OPEN ACCESS
Journal of Multidisciplinary Applied Natural Science Vol. 5 No. 2 (2025) https://journal.pandawainstitutes.com/index.php/jmans/article/view/230

Check for updates

Research Article

Invisible Cognitive Load in Nursing Practice and Its Relationship to Care Precision, Error Recovery, and Patient Trust

Maram Mohammed, Safa Alhazmi, Imranah Hatan, Hasnah Ageeli, Noha Hakami, Khdigha Bahri, Eman Alanazi, Kafiyah Alanazi,Khawla Aljezani, Hessa Alotiby, Deema Alshehri, Afnan Mahrous and Rahaf Alhawsawi

Received : August 29, 2024	Revised : September 28, 2025	Accepted : November 03, 2025	Online : November 08, 2025

Abstract:

Invisible cognitive load in nursing refers to the mental effort and processing demands that are not readily observable but significantly impact nurses' performance. This hidden aspect of workload influences care precision, the ability to recover from errors, and ultimately patient trust. This article explores how cognitive load manifests in nursing practice through decision-making complexity, interruptions, multitasking, and emotional stress. Using case studies and empirical examples, we analyze the interplay between cognitive burden and critical outcomes in patient safety and satisfaction. Methods to identify and mitigate invisible cognitive load are discussed to enhance resilience and support nurse performance. Understanding and addressing this phenomenon is essential for improving healthcare quality and fostering trust between nurses and patients. [1-5]

Keywords: Cognitive load, nursing practice, care precision, error recovery, patient trust, invisible workload, healthcare safety, clinical decision making.

1. Introduction

Nursing is a profession defined by complexity, rapid decision-making, and high stakes. Nurses operate in dynamic environments where they must juggle numerous tasks simultaneously—administering medications, monitoring patient status, responding to emergencies, and communicating with interdisciplinary teams.

While much attention has been given to the physical workload nurses bear, there is a subtler, often overlooked dimension of their work: invisible cognitive load. This term refers to the mental effort that is not directly observable but profoundly affects how nurses perform their duties. Unlike physical tasks, which are visible and measurable, cognitive load is internal and intangible, yet it shapes clinical judgment, attention, memory, and problem-solving capabilities.

Invisible cognitive load arises from the mental demands placed on nurses by multifaceted clinical scenarios. It includes managing complex patient data, anticipating potential complications, maintaining situational awareness, and continuously prioritizing care actions. These cognitive processes occur beneath the surface, often unnoticed by others, but they consume significant mental resources. As nurses navigate interruptions, multitasking pressures, and emotional stress, their cognitive capacity can become overloaded, leading to decreased care precision and increased risk of errors.

The repercussions of invisible cognitive load extend beyond clinical performance to patient safety and trust. Care precision—the accuracy and appropriateness of nursing interventions—depends heavily on a nurse's cognitive readiness and focus. When cognitive overload occurs, lapses in attention or memory can result in medication errors, missed assessments, or delayed interventions. Moreover, how nurses recover from such errors is influenced by their cognitive resilience and the support systems in place. Effective error recovery requires recognizing mistakes promptly, engaging in corrective actions, and communicating transparently with patients and colleagues.

Patient trust is another critical outcome affected by cognitive load. Trust is built on the perception of competence, attentiveness, and empathy. When nurses are cognitively overburdened, their communication may falter, responsiveness may decrease, and patients may sense a lack of engagement or confidence. This erosion of trust can impact patient satisfaction, adherence to treatment plans, and overall health outcomes.

By illuminating this hidden dimension of nursing work, we hope to contribute to a deeper understanding of the cognitive challenges nurses face daily and to encourage the development of practical tools and policies that address these challenges. Enhancing awareness of invisible cognitive load not only benefits nurses' well-being and professional efficacy but also significantly advances patient safety and healthcare quality. [6-10]

2. Methodology

The study employs a comprehensive mixed-methods approach designed to capture the multifaceted nature of invisible cognitive load in nursing practice and its impact on care precision, error recovery, and patient trust. By integrating qualitative and quantitative methods, the research aims to provide a rich, contextualized understanding supported by empirical measurement, allowing for both depth and breadth in insights.

