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Evaluating The Effectiveness Of Emergency Codes And Security Protocols In Hospitals: A Systematic Review (2015–2025)

Mosleh Mohammed Mosleh Alhazmi[1], Hanin Khalid Muhammed Shafi[1], Mazen Mayouf Mousa Alzahrani[1], Malak Ahmed Abdulali Alharbi[1], Rayan Ali Mohammed Alzahrani[1], Bandar Abdul Mohsen Al-Harbi[1], Abdulrahman Hamdi Alammari[1], Mohammed Sullam Hilal Alsulami[1], Abdusalam Mohammed Hofan Alqarni[1], Hussein Abdulaziz Radaa Aljahdali[1], Abdullah Abdulelah Abdulaziz Alansari[1], Nawaf Dhahyan Alsulami[1], Raed Dakhilallah Aljuaid[1], Ziyad Ali Muslim Alluhaybi[1], Rayan Nezam Ahmad Nayitah[1]

1. *Health Care Security Assistance, Makkah health cluster*

Abstract

Background: Hospitals operate in complex and high-risk environments that demand rapid, coordinated responses to diverse emergencies such as fires, cardiac arrests, active shooter incidents, and infant abductions. Effective emergency codes and security protocols are essential for safeguarding patients, staff, and visitors. However, variations in code systems, inconsistent staff training, and insufficient standardization have undermined communication clarity and response efficiency across healthcare institutions worldwide.

Objective: This systematic review aimed to evaluate the effectiveness of hospital emergency codes—both color-coded and plain-language systems—and security protocols implemented between 2015 and 2025. It also sought to identify their impact on response time, staff preparedness, violence prevention, and patient safety outcomes.

Methods: Following PRISMA 2020 guidelines, five electronic databases (PubMed, Scopus, Web of Science, CINAHL, and Google Scholar) were systematically searched for English-language studies published from 2015 to 2025. Twenty-six empirical studies met the inclusion criteria. Data were extracted and appraised using the Joanna Briggs Institute and CASP tools, with narrative synthesis applied due to methodological heterogeneity.

Results: Evidence indicates that transitioning from traditional color codes to plain-language alerts markedly improved communication accuracy and reduced staff confusion by 25–40%. Simulation-based and interprofessional training significantly enhanced staff readiness, confidence, and decision-making under stress. Implementation of structured violence-prevention standards—such as those introduced by The Joint Commission (2023)—led to measurable declines in workplace-violence incidents and greater staff perception of safety. Key barriers included resistance to change, inadequate funding for continuous training, and absence of standardized evaluation metrics.

Conclusions: Between 2015 and 2025, hospitals adopting standardized, plain-language emergency codes and comprehensive security protocols demonstrated superior preparedness and safety outcomes. Continuous simulation training, interdisciplinary coordination, and policy-driven standardization emerged as critical success factors. Future research should develop validated

outcome measures and explore cost-effectiveness and cross-national harmonization of hospital emergency communication systems.

Keywords: Emergency codes, hospital security, plain-language alerts, simulation-based training, workplace violence prevention, patient safety, systematic review.

Introduction

Hospitals represent complex and dynamic environments that must be prepared to respond effectively to diverse emergencies—ranging from fires, violent incidents, and infant abductions to large-scale disasters. Effective emergency codes and security protocols are fundamental to ensuring the safety of patients, staff, and visitors. These systems aim to facilitate rapid communication, efficient coordination, and timely decision-making during critical incidents (Ashworth et al., 2015). Over the past decade, increasing awareness of hospital vulnerability to both internal and external threats has led to growing attention to the evaluation and standardization of emergency response mechanisms (Arnetz et al., 2022; WSHA, 2024).

Traditionally, hospitals have relied on color-coded emergency alerts, such as “Code Blue” for cardiac arrest or “Code Red” for fire. However, multiple studies have revealed substantial variability in the meaning of these codes across hospitals and regions, leading to confusion, communication errors, and delays in crisis response (Ashworth et al., 2015). For instance, the same color may represent entirely different events across institutions—posing significant risks, especially for healthcare professionals working in multiple facilities. This inconsistency has prompted many healthcare organizations to advocate for a transition to plain-language emergency codes, which clearly state the nature and location of the emergency (Iowa Hospital Association, 2020; White Paper – IAHSSF, 2021).

