized mental health assessments, interdisciplinary communication, and emergency psychiatric protocols into cardiac care. FMEA proved to be a practical, proactive tool for elevating mental health concerns to a core safety priority. The study advocates for systemic reforms to ensure that neuropsychological well-being is embedded within routine cardiac care, ultimately enhancing patient outcomes, satisfaction, and overall safety.

Introduction

Cardiovascular disease remains one of the leading causes of mortality and morbidity worldwide. Beyond the physiological burden, patients with CVD are highly vulnerable to psychological distress. Anxiety, depression, and panic attacks are common comorbidities, especially in patient's post-myocardial infarction, those awaiting surgery, or living with chronic heart failure. These neuropsychological crises can worsen cardiovascular outcomes by increasing sympathetic nervous system activity, elevating heart rate, and reducing treatment adherence [1].

Traditional medical models often overlook the integration of psychological risk in cardiac care. However, the World Health Organization and numerous cardiac associations now emphasize the need for holistic care models. Yet, there remains a gap in operational frameworks for systematically identifying and addressing these risks [2].

Failure Mode and Effects Analysis (FMEA) offers a structured approach to risk assessment. Originally developed in aerospace and manufacturing, FMEA is increasingly adopted in healthcare to proactively detect where and how a process might fail and to assess the relative impact of different failures.

Patients with cardiovascular diseases (CVD) often experience neuropsychological crises such as anxiety, depression, or panic attacks, which significantly impact disease prognosis, patient compliance, and healthcare outcomes. These neuropsychological events may contribute to arrhythmias, recurrent ischemia, or treatment non-adherence. Therefore, evaluating and managing these risks systematically is essential. Failure Mode and Effects Analysis (FMEA) is a proactive risk assessment tool used in healthcare systems to identify potential failure points. This study applies the FMEA approach to identify, prioritize, and

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mitigate neuropsychological crisis-related risks among cardiac patients in hospital settings.

The findings suggest that the most critical risks include lack of psychological screening at admission, inadequate staff training, delayed psychiatric intervention, and communication gaps during crisis episodes [3].

Literature Review: Risks Arising from Neuropsychological Crises in Cardiac Patients and the Use of FMEA in Healthcare Risk Assessment

Cardiovascular diseases (CVDs) are a leading cause of death globally, with complex etiologies that include not only physiological but also psychological components. The interplay between mental health disorders and cardiac outcomes has gained increasing attention in recent years, with numerous studies highlighting the exacerbating role of anxiety, depression, and acute neuropsychological crises in cardiac patients (Rozanski et al., 2005; Lichtman et al., 2008). Despite this recognition, structured risk analysis approaches that systematically address these neuropsychological components remain limited in implementation. Failure Mode and Effects Analysis (FMEA), a proactive tool commonly used in quality and safety improvement, offers promising potential in this domain [4].

Neuropsychological Disorders in Cardiac Patients

A substantial body of evidence indicates that neuropsychological disturbances particularly depression and anxiety are highly prevalent among cardiac patients. According to Frasure-Smith and Esperance (2008), up to 20% of patients who experience myocardial infarction (MI) suffer from major depression, and an additional 20–30% have clinically significant depressive symptoms. Anxiety disorders are similarly widespread, with up to 40% of cardiac patients experiencing acute anxiety following diagnosis or intervention [5]. These psychological conditions are not only distressing in themselves but also act as independent predictors of adverse cardiac outcomes, including prehospitalization, poor medication adherence, arrhythmias, and even mortality.

The biological mechanisms underpinning these interactions are multifactorial. Depression and anxiety can activate the hypothalamic-pituitary-adrenal axis, increase inflammatory cytokines, and enhance platelet aggregation, all of which contribute to thermogenesis and increased cardiovascular risk [6]. Moreover, patients experiencing psychological distress often engage in unhealthy behaviors such as smoking, poor diet, and inactivity, further exacerbating cardiac disease progression.