The initial phase focuses on qualitative case study analysis conducted in three healthcare settings selected through purposive sampling to represent a range of nursing environments: a high-acuity intensive care unit, a general medical-surgical ward, and an emergency department. These settings differ in complexity, patient acuity, and workflow patterns, providing a diverse backdrop for examining cognitive load manifestations. Data collection involved direct, non-intrusive observations of nurses during their shifts, capturing real-time behaviors such as task-switching, interruptions, and communication exchanges. Complementing observations, semi-structured interviews were conducted with frontline nurses to explore their subjective experiences of cognitive workload-strategies to manage mental demands, encounters with errors, and perceptions of patient trust dynamics. Additionally, institutional incident reports related to medication errors, near misses, and communication failures were reviewed to identify objective instances where cognitive load factors may have contributed to adverse outcomes. Ethical clearance was secured to ensure participant confidentiality, informed consent, and adherence to research standards.

The second phase entailed designing and administering a quantitative survey targeting a larger sample of registered nurses across multiple hospitals. The survey instrument incorporated validated measures adapted from established cognitive workload scales, such as the NASA Task Load Index, alongside newly developed items inspired by themes emerging from the qualitative phase. The survey assessed perceived mental workload intensity, frequency and impact of interruptions, multitasking levels, emotional strain, self-reported error occurrences, confidence in error recovery, and quality of communication with patients. Demographic and professional variables, including years of experience and unit type, were collected to explore potential moderating effects. The survey was distributed electronically to 200 nurses, achieving a 75% response rate, yielding a robust dataset for statistical analysis.

Qualitative data were transcribed verbatim and subjected to thematic analysis using an iterative coding process to identify patterns related to cognitive load sources, coping mechanisms, error events, and patient interaction challenges. These themes were refined through multiple coding cycles and discussion among researchers to ensure consistency and depth. Incident reports were coded to extract recurrent factors linked to cognitive overload and error genesis, providing triangulated evidence. Quantitative data were analyzed using descriptive statistics to characterize the prevalence and intensity of invisible cognitive load experiences. Correlational analyses explored relationships between cognitive load indicators and outcomes such as care precision, error recovery efficacy, and patient communication. Multiple regression models controlled for demographic-

variables to test the predictive value of cognitive load factors on these outcomes.To enhance validity, data triangulation was performed by comparing findings across qualitative interviews, observations, incident reports, and survey responses. Member checking was employed by sharing preliminary qualitative results with participants for verification and refinement. The survey instrument underwent pilot testing, demonstrating high internal consistency with Cronbach's alpha coefficients exceeding 0.80 for key scales, indicating reliable measurement.

Despite the strengths of a mixed-methods approach, certain limitations are acknowledged. The purposive sampling of case settings prioritizes depth over generalizability, potentially limiting broader applicability. The reliance on self-reported survey data introduces risks of bias, including social desirability and recall inaccuracies. Future research could incorporate objective cognitive load measures, such as physiological monitoring, and larger randomized samples to address these constraints and build on the current findings.[11-15]

3. Literature Review

Nursing practice operates at the intersection of complex cognitive, emotional, and physical demands, making the concept of cognitive load particularly relevant to understanding nurse performance and patient outcomes. Cognitive load theory, initially developed to explain learning processes in educational settings, has found increasing application in healthcare to elucidate how mental effort influences clinical tasks. The theory categorizes cognitive load into intrinsic, extraneous, and germane components. Intrinsic load refers to the complexity inherent in the task itself—such as assessing a patient's condition or making a clinical judgment—while extraneous load is imposed by the environment, including interruptions, multitasking demands, and organizational inefficiencies. Germane load involves the mental resources allocated toward processing, integrating, and adapting new information. In the nursing context, invisible cognitive load is often the cumulative effect of intrinsic and extraneous demands that remain unobserved yet profoundly shape clinical performance.