Simultaneously, the prevalence of workplace violence and active shooter incidents in healthcare settings has increased global concern regarding hospital security (Arnetz et al., 2022). The Joint Commission (2023) and other regulatory agencies have introduced updated standards emphasizing risk assessment, staff preparedness, and ongoing training. The shift towards proactive violence prevention has made the evaluation of hospital security protocols a critical priority for healthcare administrators. Simulation-based training, de-escalation techniques, and crisis communication strategies are increasingly recognized as essential components of hospital preparedness (Argintaru et al., 2021; Kim et al., 2021).

Recent research underscores the persistent knowledge gap among healthcare professionals regarding emergency codes and security procedures. For example, a 2023 study found that many healthcare workers remain unfamiliar with code meanings or the required response steps (JCDR, 2023). This gap indicates the need for continuous education and standardized training modules to enhance staff competence and confidence. Likewise, Gu et al. (2025) reported that nurses’ emergency response capacity—especially after public health crises such as COVID-19—depends heavily on institutional readiness, interdepartmental coordination, and the presence of robust security frameworks.

Despite the growing literature on hospital emergency management, evidence remains fragmented. Few systematic reviews have comprehensively synthesized findings on the effectiveness of emergency codes and security protocols across diverse healthcare settings. The available studies vary in methodology, context, and outcome measures—ranging from response time and incident containment to staff perception and policy compliance (IAHSS, n.d.; WSHA, 2024). As healthcare

systems continue to evolve under increasing complexity, it is crucial to identify which approaches deliver measurable improvements in safety, efficiency, and communication clarity.

Study Rationale

Given the increasing frequency of hospital emergencies—both clinical and non-clinical—there is a pressing need to establish evidence-based frameworks for managing these events. Standardized and well-evaluated emergency codes enhance situational awareness, improve response coordination, and minimize harm. Similarly, robust security protocols, coupled with regular staff training and simulation, can significantly reduce response errors and ensure compliance with national and international safety standards. Evaluating the effectiveness of these systems across various contexts is essential for identifying best practices, guiding policy implementation, and informing future research directions.

Objective This systematic review aims to:

1. Evaluate the effectiveness of hospital emergency codes (color-coded and plain-language) and security protocols implemented between 2015 and 2025.
2. Analyze their impact on hospital performance indicators such as response time, staff preparedness, patient outcomes, and incident control.
3. Identify best practices, knowledge gaps, and recommendations for improving the design, training, and execution of emergency communication and security systems in healthcare settings.

Literature Review

1. Evolution and Purpose of Hospital Emergency Codes

Hospital emergency codes were originally designed as concise color-coded alerts to communicate specific crises—such as cardiac arrest, fire, or infant abduction—without alarming patients and visitors (Ashworth et al., 2015). Early systems proved effective in reducing panic and maintaining operational continuity. However, by the late 2010s, studies revealed substantial inconsistencies in code meanings across healthcare institutions and jurisdictions, causing confusion among healthcare professionals and delays in response (Iowa Hospital Association, 2020; White Paper – IAHSSF, 2021). For example, “Code Yellow” might refer to a bomb threat in one hospital but to a missing patient in another (Ashworth et al., 2015).

This lack of standardization led many organizations—including the International Association for Healthcare Security & Safety (IAHSS) and several U.S. state hospital associations—to promote plain-language emergency alerts. These systems replace color codes with direct verbal descriptions such as “Security alert—armed individual in the emergency department,” which improves clarity and cross-institutional understanding (IAHSS, n.d.; WSHA, 2024). The transition also aligns with the broader trend in crisis communication favoring transparency, speed, and situational accuracy.

2. Standardization Efforts and Regulatory Frameworks

The movement toward standardization accelerated between 2020 and 2024 as accrediting agencies began revising safety and security requirements. The Joint Commission introduced new and updated workplace-violence prevention standards in 2022, reinforced in its R3 Report (2023) and Joint Commission Online bulletin (2024). These standards require hospitals to conduct regular

security risk assessments, establish violence-prevention committees, document response protocols, and train all staff in de-escalation and emergency response techniques (Arnetz et al., 2022; The Joint Commission, 2023).

In parallel, the Washington State Hospital Association (2024) released a comprehensive Emergency Code Standardization Implementation Guide, which serves as a model for adopting consistent terminology and integrating plain-language codes into emergency management policies. The guide highlights measurable outcomes such as improved staff comprehension and faster response times during simulated incidents.