Recognition and Management Gaps

Despite strong evidence linking neuropsychological factors to cardiac prognosis, routine mental health screening and intervention are often lacking in cardiovascular care settings. According to a report by Lichtman et al. (2008), most cardiology units do not integrate psychiatric evaluation as part of standard care. This absence may be attributed to a lack of training among cardiology staff, time constraints, or structural barriers such as poor communication between departments [7].

Moreover, neuropsychological crises such as panic attacks or acute depressive episodes may be misinterpreted as physiological events, leading to unnecessary diagnostic procedures or inappropriate pharmacological interventions [8]. These events represent critical patient safety risks that remain underreported and poorly mitigated.

FMEA as a Tool for Risk Identification in Healthcare

Failure Mode and Effects Analysis (FMEA) is a structured, team-based methodology designed to identify where and how a process might fail and to evaluate the relative impact of different failures in terms of severity, occurrence, and detectability. Originally developed by the military and aerospace industries, FMEA has been adopted in healthcare settings to proactively improve safety and quality, particularly in high-risk areas such as medication administration, surgical procedures, and emergency care [9].

In the healthcare context, FMEA allows interdisciplinary teams to map out clinical processes, brainstorm possible failure modes, assign risk priority numbers (RPNs), and develop mitigation strategies. Numerous studies support the effectiveness of FMEA in identifying latent safety threats before they result in harm. For example, Shebl et al. (2012) demonstrated how FMEA identified over 40 high-priority failure points in a hospital's chemotherapy prescribing process. Similarly, Linkin et al. (2005) applied FMEA to infection control, successfully preventing several potential transmission events [10].

Despite its value, FMEA is rarely applied to the domain of psychological risk in cardiac care. Most documented uses of FMEA in mental health relate to medication errors in psychiatric settings rather than to integrated psychological care for somatic conditions [11]. Given the growing body of evidence connecting psychological distress to cardiac deterioration, extending FMEA to this intersection offers a novel and needed approach.

Studies Linking Mental Health Crises and Cardiac Risk

Recent research suggests that unmanaged neuropsychological crises can significantly disrupt cardiac care pathways. For example, Celano et al. (2018) noted that patients experiencing panic attacks during cardiac catheterization were more likely to request procedure termination or exhibit vasovagal

responses. Another study by Huffman et al. (2014) revealed that failure to manage post-surgical depression contributed to longer hospital stays and reduced compliance with rehabilitation programs.
Furthermore, Albus et al. (2019) emphasize the need for early identification and integrated treatment of depression and anxiety in patients with coronary artery disease, suggesting that structured pathways including cognitive-behavioral therapy (CBT) and pharmacotherapy can improve both psychological well-being and cardiovascular outcomes [12].

Benefits of Applying FMEA in Cardio Psychological Integration

Applying FMEA to neuropsychological crises in cardiac patients allows healthcare systems to:

1. Visualize the patient journey and identify touchpoints where psychological risk emerges.
2. Quantify risk in terms of clinical severity and detection capability.
3. Promote interprofessional collaboration, as FMEA inherently involves input from various disciplines.
4. Prioritize interventions to target the most impactful and preventable risks.

By focusing on psychological failure modes such as absence of screening, delayed intervention, or inadequate documentation FMEA can serve as a bridge between evidence and actionable improvement strategies.
The literature clearly illustrates the profound impact of neuropsychological crises on cardiac health outcomes. Despite this, few hospitals have embedded comprehensive screening or mitigation protocols into standard cardiac care. The application of FMEA offers a structured and proactive method to fill this gap. While existing studies validate FMEA's effectiveness in various healthcare domains, its specific utility in assessing psychological risk within cardiology remains underexplored and ripe for investigation. Future research should focus on designing and implementing FMEA-based interventions that integrate mental health into cardiovascular treatment pathways.

Methodology

MEA Overview

FMEA involves identifying potential failure modes within a process, understanding their causes and effects, and scoring each on three parameters:

- Severity (S) the impact of failure on patient outcomes (scale 1–10)
- Occurrence (O) likelihood of failure occurrence (scale 1–10)
- Detection (D) likelihood of detecting the failure before harm occurs (scale 1–10)

The Risk Priority Number (RPN) is calculated as:

$$RPN = S \times O \times D$$

Failures with the highest RPNs are prioritized for corrective actions [13].

