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PREDICTIVE ANALYTICS IN NURSING: EARLY DETECTION OF PATIENT DETERIORATION IN TEACHING HOSPITALS IN NORTH-CENTRAL NIGERIA

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Abstract: The increasing complexity of healthcare delivery and the persistent occurrence of preventable adverse events have heightened the need for intelligent approaches to patient surveillance, particularly in resource-constrained healthcare settings. This study investigated the determinants of predictive analytics utilisation and its influence on the early detection of patient deterioration among nurses in teaching hospitals in North-Central Nigeria. Anchored on the Technology–Organisation–Environment framework, the study adopted a quantitative cross-sectional survey design. Data were collected from registered nurses in selected teaching hospitals using a structured questionnaire. A total of 596 valid responses were analysed using confirmatory factor analysis and structural equation modelling with AMOS version 29. The measurement model demonstrated satisfactory reliability and validity, while the structural model exhibited acceptable goodness-of-fit indices. The findings revealed that data quality, nursing informatics competence, technological infrastructure and organisational support significantly and positively influenced predictive analytics utilisation. Furthermore, predictive analytics utilisation exerted a strong positive effect on the early detection of patient deterioration. Among the predictor variables, nursing informatics competence emerged as the most influential determinant, highlighting the strategic role of digital capabilities in intelligent patient surveillance. The study demonstrates that the effectiveness of predictive analytics extends beyond technological sophistication to encompass organisational readiness and professional competencies. By validating a context-sensitive structural model within a resource-constrained healthcare environment, the study contributes to the growing body of knowledge on nursing informatics and patient safety in sub-Saharan Africa. The findings underscore the need for sustained investments in digital infrastructure, health information management systems and nursing informatics education to facilitate the integration of predictive technologies into routine clinical practice and enhance proactive patient care in tertiary healthcare institutions.

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Keywords: Early detection of patient deterioration; Nursing informatics; North-Central Nigeria; Patient safety; Predictive analytics; Structural equation modelling.

Introduction

The timely recognition of patient deterioration remains a critical determinant of patient safety and quality healthcare delivery. Despite advances in clinical practice, unexpected deterioration continues to contribute substantially to avoidable morbidity, prolonged hospitalisation and mortality, particularly in resource-constrained healthcare settings. Evidence suggests that physiological instability is often preceded by subtle changes in vital signs and clinical parameters; however, these warning signals are not always recognised promptly, thereby delaying intervention and increasing the likelihood of adverse outcomes (Sendak et al., 2021; Shillan et al., 2022).

Recent developments in health informatics have shifted attention towards predictive analytics as a mechanism for enhancing proactive patient surveillance. By leveraging clinical data to identify patterns associated with impending deterioration, predictive analytics offers opportunities for improving nursing responsiveness and supporting timely clinical decision-making. Nevertheless, the effectiveness of such systems depends not only on technological capabilities but also on organisational readiness, data quality and the informatics competence of healthcare professionals (Topaz & Pruinelli, 2021).

Although predictive analytics has received increasing scholarly attention in developed healthcare systems, empirical evidence from Nigeria remains limited. In teaching hospitals across North-Central Nigeria, where increasing patient complexity coexists with infrastructural and workforce challenges, understanding the determinants and implications of predictive analytics utilisation has become imperative. Existing studies have focused largely on electronic health records and digital health adoption, leaving insufficient attention to how predictive analytics may strengthen early detection of patient deterioration within nursing practice.

Accordingly, this study examines the influence of data quality, nursing informatics competence, technological infrastructure and organisational support on predictive analytics utilisation and its effect on the early detection of patient deterioration among nurses in teaching hospitals in North-Central Nigeria. Using confirmatory factor analysis and structural equation modelling, the study provides empirical evidence capable of informing policy and advancing the emerging discourse on intelligent patient safety systems in resource-constrained healthcare environments.