The intrinsic cognitive load in nursing is substantial due to the unpredictable and dynamic nature of patient care. Nurses must rapidly synthesize data from diverse sources, including vital signs, lab results, medication regimens, and patient histories, often under time pressure. The mental effort required to maintain situational awareness—understanding what is happening, anticipating what might happen next, and deciding how to respond—is immense. Endsley's (1995) seminal work on situation awareness underscores how failure at any level of awareness can compromise decision-making quality. In nursing, lapses in situational awareness caused by excessive cognitive load can lead to errors such as missed changes in patient status or delayed interventions.

Beyond intrinsic task complexity, extraneous cognitive load plays a critical role in undermining care precision. Numerous studies have documented how interruptions and multitasking—common in hectic clinical environments—impose additional mental burdens that disrupt focus and working memory. Westbrook et al. (2010) provided compelling evidence that interruptions during medication administration increase both the risk and severity of errors. These interruptions can come from multiple sources: alarms, colleagues, patients, or electronic notifications, each fracturing the nurse's cognitive flow. Similarly, Horwitz et al. (2008) studied transitions of care, where communication failures often arise from cognitive overload, leading to errors in handoffs between emergency departments and inpatient units. The fragmentation caused by these extraneous demands not only elevates error risk but also contributes to nurse fatigue and burnout.

The concept of germane load—though less often discussed in nursing—is equally important. It involves the mental effort invested in learning, adapting, and problem-solving in real time. Nurses constantly adjust care plans based on new information and changing patient conditions. This adaptive capacity is a key component of clinical resilience, enabling nurses to recover from errors-

and manage unforeseen complications. Hollnagel (2011) and Woods and Hollnagel (2006) highlight resilience engineering as a framework for understanding how healthcare systems and professionals anticipate, monitor, respond to, and learn from errors. The capacity to detect and recover from mistakes is heavily influenced by cognitive load. When mental resources are depleted, recognizing and correcting errors becomes more difficult, delaying recovery and potentially worsening patient outcomes.

The literature reveals a growing recognition of invisible cognitive load as a significant, though often hidden, factor influencing nursing practice. It affects care precision by challenging nurses' ability to maintain attention and execute complex tasks accurately. It influences error recovery by shaping nurses' situational awareness and adaptive responses. And it impacts patient trust by affecting the quality of nurse-patient communication and perceived engagement.

Despite these insights, there remains a notable gap in systematic approaches to measuring and managing invisible cognitive load in clinical settings. Most workload assessments focus on quantifiable metrics such as patient-to-nurse ratios or task counts, overlooking the cognitive dimension that underpins safe and effective care. Future research must develop reliable tools to capture this hidden workload and design interventions that address cognitive demands through workflow redesign, team-based strategies, and supportive technologies.[3, 18-20]

4. Results

The results of this study reveal the pervasive impact of invisible cognitive load on nursing practice across multiple dimensions, including care precision, error recovery, and patient trust. Through qualitative case studies and quantitative survey data, the findings highlight how cognitive demands that remain unseen by observers significantly shape nursing performance and patient outcomes.In the intensive care unit (ICU) case study, observations demonstrated that nurses frequently encountered interruptions from alarms, family inquiries, and interdisciplinary consultations. Nurse A, responsible for multiple critically ill patients, was observed juggling rapid assessments, medication titration, and documentation under constant interruption. This error was identified only after the patient exhibited an adverse reaction, requiring immediate intervention. Interviews with Nurse A revealed a sense of cognitive overload, describing the mental juggling of concurrent demands as "running a mental marathon." The invisible cognitive load imposed by constant task-switching reduced situational awareness and contributed to the lapse in care precision. This example illustrates how intrinsic task complexity combined with extraneous distractions can overwhelm cognitive capacity, increasing error risk. It also underscores the delayed error detection that often accompanies high cognitive burden, highlighting barriers to timely recovery.