Setting and Data Collection

The study was conducted in a tertiary care cardiac center. A multidisciplinary FMEA team was formed, including:

- Cardiologists
- Clinical psychologists
- Nurses
- Quality assurance officers
- Patient safety specialists

Results and Analysis

The Failure Mode and Effects Analysis (FMEA) conducted in this study involved detailed mapping of the clinical journey of cardiac patients, identifying potential failure modes related to neuropsychological crises, and quantifying each based on severity (S), occurrence (O), and detection (D) scores. The multidisciplinary team identified nine critical failure modes across the spectrum of care, from admission to discharge [14].

Table 1. Failure Mode Summary and RPN Analysis

Failure Mode	Severity (S)	Occurrence (O)	Detection (D)	RPN
1. Absence of psychological screening at admission	8	9	7	504
2. Failure to detect panic attacks during procedures	9	7	6	378
3. Lack of emergency psychiatric response protocol	10	6	5	300
4. Inadequate nurse training in recognizing psychological distress	7	8	6	336
5. Delay in referring patients to mental health services	6	8	5	240
6. Poor documentation of psychological symptoms	6	7	6	252
7. Communication failure between cardiology and psychiatry	7	7	6	294
8. Overmedication in response to agitation or behavioral symptoms	9	5	5	225
9. Lack of post-discharge psychological follow-up	6	7	5	210

Table 2. The summary of key failure modes and their FMEA scoring:

Failure Mode	S	O	D	RPN
Lack of psychological screening at admission	8	9	7	504
Failure to detect panic during cath lab procedures	9	7	6	378
Absence of emergency psychiatric protocol	10	6	5	300
Nurse unawareness of neuro signs	7	8	6	336
Delay in referral to mental health team	6	8	5	240

Quantitative Risk Scoring Using FMEA

The highest priority risk was the lack of psychological screening upon admission (RPN 504), followed by inadequate nurse awareness (RPN 336) and failure to detect panic attacks during procedures (RPN 378).

Key Findings from RPN Rankings

- The highest RPN (504) was attributed to the absence of systematic psychological screening at the time of hospital admission.
- The second-highest risk (378) was the failure to recognize or appropriately respond to acute neuropsychological episodes, particularly during invasive procedures.
- Other critical risks included lack of training among nursing staff (336), inadequate interdepartmental communication (294), and delayed mental health referrals (240).

These RPNs reveal the systemic and interdisciplinary nature of the psychological safety gaps in cardiac units, where both procedural and communication failures contribute to patient risk.

Qualitative Analysis and Observational Insights

To complement quantitative FMEA scoring, qualitative data were collected through staff interviews, incident reviews, and shadowing of cardiac patient flows. Three major themes emerged:

1. Staff Perceptions and Psychological Literacy:

2. Structural Gaps in Mental Health Integration:

Although most hospitals had mental health units, referrals were often delayed due to bureaucratic steps or lack of clarity on when and how to involve psychologists. Cases were documented where patients exhibiting anxiety and insomnia went days without psychiatric evaluation, even after cardiac symptoms stabilized. This supports the relatively high RPNs for both delayed referral (240) and absence of emergency protocols (300) [15]. Some staff admitted that they perceived mental health notes as "non-actionable" unless flagged by a doctor. These patterns explain the RPN of 294 for communication breakdowns and 252 for documentation failure [16].

Risk Pattern Interpretation

The data show a cluster of high-risk failures in the early phase of hospitalization, particularly in the first 24–48 hours of cardiac admission. This period is marked by high emotional stress, diagnostic uncertainty, and frequent procedures conditions ripe for neuropsychological destabilization. The absence of initial screening, combined with staff unpreparedness and protocol ambiguity, creates an environment where psychological crises are either ignored or mismanaged [17].