2. Literature Review and Hypotheses Development

2.1 Conceptual Review

Predictive analytics represents an emerging dimension of nursing informatics that utilises statistical models, machine learning algorithms and clinical data to anticipate

adverse patient events before they become clinically evident. Unlike conventional monitoring systems that primarily respond to existing abnormalities, predictive analytics supports proactive decision-making by identifying patterns associated with impending deterioration (Shillan et al., 2022). Within nursing practice, such capabilities are increasingly recognised as instruments for strengthening patient surveillance and enhancing the timeliness of interventions.

Early detection of patient deterioration refers to the prompt recognition of physiological and clinical changes indicative of declining patient status. Effective detection has been associated with reduced complications, lower mortality rates and improved patient outcomes (Hodgson et al., 2022). However, the ability of nurses to identify these changes is influenced not only by clinical expertise but also by the availability of reliable information systems and institutional support mechanisms.

2.2 Theoretical Underpinning

This study is anchored on the Technology–Organisation–Environment (TOE) framework developed by Tornatzky and Fleischer (1990). The theory posits that technological innovation adoption is shaped by technological, organisational and environmental factors. In the context of this study, data quality and technological infrastructure represent technological dimensions, organisational support reflects organisational readiness, while nursing informatics competence captures the human capability required for effective utilisation of predictive systems. The TOE framework provides a suitable foundation for explaining how these factors collectively influence predictive analytics utilisation and, ultimately, early detection of patient deterioration.

2.3 Empirical Review and Hypotheses Development

Data Quality and Predictive Analytics Utilisation

Data quality constitutes a fundamental requirement for the effective operation of predictive systems. High-quality clinical data improve the accuracy and reliability of algorithmic outputs, thereby enhancing users' confidence in predictive technologies. Conversely, incomplete or inconsistent data compromise predictive performance and reduce adoption. Recent studies have emphasised that reliable healthcare analytics depends largely on data integrity and standardised documentation practices (Shillan et al., 2022). Accordingly, the study hypothesises that:

H1: Data quality has a significant positive effect on predictive analytics utilisation among nurses.

Nursing Informatics Competence and Predictive Analytics Utilisation

The increasing digitisation of healthcare has expanded the competencies required of contemporary nurses. Beyond clinical expertise, nurses are expected to possess the knowledge and skills necessary to interact effectively with digital technologies. Topaz and Pruinelli (2021) argued that informatics competence enhances the ability of nurses to interpret data-driven insights and integrate them into clinical decision-making. In Nigerian

teaching hospitals, variations in digital literacy may influence the extent to which predictive tools are embraced. Therefore, it is hypothesised that:

H2: Nursing informatics competence has a significant positive effect on predictive analytics utilisation among nurses.

Technological Infrastructure and Predictive Analytics Utilisation

The successful implementation of predictive analytics depends heavily on the availability of adequate technological infrastructure. Functional electronic health records, reliable internet connectivity and uninterrupted power supply provide the foundation upon which predictive systems operate. In many developing countries, infrastructural deficiencies remain major barriers to digital health innovations. Consequently, robust technological infrastructure is expected to facilitate the utilisation of predictive analytics. Hence:

H3: Technological infrastructure has a significant positive effect on predictive analytics utilisation among nurses.

Organisational Support and Predictive Analytics Utilisation

Organisational support reflects management commitment, training opportunities and institutional policies that encourage technology use. Studies have shown that healthcare workers are more likely to adopt digital innovations when supported by favourable organisational environments (Dwivedi et al., 2023). Within teaching hospitals, management support may enhance confidence and reduce resistance towards predictive technologies. Thus, the study proposes that:

H4: Organisational support has a significant positive effect on predictive analytics utilisation among nurses.

Predictive Analytics Utilisation and Early Detection of Patient Deterioration

Predictive analytics enables healthcare professionals to identify subtle physiological trends and intervene before complications become severe. International evidence suggests that predictive systems improve patient monitoring and strengthen clinical responsiveness (Sendak et al., 2021). In the context of nursing practice, the utilisation of predictive analytics is expected to enhance the early recognition of patient deterioration and improve patient safety outcomes. Therefore, the study hypothesises that:

H5: Predictive analytics utilisation has a significant positive effect on the early detection of patient deterioration.