In the medical-surgical ward, Nurse B's experience highlighted the emotional and cognitive strain of multitasking in a busy environment. Managing a patient with deteriorating respiratory status, Nurse B simultaneously coordinated diagnostic testing, updated family members, and responded to new admissions. The mental effort required to prioritize actions and maintain situational awareness was substantial. Despite best efforts, subtle signs of hypoxia were missed initially, detected only after the patient's condition worsened. Nurse B described feeling "mentally drained" and "pulled in too many directions," emphasizing the role of invisible cognitive load in compromising vigilance. The emotional labor of balancing clinical demands with empathetic communication added to the cognitive burden, illustrating the interplay between emotional and cognitive workload. This case further demonstrates that invisible cognitive load extends beyond task complexity to include emotional and interpersonal dimensions, which critically influence care outcomes.

Survey results from 150 nurses across diverse clinical settings reinforced the qualitative findings. Seventy-eight percent of respondents reported experiencing invisible cognitive load as a significant source of stress during their shifts. High frequencies of interruptions and multitasking were strongly correlated with self-reported errors and near-misses ($r = 0.62$, $p < 0.01$). Nurses who reported higher cognitive load also indicated lower confidence in their ability to recover from errors-

($r = -0.54$, $p < 0.01$), suggesting that mental overload impairs adaptive capacities. Furthermore, a majority of nurses (65%) agreed that cognitive overload negatively affected their communication with patients, which they believed diminished patient trust and satisfaction. Regression analyses revealed that invisible cognitive load variables significantly predicted care precision scores ($\beta = -0.48$, $p < 0.001$) and patient trust metrics ($\beta = -0.42$, $p < 0.01$), controlling for years of experience and unit type.

In summary, the evidence from this study confirms that invisible cognitive load is a hidden but powerful determinant of nursing care quality and patient outcomes. By illuminating this dimension, healthcare organizations can develop targeted strategies to support nurses, enhance safety, and foster trustful patient relationships. [6, 7, 12-15]

5. Discussion

This study highlights the crucial but often hidden role of invisible cognitive load in nursing practice. The findings show that mental demands beneath observable tasks heavily influence care precision, error recovery, and patient trust, revealing a complex mix of cognitive, environmental, and emotional challenges. This shifts the conversation beyond visible workload to emphasize the mental strain nurses endure daily.

The case studies and survey data confirm how intrinsic task complexity combined with frequent interruptions and multitasking creates a relentless cognitive burden. This aligns with cognitive load theory and previous research linking high mental workload to errors and reduced situational awareness . Importantly, this study also underscores the emotional labor involved, showing how empathy and interpersonal demands add to cognitive strain. This highlights the need for holistic approaches that address both mental and emotional workload.

Invisible cognitive load significantly impairs nurses' ability to detect and recover from errors, weakening a critical safety barrier. This supports resilience engineering ideas about the importance of cognitive flexibility in managing mistakes .

Nurses' lower confidence in error recovery when overloaded points to the value of interventions focused on building resilience, teamwork, and supportive technology. Patient trust, often seen as relational, is closely linked to nurses' cognitive capacity. Overload harms communication quality and can erode trust, which affects satisfaction and adherence. This broadens our understanding of cognitive load's impact beyond technical tasks to include the nurse-patient relationship.

Survey results confirm the widespread impact of invisible cognitive load and its strong association with errors and communication issues. These findings call on healthcare leaders to improve workflow design, reduce interruptions, and optimize technology usability to ease extraneous cognitive demands [8, 12]. Collaborative strategies like cross-checking distribute mental workload and build team resilience, emphasizing the value of supportive work cultures .

Future research should focus on developing objective measures of invisible cognitive load and testing interventions in varied clinical settings. Understanding how cognitive load changes over time and across career stages will also be valuable.In sum, this study brings invisible cognitive load into sharper focus as a key factor in nursing care quality and patient safety. Addressing this hidden mental workload is essential to support nurses, enhance error management, and sustain trustful patient relationships. Integrating cognitive load awareness into practice and system design offers a path toward safer, more compassionate care.[2-12]

6. Conclusion

This study brings to light the profound yet often overlooked role of invisible cognitive load in shaping nursing practice and patient outcomes. By thoroughly examining how unseen mental demands affect care precision, error recovery, and patient trust, it exposes a critical dimension of nursing workload that has traditionally escaped direct measurement and focused intervention. The findings emphasize that invisible cognitive load is not merely an abstract concept but a tangible force that compromises patient safety and the quality of care nurses provide daily.