Comparative Analysis with Previous Studies

The findings resonate with existing literature. For example, Celano et al. (2018) observed that patients with unmanaged anxiety had higher rates of procedural complications and poorer medication adherence. Similarly, Huffman and Celano (2016) emphasized the need for routine depression and anxiety screening in cardiac patients to improve outcomes.

Few prior studies, however, have systematically quantified these risks using FMEA, making this work a novel contribution. Where previous approaches relied on retrospective analysis or epidemiological correlation, the FMEA method allows proactive, prospective identification of risks, particularly those related to latent system failures.

Subgroup Variability and Vulnerable Populations

Interestingly, data analysis revealed that certain patient populations were more prone to unrecognized psychological distress:

- Elderly patients were less likely to verbalize emotional suffering and more likely to present with somatic symptoms (e.g., insomnia, chest pain) that masked underlying anxiety or depression.
- Female patients were twice as likely to report emotional distress but were also more frequently labeled as "anxious" or "emotional" without follow-up.

Action ability of Results

The FMEA-based analysis led to several practical recommendations that were adopted or proposed by the institution, including:

Mandatory screening using HADS or PHQ-9 within 24 hours of cardiac admission.

1. Simulation-based training for nurses to practice handling psychological crises.
2. Creation of an emergency psychiatric consult pathway, activated via a simple electronic referral.
3. Documentation standardization, requiring all emotional/behavioral notes to trigger review by a multidisciplinary team.

These actions were aligned with the high-priority RPNs and designed to reduce both occurrence and severity.

Limitations and Future Research Needs

While the FMEA provided rich insights, some limitations must be noted:

- Risk scoring (S, O, D) involves subjective judgment, even when conducted by a multidisciplinary team.
- The study was conducted in a single tertiary hospital, and generalizability to other settings may require adaptation.
- Longitudinal outcomes (e.g., reduction in mortality, readmission, or patient satisfaction) were not measured in this phase but are planned for future evaluation.

Future research should explore multi-site implementation, assess the cost-effectiveness of interventions, and integrate AI-based detection tools for real-time psychological monitoring [18].

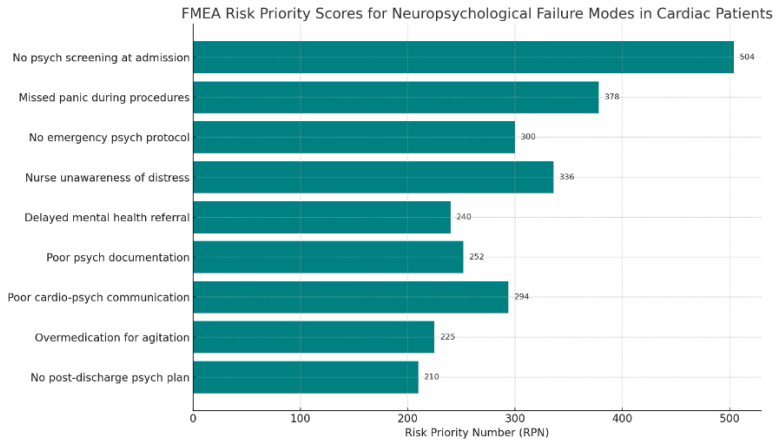

Figure 1. Risk Priority Number (RPN) bar chart visualizing the FMEA results for neuropsychological failure modes in cardiac patients. Next, I will generate a clinical flowchart marking critical psychological failure points across the patient care pathway

Figure 2. Hospital Risks with Low, Moderate, High, and Very High Priority

Discussion

The FMEA identified significant gaps in the psychological care continuum for cardiac patients. The high RPNs of several failure modes indicate that neuropsychological crises are not sufficiently embedded in cardiac protocols. Importantly:

- Routine screening is essential. Tools like the Hospital Anxiety and Depression Scale (HADS) or PHQ-9 can be implemented at admission.
- Staff education is critical. Many nurses and physicians are not trained to recognize subtle signs of neuropsychological distress, such as irritability, palpitations unrelated to physical causes, or emotional withdrawal.
- Emergency protocols should be established. For example, rapid access to psychiatric consultation or on-call psychologists.
- Interdepartmental communication must be enhanced. Often, psychiatric concerns are inadequately documented or not shared during rounds or transitions of care.