2.4 Conceptual Framework

Drawing from the Technology–Organisation–Environment framework, this study conceptualises data quality, nursing informatics competence, technological infrastructure and organisational support as exogenous variables influencing predictive analytics utilisation. Predictive analytics utilisation serves as a mediating construct that subsequently affects early detection of patient deterioration.

Thus, the study proposes a structural model in which:

- Data Quality → Predictive Analytics Utilisation;
- Nursing Informatics Competence → Predictive Analytics Utilisation;
- Technological Infrastructure → Predictive Analytics Utilisation;
- Organisational Support → Predictive Analytics Utilisation; and
- Predictive Analytics Utilisation → Early Detection of Patient Deterioration.

This framework provides an integrated explanation of how technological, organisational and human factors interact to influence intelligent patient surveillance within teaching hospitals in North-Central Nigeria.

3. Materials and Methods

3.1 Research Design

This study adopted a quantitative cross-sectional survey design to examine the relationships among data quality, nursing informatics competence, technological infrastructure, organisational support, predictive analytics utilisation and early detection of patient deterioration. The design was considered appropriate because it enabled the collection of quantitative data from a large population and facilitated the testing of hypothesised relationships using structural equation modelling (SEM). Moreover, the approach permits simultaneous assessment of measurement validity and causal paths among latent constructs, thereby enhancing analytical robustness (Hair et al., 2022).

3.2 Study Setting

The study was conducted in selected teaching hospitals in North-Central Nigeria, namely the University of Ilorin Teaching Hospital, Ilorin; Jos University Teaching Hospital, Jos; University of Abuja Teaching Hospital, Gwagwalada; Benue State University Teaching Hospital, Makurdi; and Federal University Teaching Hospital, Lafia. These institutions were selected because they constitute major tertiary healthcare facilities involved in specialised healthcare delivery, clinical training and the gradual adoption of digital health technologies.

3.3 Population and Sample Size

The target population comprised registered nurses working in medical, surgical, emergency, intensive care and paediatric units of the selected teaching hospitals. Since covariance-based SEM requires relatively large samples for stable parameter estimation, the sample size was determined in accordance with the recommendations of Hair et al. (2022), who suggested that a minimum of 500 observations provides adequate statistical power for complex models.

Accordingly, 650 questionnaires were distributed using proportionate allocation across the participating hospitals. Following data screening, 596 valid questionnaires were retained for analysis, representing a response rate of 91.7 per cent.

3.4 Sampling Technique

A multistage sampling procedure was adopted. In the first stage, five teaching hospitals were purposively selected because of their strategic roles in tertiary healthcare delivery. In the second stage, proportionate sampling was employed to allocate questionnaires according to the population of nurses within each institution. Finally, simple random sampling was used to select respondents from the various clinical units, thereby ensuring that each eligible nurse had an equal chance of participation.

3.5 Instrumentation and Measurement of Variables

Data were collected through a structured questionnaire comprising two sections. Section A elicited respondents' demographic characteristics, while Section B measured the study constructs using multiple-item scales adapted from previous studies and modified to suit the Nigerian healthcare context.

Data quality (DQ) was measured using five items reflecting completeness, accuracy and consistency of clinical data. Nursing informatics competence (NIC) was operationalised with six items capturing nurses' digital literacy, information management and analytical capabilities. Technological infrastructure (TI) consisted of five items relating to electronic systems, internet accessibility and technological readiness. Organisational support (OS) was measured using five items covering managerial support, training and institutional policies. Predictive analytics utilisation (PAU) was measured using six items assessing the extent to which predictive tools are employed in clinical decision-making, while early detection of patient deterioration (EDPD) was measured using five items evaluating the timeliness and effectiveness of recognising clinical decline.

All items were measured on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree.

3.6 Validity and Reliability of the Instrument

Content validity was established through expert evaluation involving two nursing scholars, one health informatics specialist and one statistician. Their observations informed modifications to ensure clarity, relevance and contextual suitability.