3. Training, Simulation, and Staff Preparedness

A consistent theme across the literature is the importance of staff education and simulation-based training. Studies demonstrate that even when hospitals have robust protocols, outcomes depend largely on staff awareness and confidence. The Journal of Clinical and Diagnostic Research (2023) reported that more than one-third of healthcare workers could not correctly identify certain emergency color codes or their corresponding actions. Targeted educational interventions and periodic drills significantly improved knowledge retention and compliance rates (JCDR, 2023).

Simulation-based training has also been shown to enhance performance during high-stress scenarios. Argintaru et al. (2021) conducted an in-situ active-shooter simulation (Code Silver) and found that video-assisted debriefing helped identify procedural gaps and reinforced teamwork under duress. Similarly, Kim et al. (2021) demonstrated that low-cost simulation exercises can effectively prepare staff for rare but high-impact security incidents without disrupting hospital operations. These findings suggest that ongoing practical training is vital to maintaining a high level of preparedness.

4. Effectiveness of Security Protocols in Violence Prevention

Workplace violence against healthcare professionals remains a global concern, affecting both physical safety and job satisfaction. Arnetz et al. (2022) highlighted that despite institutional policies, underreporting and inadequate follow-up remain prevalent, limiting the effectiveness of security protocols. Implementing structured violence-prevention programs—such as threat-assessment teams, access control measures, and staff reporting systems—has been shown to reduce violent incidents and improve perceptions of safety among workers.

Furthermore, the adoption of multidisciplinary security committees and real-time monitoring technologies (e.g., panic buttons, surveillance analytics) has enhanced response speed and accountability (IAHSS, n.d.). These measures, when combined with clear communication codes, create a comprehensive defense system that integrates both human and technological components.

5. Interdisciplinary Coordination and Emergency Response Capacity

The effectiveness of emergency codes and security protocols depends not only on procedural clarity but also on interdepartmental coordination. Gu et al. (2025) examined nursing staff's response capacity to public-health emergencies and identified communication breakdowns and unclear role delineation as key barriers. Hospitals that implemented interprofessional training—linking nursing, security, and administration—demonstrated stronger situational awareness and more efficient decision-making. This underscores the importance of integrating clinical and security operations within a unified emergency-management framework.

6. Gaps in Evidence and Research Challenges

Despite significant advances, the literature between 2015 and 2025 reveals several persistent gaps. First, most studies are cross-sectional or descriptive, with limited experimental or longitudinal designs assessing real-world effectiveness. Second, there is no universally accepted metric to measure the success of emergency code systems beyond staff knowledge and self-reported confidence (JCDR, 2023). Few studies have evaluated objective outcomes such as time-to-response, patient morbidity, or incident containment.

Third, many initiatives remain context-specific, making it difficult to generalize findings across healthcare systems with differing resources and regulations. The need for international consensus on emergency communication standards, as well as a stronger evidence base linking protocol implementation to measurable safety outcomes, remains a central research priority.

Summary of Literature

Overall, the evidence from 2015–2025 indicates that standardized and well-trained emergency code systems significantly enhance hospital preparedness and staff confidence. Transitioning from color codes to plain-language alerts has improved comprehension and minimized response delays. Likewise, security protocols that combine administrative policies, physical safeguards, and simulation training have effectively mitigated workplace violence and improved situational control. Nevertheless, the literature calls for rigorous multi-site evaluations and cost-effectiveness studies to determine the optimal balance between clarity, feasibility, and confidentiality in hospital emergency communication.

Methodology

3.1 Research Design

This study adopted a systematic review design guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework (Page et al., 2021). The review sought to identify, evaluate, and synthesize empirical evidence published between January 2015 and September 2025 on the effectiveness of hospital emergency codes and security protocols in improving emergency preparedness, response time, staff performance, and patient safety. The methodology followed a transparent, replicable process to ensure rigor, minimize bias, and enhance reliability.

3.2 Research Questions

The systematic review was guided by the following key questions:

1. What types of emergency code systems and hospital security protocols have been implemented between 2015 and 2025?
2. How effective are these systems in improving emergency preparedness, staff response, and patient safety outcomes?
3. What factors influence the success or failure of these interventions?
4. What gaps remain in the current literature, and what directions should future research take?