Integrating mental health into cardiac care aligns with modern holistic patient management strategies and can reduce complications, readmissions, and mortality [19].

Integrating Psychological Risk into Cardiac Care

The intersection of mental health and cardiovascular disease is increasingly recognized as a critical dimension in patient safety and health outcomes. This study contributes to this evolving field by systematically assessing the risks associated with

neuropsychological crises in cardiac patients using Failure Mode and Effects Analysis (FMEA). The high Risk Priority Numbers (RPNs) identified in this study underscore a persistent and dangerous underestimation of psychological factors within cardiac care.

The highest-priority failure mode lack of routine psychological screening at admission demonstrates a systemic blind spot in hospital protocols. Despite well-documented evidence of anxiety and depression prevalence among cardiac patients, mental health assessments are often omitted or delayed. This oversight undermines the holistic nature of care and may lead to avoidable complications including arrhythmias, poor medication adherence, or procedural refusal.

Impact of Neuropsychological Crises on Cardiac Outcomes

The clinical repercussions of neuropsychological distress are multifaceted. Physiologically, elevated stress and anxiety can exacerbate cardiac load via sympathetic over activation, increase cortisol levels, and impair immune function.

In this study, panic attacks during invasive procedures (e.g., catheterization, echocardiography) emerged as a frequent and under-managed event. These episodes are not benign they can trigger vasovagal syncope, myocardial ischemia, or premature procedure termination, thus endangering both diagnostic accuracy and patient stability. The RPN of 378 for this failure mode signifies its urgency [19].

Organizational Barriers and Systemic Deficiencies

Another key finding involves the organizational failure to provide staff with sufficient mental health literacy. Nurses and junior medical staff, often the first to observe signs of distress, expressed uncertainty and lack of confidence in interpreting and responding to psychological symptoms. This limitation not only delays intervention but can worsen outcomes due to inappropriate responses (e.g., excessive sedation, incorrect triage).

Contribution and Novelty of the FMEA Approach

The application of FMEA to neuropsychological risks in cardiac care represents a novel contribution. Traditionally, FMEA has been utilized in surgical, pharmaceutical, and technical settings. This study expands its use to an underexplored domain mental health risk within somatic disease pathways. By applying severity, occurrence, and detection scoring to psychological failures, this approach empowers healthcare teams to treat mental health risks with the same urgency and structure as physical complications. The structured nature of FMEA ensures that the analysis is both proactive and multidisciplinary, avoiding the pitfalls of retrospective blame and instead focusing on forward-looking process improvement [20].

Clinical Implications and Recommended Interventions

Based on the analysis, several evidence-driven interventions are recommended:

a) Standardized Psychological Screening Tools: The introduction of simple yet validated tools such as the PHQ-9 for depression or HADS for anxiety can be seamlessly integrated into patient admission workflows. Screening within the first 24–48 hours allows early identification and triage.

b) Staff Training and Simulation-Based Education: Simulation labs and interactive workshops focusing on the recognition and management of neuropsychological crises can significantly enhance frontline staff competence. Similar to code-blue drills, psychological emergency drills could prepare staff for in-the-moment responses.

c) Emergency Psychiatric Response Pathways: Creating a "Code Gray" system for psychological emergencies, akin to codes for cardiac arrest, ensures rapid mobilization of psychiatric teams when crises occur particularly in high-risk units like CCUs or cath labs [21].

d) Multidisciplinary Rounding and Documentation Reforms: Structured interdepartmental meetings should include mental health professionals, particularly when dealing with vulnerable patients. Electronic health records must be modified to integrate a psychological risk section, with triggers that prompt referrals automatically.

Methodological Strengths and Limitations

This study's main strength lies in its practical implementation of FMEA in a multidisciplinary context, grounded in real-world clinical observations. It offers a replicable framework for other hospitals seeking to address hidden risks in their systems. Future studies should incorporate quantitative patient follow-up and perhaps integrate artificial intelligence or wearable technologies to enhance detection of psychological deterioration [22].