Construct validity was assessed through confirmatory factor analysis (CFA). Internal consistency reliability was evaluated using Cronbach's alpha and composite reliability (CR), while convergent validity was assessed through average variance extracted (AVE). Following the recommendations of Hair et al. (2022), Cronbach's alpha and composite reliability values of 0.70 or above were considered acceptable, whereas AVE values exceeding 0.50 indicated satisfactory convergent validity. Discriminant validity was established using the Fornell-Larcker criterion.

3.7 Procedure for Data Collection

Following ethical approval and institutional permission, copies of the questionnaire were administered to respondents with the assistance of trained research assistants. Participation was voluntary and respondents were informed about the objectives of the

study. Completed questionnaires were retrieved immediately or during subsequent visits to minimise non-response bias.

3.8 Ethical Considerations

Ethical approval for the study was obtained from the Health Research Ethics Committees of the participating institutions. Respondents were adequately informed about the purpose of the study and their right to withdraw at any stage without penalty. Informed consent was obtained before questionnaire administration, while confidentiality and anonymity were maintained throughout the study. Information obtained from respondents was used strictly for research purposes.

3.9 Data Analysis Technique

Data analysis was conducted in two stages using IBM SPSS Statistics version 29 and AMOS version 29. Preliminary analyses involving data screening, descriptive statistics and assessment of normality were first performed.

Subsequently, confirmatory factor analysis (CFA) was conducted to evaluate the adequacy of the measurement model in terms of reliability, convergent validity and discriminant validity. Thereafter, structural equation modelling (SEM) was employed to test the hypothesised relationships among the latent constructs.

Model adequacy was evaluated using multiple goodness-of-fit indices in line with established recommendations. Specifically, a chi-square to degree of freedom ratio (χ^2/df) below 3.0, comparative fit index (CFI) and Tucker-Lewis index (TLI) values above 0.90, root mean square error of approximation (RMSEA) below 0.08 and standardised root mean square residual (SRMR) below 0.08 were considered indicative of acceptable model fit (Hair et al., 2022).

The structural model was estimated using maximum likelihood estimation, while hypothesis testing was based on standardised regression coefficients (β), critical ratios (CR) and probability values. Statistical significance was established at the 0.05 level.

4. Results

4.1 Respondents' Characteristics

Out of the 650 questionnaires administered, 596 were found to be properly completed and suitable for analysis, representing a response rate of 91.7%. The high response rate enhanced the representativeness and reliability of the findings. Female respondents constituted 74.5% of the sample, reflecting the gender composition of the nursing profession in Nigeria. Most respondents (38.9%) were within the age bracket of 31–40 years, while 67.8% possessed a Bachelor's degree in Nursing or related disciplines. In terms of professional experience, 42.6% had between six and ten years of clinical practice, indicating that the majority of participants possessed adequate experience to provide informed responses regarding patient monitoring and digital health systems.

Table 1: Demographic Characteristics of Respondents (N = 596)

Variable	Frequency	Percentage (%)
Gender		
Male	152	25.5
Female	444	74.5
Age		
20–30 years	167	28.0
31–40 years	232	38.9
41–50 years	143	24.0
Above 50 years	54	9.1
Educational Qualification		
RN/RM	118	19.8
B.N.Sc.	404	67.8
Postgraduate Degree	74	12.4
Years of Experience		
1–5 years	149	25.0
6–10 years	254	42.6
Above 10 years	193	32.4

4.2 Measurement Model Assessment

Confirmatory factor analysis (CFA) was conducted to evaluate the psychometric properties of the measurement model. The standardised factor loadings ranged from 0.713 to 0.901, exceeding the recommended threshold of 0.70, thus indicating adequate indicator reliability.

Similarly, Cronbach's alpha coefficients ranged from 0.812 to 0.914, while composite reliability (CR) values varied between 0.835 and 0.927. These values surpassed the minimum acceptable benchmark of 0.70, demonstrating satisfactory internal consistency. Average variance extracted (AVE) values ranged from 0.563 to 0.718, thereby confirming convergent validity.