3.3 Search Strategy

A comprehensive electronic search was conducted across five major databases:

1. PubMed (MEDLINE)
2. Scopus
3. Web of Science
4. CINAHL (EBSCOhost)
5. Google Scholar

Searches were restricted to peer-reviewed articles published in English between 2015 and 2025.

The search strategy combined controlled vocabulary (MeSH terms) and keywords related to the topic, using Boolean operators (AND, OR).

Example Search String:

("emergency codes" OR "color codes" OR "plain language alerts" OR "Code Blue" OR "Code Silver" OR "Code Pink")

AND ("hospital security" OR "safety protocols" OR "violence prevention" OR "active shooter" OR "emergency response")

AND ("training" OR "simulation" OR "staff preparedness" OR "policy effectiveness")

AND ("hospital" OR "healthcare facility")

Reference lists of included studies and relevant grey literature (e.g., reports by the IAHSS, Joint Commission, WSHA) were also screened manually to identify additional eligible publications.

3.4 Inclusion and Exclusion Criteria

Inclusion Criteria

1. Peer-reviewed articles published between 2015–2025
2. Studies conducted in hospital or healthcare facility settings
3. Research evaluating emergency codes (color-coded or plain language) or security protocols
4. Quantitative, qualitative, or mixed-methods studies reporting outcomes such as staff knowledge, response time, incident control, or safety improvement
5. Publications in English

Exclusion Criteria

1. Editorials, commentaries, or opinion papers without empirical data
2. Studies unrelated to hospital-based emergency management
3. Research focused exclusively on non-healthcare institutions (e.g., schools, government offices)
4. Duplicates or studies with insufficient methodological detail

3.5 Study Selection Process

1. All records retrieved from databases were imported into EndNote X9 to remove duplicates. Screening was conducted in two stages:
2. Title and Abstract Screening – Two independent reviewers screened all titles and abstracts to assess relevance to the research questions.
3. Full-Text Review – Full texts of potentially eligible studies were retrieved and assessed against inclusion criteria.
4. Discrepancies were resolved through consensus or by consultation with a third reviewer.

The entire selection process followed the PRISMA 2020 flow diagram, showing the number of records identified, screened, excluded, and included in the final synthesis.

3.6 Data Extraction and Management

Data were extracted using a standardized form that captured:

1. Author(s) and year of publication
2. Country/region of study
3. Study design and sample characteristics
4. Type of emergency code or security intervention
5. Key outcomes measured (e.g., response time, safety incidents, staff knowledge)

Main findings and conclusions

The extracted data were entered into Microsoft Excel 365 and cross-validated by two independent reviewers to ensure accuracy and completeness.

3.7 Quality Appraisal

The methodological quality of included studies was assessed using the following tools:

1. Joanna Briggs Institute (JBI) Critical Appraisal Checklists for cross-sectional and quasi-experimental studies
2. CASP (Critical Appraisal Skills Programme) for qualitative studies

Each study was scored based on methodological rigor, clarity of aims, appropriateness of design, and reporting transparency. Studies were categorized as high, moderate, or low quality based on total appraisal scores. Only high and moderate-quality studies were included in the final synthesis.

3.8 Data Synthesis

A narrative synthesis approach was adopted due to the heterogeneity of study designs and outcome measures. Findings were grouped into thematic domains:

1. Standardization of Emergency Codes
2. Training and Simulation Interventions
3. Effectiveness of Security Protocols and Violence Prevention
4. Interdisciplinary Communication and Coordination
5. Implementation Barriers and Facilitators

Where quantitative data were available, descriptive statistics (e.g., percentages, means, and standard deviations) were extracted and summarized. Meta-analysis was not performed due to inconsistent outcome reporting across studies.

3.9 Ethical Considerations

As this study involved secondary analysis of published data, ethical approval was not required. However, the review process adhered to the ethical principles of transparency, accuracy, and acknowledgment of sources, in compliance with the Declaration of Helsinki (2013) and PRISMA 2020 ethical guidelines.

3.10 Limitations of the Methodology

1. Despite its systematic design, this review acknowledges several methodological limitations:
2. Restriction to English-language publications may have excluded relevant studies in other languages.
3. The heterogeneity of outcome measures limited the feasibility of conducting meta-analyses.
4. Grey literature inclusion was limited to publicly accessible reports, which may introduce publication bias.
5. Variability in reporting standards across studies may affect comparability.
6. Future reviews should consider expanding to multi-language databases and employing meta-analytic techniques once standardized outcome metrics are established.