The complexity and unpredictability of clinical environments place relentless cognitive demands on nurses, who must process vast amounts of information, manage interruptions, multitask, and simultaneously maintain empathetic communication with patients and families. This study demonstrates that these mental burdens, though often invisible to observers and managers, lead to decreased situational awareness, increased errors, delayed error detection, and impaired communication—all of which jeopardize patient outcomes and trust. Emotional labor further compounds cognitive strain, underlining that nursing workload encompasses both intellectual and affective challenges.

Addressing invisible cognitive load calls for a comprehensive, system-level response. Healthcare organizations need to redesign workflows to reduce unnecessary interruptions and fragmentation of attention. This includes streamlining communication channels, optimizing staffing levels, and improving the usability of electronic health records and clinical decision support tools to prevent additional mental burdens. Fostering a culture of teamwork and collaboration is essential, as shared cognitive workload through practices like cross-checking not only enhances resilience but also distributes mental effort more sustainably. Providing emotional support and resilience training can equip nurses with adaptive strategies to manage both cognitive and emotional demands effectively.

Furthermore, this study highlights the importance of integrating cognitive ergonomics into healthcare delivery design. Technologies and protocols should be developed with an understanding of nurses' cognitive workflows to minimize extraneous load and support real-time decision-making. Such human-centered design principles are crucial for creating environments where nurses can maintain high levels of attention and deliver precise, compassionate care.

Beyond immediate care delivery, addressing invisible cognitive load has broader implications for nurse well-being and workforce sustainability. Cognitive overload contributes to stress, burnout- and job dissatisfaction, factors that exacerbate nursing shortages and turnover. By alleviating hidden mental burdens, healthcare organizations can improve retention and job satisfaction, creating a healthier and more stable nursing workforce. Furthermore, enhancing nurse-patient communication by reducing cognitive strain strengthens patient trust—a cornerstone of therapeutic relationships that influences adherence, satisfaction, and health outcomes.

The findings also highlight important avenues for future research. Developing precise, objective measures of invisible cognitive load—such as physiological monitoring or real-time cognitive workload assessments—would enable more accurate identification of overload and timely interventions. Longitudinal and large-scale studies could explore how cognitive load fluctuates over time and across different nursing roles and specialties, providing deeper insight into its dynamics and cumulative effects. Research evaluating the effectiveness of targeted interventions, including workflow redesign, technology enhancements, team-based approaches, and resilience training, will be crucial for translating knowledge into practice.

By bringing invisible cognitive load into the spotlight, healthcare leaders, educators, and policymakers can develop informed strategies that enhance safety, foster trust, and promote sustainable nursing practice in the face of growing complexity and demand. Ultimately, illuminating and mitigating invisible cognitive load offers a promising pathway toward safer, more effective, and more humane healthcare. It challenges us to rethink how we design work environments, technologies, and support systems—placing nurses' cognitive well-being at the heart of patient care. Through such efforts, we can build resilient healthcare systems where nurses are empowered to perform at their best, patients receive the highest quality care, and trust flourishes at every level of the clinical encounter. The journey to fully understand and manage invisible cognitive load is only beginning, but its potential to transform nursing practice and patient outcomes is profound and urgent.[2, 3, 6-8, 12-25]

References

1. Endsley, M.R. (1995). Toward a theory of situation awareness in dynamic systems. *Human Factors*, 37(1), 32-64.

2. Patterson, E.S., Woods, D.D., Williams, T.A., & Roth, E.M. (2005). Collaboration, coordination, and teamwork in complex systems. *Journal of Cognitive Engineering and Decision Making*, 1(1), 1-14.

3. Lingard, L., Espin, S., Whyte, S., Regehr, G., Baker, G.R., Reznick, R., & Orser, B. (2004). Communication failures in the operating room: an observational classification of recurrent types and effects. *Quality and Safety in Health Care*, 13(5), 330-334.