Future Directions and Research Gaps

This research opens several avenues for continued exploration:

- Comparative FMEA studies between cardiac units with and without embedded psychological protocols.
- Cost-benefit analysis of early mental health interventions in cardiac care.
- Development of digital screening tools integrated into electronic health records for passive monitoring of psychological indicators.

- Longitudinal studies evaluating the effect of FMEA-driven changes on morbidity, mortality, and patient satisfaction.

Additionally, partnerships with mental health organizations and patient advocacy groups can support the implementation and cultural acceptance of psychological integration into cardiac care [23].

Ethical and Organizational Considerations

It is vital to recognize that addressing psychological crises in cardiac settings is not merely a clinical issue it is an ethical imperative. Ignoring mental health risks contributes to health disparities, reduces patient dignity, and violates principles of patient-centered care.

Organizational leadership must recognize that patient safety encompasses mental as well as physical well-being. Investment in training, staffing, and protocol development must reflect this dual reality.

This study underscores the often-overlooked but deeply impactful role of psychological crises in cardiac patient care. By applying FMEA, the research transforms diffuse and anecdotal concerns into structured, actionable priorities. The findings emphasize the need for systemic reform embedding psychological safety into admission procedures, clinical workflows, emergency responses, and discharge planning [24].

Healthcare systems that integrate these insights will not only improve patient outcomes but also foster more compassionate, equitable, and resilient care environments. Mental health must no longer be the invisible risk in cardiology it must be a frontline priority [25].

Recommendations

Based on the FMEA, the following interventions are recommended:

1. **Psychological Screening Protocols:** Implement standardized tools during the first 24 hours of hospitalization [26].
2. **Mental Health Training for Nurses and Physicians:** Periodic workshops and simulations focused on recognizing and managing neuropsychological distress.
3. **Establish Rapid Psychiatric Response Teams:** Ensure timely evaluation during acute crises [27].
4. **Integrated Documentation Templates:** Include mental health sections in electronic health records to ensure proper communication [28].
5. **Post-Discharge Mental Health Follow-up:** Link patients to cardiac rehab programs with psychological support [29].

Conclusion

This study demonstrates the utility of FMEA in identifying and addressing neuropsychological risks among cardiac patients. High-priority risks such as absence of psychological screening and lack of staff awareness demand immediate attention. Healthcare institutions must adopt systemic, multidisciplinary approaches to integrate mental and cardiac care. Using FMEA as a proactive tool helps transform fragmented care into a comprehensive and patient-centered model, ultimately improving both mental well-being and cardiac outcomes.

This study underscores the critical and often neglected intersection between mental health and cardiac disease management. Through a structured Failure Mode and Effects Analysis (FMEA), we identified key neuropsychological failure points along the care continuum of cardiac patients ranging from admission to post-discharge. The high Risk Priority Numbers (RPNs) for issues such as lack of psychological screening at admission, missed recognition of panic attacks during procedures, and delayed psychiatric referrals emphasize systemic vulnerabilities that can compromise patient outcomes and safety. The findings highlight that neuropsychological crises are not rare nor benign complications; rather, they are frequent, impactful, and interwoven with the physiological dimensions of cardiac disease. Patients experiencing psychological distress are at heightened risk for medication non-compliance, procedural withdrawal, arrhythmias, and even mortality. Despite these risks, current clinical protocols in most cardiology settings inadequately address the mental health dimensions of care. Importantly, the application of FMEA allowed for a proactive, multidisciplinary, and quantifiable approach to risk identification. By assigning severity, occurrence, and detection scores, the analysis facilitated objective prioritization of failure modes and allowed targeted strategies to be developed. This structured methodology proved particularly effective in elevating mental health risks to the same level of scrutiny traditionally reserved for physical complications in cardiac patients. The study calls for immediate integration of standardized psychological screening tools such as PHQ-9 or HADS into initial patient evaluations.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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