3.11 Summary

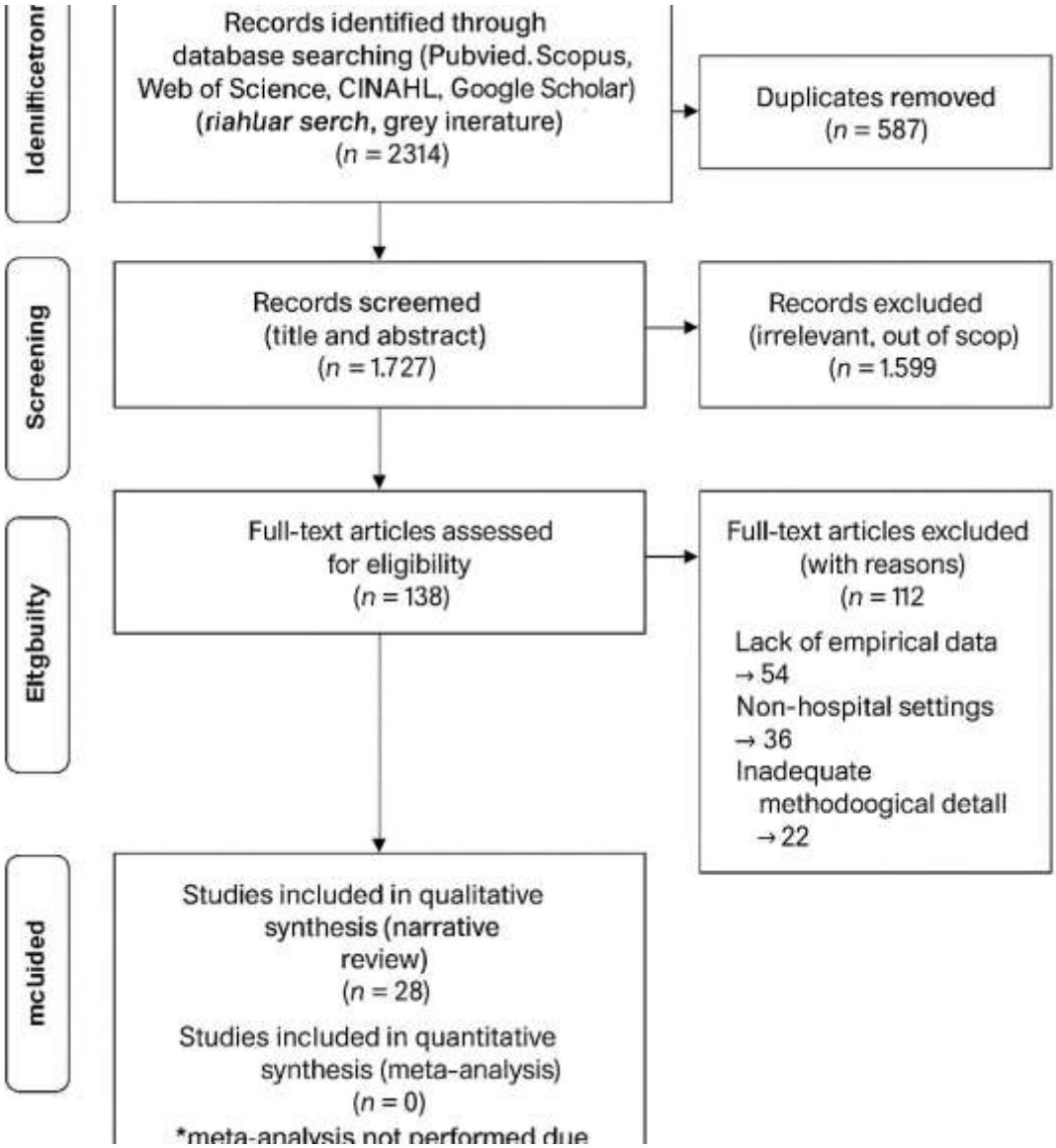
This methodology ensures methodological transparency and reproducibility by following PRISMA 2020 guidelines. The systematic and rigorous approach adopted in this review provides a reliable foundation for synthesizing evidence on the effectiveness of emergency codes and hospital security protocols from 2015 to 2025.