4. Graber, M.L., Franklin, N., & Gordon, R. (2005). Diagnostic error in internal medicine. *Archives of Internal Medicine*, 165(13), 1493-1499.

5. Hollnagel, E. (2011). *Prologue: The scope of resilience engineering.* In E. Hollnagel, J. Pariès, D.D. Woods, & J. Wreathall (Eds.), *Resilience Engineering in Practice: A Guidebook* (pp. 3-14). Ashgate.

6. Westbrook, J.I., Woods, A., Rob, M.I., Dunsmuir, W.T., & Day, R.O. (2010). Association of interruptions with an increased risk and severity of medication administration errors. *Archives of Internal Medicine*, 170(8), 683-690.

7. Woods, D.D., & Hollnagel, E. (2006). *Resilience Engineering: Concepts and Precepts*. Ashgate.

8. Carayon, P., & Gürses, A.P. (2005). A human factors engineering conceptual framework of nursing workload and patient safety in intensive care units. *Intensive and Critical Care Nursing*, 21(5), 284-301.

9. Patel, V.L., & Kaufman, D.R. (2006). Cognitive science and biomedical informatics: implications for healthcare design. *Journal of Biomedical Informatics*, 39(1), 28-38.

10. Vincent, C., Young, M., & Phillips, A. (1998). Why do people sue doctors? A study of patients and relatives taking legal action. *The Lancet*, 343(8913), 1609-1613.

11. Carroll, J.K., Moorhead, A., Bond, R., Leary, A., & Foy, R. (2008). The role of trust in the nurse-patient relationship. *Journal of Advanced Nursing*, 62(3), 333-344.

12. Horwitz, L.I., Meredith, T., & Schuur, J.D. (2008). Dropping the baton: a qualitative analysis of failures during the transition from emergency department to inpatient care. *Annals of Emergency Medicine*, 53(6), 701-710.

13. Sim, I., Gorman, P., Greenes, R.A., Haynes, R.B., Kaplan, B., Lehmann, H., & Tang, P.C. (2001). Clinical decision support systems for the practice of evidence-based medicine. *Journal of the American Medical Informatics Association*, 8(6), 527-534.

14. Nagpal, K., Vats, A., Lamb, B., et al. (2010). Information transfer and communication in surgery: a systematic review. *Annals of Surgery*, 252(2), 225-239.

15. Lingard, L., Espin, S., Evans, C., & Hawryluck, L. (2012). Communication failures in the operating room: an observational study. *BMJ Quality & Safety*, 21(8), 670-677.

16. Carayon, P., & Gürses, A.P. (2005). Human factors in patient safety as an innovation. *Applied Ergonomics*, 36(4), 423-433.

17. Patel, V.L., & Arocha, J.F. (2015). Cognitive science and biomedical informatics: implications for healthcare design. *Journal of Biomedical Informatics*, 58, 1-4.

18. Vincent, C. (2010). *Patient safety*. Wiley-Blackwell.

19. Patterson, E.S., & Wears, R.L. (2010). Patient safety: The role of cognitive engineering. *Theoretical Issues in Ergonomics Science*, 11(3), 189-204.

20. Hollnagel, E., Woods, D.D., & Leveson, N. (2006). *Resilience Engineering: Concepts and Precepts*. Ashgate.

21. Reason, J. (2000). Human error: models and management. *BMJ*, 320(7237), 768-770.

22. Carayon, P. (2006). Human factors in patient safety as an innovation. *Applied Ergonomics*, 37(4), 525-527.

23. Patterson, E.S., Roth, E.M., Woods, D.D., Chow, R., & Gomes, J.O. (2004). Handoff strategies in settings with high consequences for failure: lessons for health care operations. *International Journal for Quality in Health Care*, 16(2), 125-132.

24. Gurses, A.P., & Carayon, P. (2007). Performance obstacles of intensive care nurses. *Nursing Research*, 56(3), 185-194.

25. Endsley, M.R. (2000). Theoretical underpinnings of situation awareness: A critical review. *Situation Awareness Analysis and Measurement*, 3-32.