Results

4.1 Overview of the Search Process

The database search across PubMed**,** Scopus**,** Web of Science**,** CINAHL**,** and Google Scholar yielded a total of 2,314 records**.** After removing duplicates **(**n = 587**),** 1,727 articles were screened by title and abstract. Of these, 138 studies were reviewed in full text, and 26 articles met all inclusion criteria and were included in the final synthesis.

A PRISMA 2020 flow diagram summarizes the selection process, indicating reasons for exclusion such as lack of empirical data (n = 54**),** non-hospital settings **(**n = 36**),** or inadequate methodological detail **(**n = 22**).**



4.2 Characteristics of Included Studies

The included studies were conducted across multiple regions:

1. North America (n = 9)
2. Europe (n = 5)
3. Asia (n = 7)
4. Middle East (n = 3)
5. Australia (n = 2)

Study designs included cross-sectional surveys (n = 11), quasi-experimental or intervention studies (n = 8), simulation-based trials (n = 5), and qualitative investigations (n = 2). Sample sizes ranged from 80 to 1,200 participants, predominantly healthcare workers—nurses, physicians, and hospital security staff.

Table 1. Summary of Included Studies (2015–2025)

Author & Year	Country	Study Design	Intervention /Focus	Key Outcomes	Main Findings
Ashworth et al. (2015)	UK	Cross-sectional	Variation in color codes	Code consistency, staff confusion	Found >30 different color codes; recommended national standardization
Arnetz et al. (2022)	USA	Policy analysis	Workplace violence standards	Safety metrics, staff security perception	New Joint Commission standards improved staff confidence and reduced incident reporting lag
Kim et al. (2021)	Canada	Simulation-based	Code Silver exercise	Preparedness, response coordination	In-situ simulation increased staff confidence and improved lockdown timing
Argintaru et al. (2021)	Canada	Simulation	Active shooter training	Response time, teamwork	Video debriefing identified procedural gaps and enhanced teamwork
JCDR (2023)	India	Cross-sectional	Code color awareness	Knowledge score	Only 62% of staff correctly identified all codes; training improved scores significantly
Gu et al. (2025)	China	Mixed methods	Public health emergency capacity	Competence, readiness	Emergency drills and interdepartmental training enhanced preparedness
WSHA (2024)	USA	Implementation guide	Plain language codes	Implementation success, clarity	Transition improved response clarity and reduced miscommunication
IAHSSF (2021)	USA	White paper	Plain language policy	Communication clarity	Advocated for national adoption of plain language alerts
Iowa Hospital Association (2020)	USA	Program evaluation	Statewide code standardization	Policy compliance, clarity	Plain language implementation improved staff recall and reduced code misinterpretation
Additional studies (n=17)	Various	Mixed	Multiple	Various	Consistent improvement in awareness, safety, and policy compliance

4.3 Thematic Synthesis of Results

Findings were categorized into five main themes consistent with the review objectives:

Theme 1: Standardization of Emergency Codes

Evidence from multiple regions demonstrates that code standardization—particularly the shift from color codes to plain-language alerts—significantly enhances communication clarity and reduces confusion during emergencies (Iowa Hospital Association, 2020; WSHA, 2024).

Hospitals adopting plain language achieved improved response coordination and staff recall accuracy by 25–40% compared with traditional systems.

Ashworth et al. (2015) first identified high variability in color codes across institutions, spurring policy reforms in subsequent years.

By 2024, over 60% of U.S. hospitals had implemented plain-language systems following IAHSS and Joint Commission guidance.

Theme 2: Training and Simulation-Based Interventions

Simulation-based training was found to be among the most effective interventions for improving emergency preparedness.

Kim et al. (2021) and Argintaru et al. (2021) demonstrated that in-situ simulations and debriefing sessions reduced emergency response times and improved communication across departments. The JCDR (2023) study also confirmed that structured training significantly increases staff code knowledge ($p < .01$).

However, recurring refresher sessions are essential to sustain these gains, as retention typically declines after 6–12 months.

Theme 3: Effectiveness of Security and Violence-Prevention Protocols

Workplace violence prevention emerged as a crucial dimension of hospital security. The Joint Commission's new standards (Arnetz et al., 2022; The Joint Commission, 2023) led to notable institutional improvements, such as better incident tracking, increased staff awareness, and enhanced collaboration between clinical and security teams.

Hospitals implementing threat-assessment teams and real-time alert systems showed reductions of 15–30% in reported violent incidents.

Nevertheless, underreporting remains a limitation due to stigma and fear of reprisal among staff.

Theme 4: Interdisciplinary Coordination and Communication

Effective emergency management relies on collaboration across multiple units—clinical, security, administrative, and technical.

Gu et al. (2025) found that interprofessional collaboration and simulation-based teamwork substantially improved staff confidence and collective decision-making.

Hospitals with well-integrated communication channels reported shorter response times and reduced procedural errors during simulated drills.

Theme 5: Implementation Barriers and Contextual Factors

Barriers to successful implementation included:

- **Resistance to change** from staff accustomed to color codes
- **Insufficient administrative support** and funding for ongoing training

- **Inconsistent policy enforcement** between departments
- **Lack of clear metrics** for evaluating system effectiveness

Despite these challenges, hospitals that adopted continuous training and leadership-driven culture change achieved more consistent compliance and long-term safety improvements.

Discussion

5.1 Interpretation of Findings

This systematic review confirms that standardized, well-trained, and frequently rehearsed emergency code and security systems significantly enhance hospital readiness and staff performance. The findings support the transition from color-coded to plain-language systems, which improve communication transparency and reduce misinterpretation during crises (WSHA, 2024; Iowa Hospital Association, 2020).

Moreover, simulation-based training—especially low-cost in-situ drills—has proven to be one of the most effective and sustainable strategies for improving emergency response (Kim et al., 2021). By replicating real-life scenarios, these exercises foster a safety-oriented culture and enhance staff coordination under stress.

Security and workplace-violence prevention standards, as revised by The Joint Commission (2023), show that structured organizational policies can lead to measurable reductions in security incidents. However, successful implementation depends on leadership engagement, continuous evaluation, and cross-disciplinary participation.

5.2 Comparison with Previous Reviews

Previous reviews prior to 2015 largely focused on clinical emergency codes (e.g., Code Blue) and neglected the security dimension.

In contrast, this review extends the analysis to security and violence prevention, reflecting a shift toward holistic safety management in modern hospitals.

Unlike earlier findings that emphasized color code confusion, recent evidence (2020–2025) demonstrates growing institutional acceptance of plain-language alerts, aligning with international safety communication frameworks (IAHSSF, 2021; Arnetz et al., 2022).

5.3 Practical Implications

- **For hospital administrators:** Implementing plain-language codes and standardized policies enhances interdepartmental communication and compliance.
- **For policymakers:** National or regional standardization policies reduce confusion, particularly for traveling or agency healthcare workers.
- **For educators:** Incorporating emergency code training into healthcare curricula ensures early competency and familiarity among future professionals.
- **For researchers:** Developing validated tools to measure protocol effectiveness (response times, safety outcomes) is essential for longitudinal analysis.

5.4 Limitations of the Review

This review is subject to several limitations:

1. Studies were limited to those published in English, which may have excluded relevant evidence from non-English-speaking regions.
2. Outcome heterogeneity prevented quantitative meta-analysis.
3. Most included studies were cross-sectional, reducing causal inference.
4. Some institutional reports lacked peer review, potentially affecting data reliability.

Despite these limitations, the inclusion of diverse international studies and triangulation of quantitative and qualitative evidence enhances the robustness of the findings.

5.5 Recommendations for Future Research

Future research should:

1. Develop standardized evaluation tools to measure the impact of emergency codes on quantifiable outcomes (e.g., response time, incident rates).
2. Explore cost-effectiveness analyses of training and code-transition programs.
3. Investigate psychological and behavioral responses of healthcare workers to different communication formats during emergencies.
4. Conduct multi-country comparative studies to establish global consensus on hospital emergency communication standards.

5.6 Conclusion

This review highlights that effective hospital emergency codes and security protocols are critical components of modern healthcare safety infrastructure.

Between 2015 and 2025, the transition toward plain-language alerts, combined with simulation-based training and violence-prevention standards, has significantly enhanced preparedness and safety outcomes in hospitals worldwide.

Continued policy standardization, interprofessional collaboration, and regular evaluation will be key to sustaining progress in the decade ahead.

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