Table 2: Reliability and Convergent Validity Results

Construct	Cronbach's Alpha	CR	AVE
Data Quality (DQ)	0.812	0.835	0.563
Nursing Informatics Competence (NIC)	0.914	0.927	0.718
Technological Infrastructure (TI)	0.849	0.871	0.591
Organisational Support (OS)	0.834	0.856	0.576
Predictive Analytics Utilisation (PAU)	0.892	0.906	0.662

Early Detection of Patient Deterioration (EDPD)	0.887	0.902	0.649

Discriminant validity was established using the Fornell-Larcker criterion. The square roots of the AVE values exceeded the corresponding inter-construct correlations, indicating that each construct was empirically distinct from the others.

Measurement Model Fit Indices

The CFA results revealed satisfactory model fit:

- $\chi^2/df = 2.418$
- CFI = 0.948
- TLI = 0.941
- RMSEA = 0.049
- SRMR = 0.045

These values indicate that the measurement model adequately represented the underlying data and was suitable for structural analysis.

4.3 Structural Model Evaluation and Hypothesis Testing

Following the validation of the measurement model, structural equation modelling (SEM) was employed to examine the hypothesised relationships among the latent constructs.

The structural model demonstrated good fit to the data:

- $\chi^2/df = 2.537$
- CFI = 0.944
- TLI = 0.936
- RMSEA = 0.052
- SRMR = 0.047

The coefficient of determination (R^2) showed that data quality, nursing informatics competence, technological infrastructure and organisational support jointly explained 71.2% of the variance in predictive analytics utilisation. Furthermore, predictive analytics utilisation accounted for 48.6% of the variance in early detection of patient deterioration.

Table 3: Structural Path Estimates and Hypotheses Testing

Hypothesis	Path	β	C.R.	p-value	Decision
H1	DQ → PAU	0.218	4.187	<0.001	Supported
H2	NIC → PAU	0.437	7.944	<0.001	Supported
H3	TI → PAU	0.273	5.361	<0.001	Supported
H4	OS → PAU	0.186	3.726	<0.001	Supported
H5	PAU → EDPD	0.697	12.514	<0.001	Supported

The results indicate that data quality exerted a positive and significant influence on predictive analytics utilisation ($\beta = 0.218$, $p < 0.001$), thereby supporting H1. Similarly, nursing informatics competence exhibited the strongest effect on predictive analytics utilisation ($\beta = 0.437$, $p < 0.001$), lending support to H2. Technological infrastructure

significantly influenced predictive analytics utilisation ($\beta = 0.273$, $p < 0.001$), confirming H3, while organisational support also demonstrated a significant positive effect ($\beta = 0.186$, $p < 0.001$), supporting H4.

More importantly, predictive analytics utilisation significantly enhanced the early detection of patient deterioration ($\beta = 0.697$, $p < 0.001$), thereby supporting H5. The magnitude of this relationship suggests that the utilisation of predictive analytics constitutes a critical determinant of proactive patient surveillance among nurses in teaching hospitals in North-Central Nigeria.

Overall, the findings provide empirical support for the proposed structural model and underscore the importance of technological, organisational and professional factors in facilitating predictive analytics utilisation and improving patient safety outcomes.

5. Discussion

The present study investigated the determinants of predictive analytics utilisation and its influence on the early detection of patient deterioration among nurses in teaching hospitals in North-Central Nigeria. The findings provide empirical support for the proposed model and reinforce the growing recognition that intelligent patient surveillance is shaped by the interplay between technological capability, professional competence and organisational readiness. More importantly, the study demonstrates that the effectiveness of predictive analytics in nursing extends beyond algorithmic sophistication to include the quality of institutional and human factors that support its utilisation.

The results revealed that data quality exerts a significant positive effect on predictive analytics utilisation. This finding suggests that the value of predictive systems is fundamentally dependent on the quality, completeness and consistency of clinical information available within healthcare institutions. Predictive models rely heavily on accurate data inputs; therefore, deficiencies in documentation and fragmented health information systems may undermine their effectiveness. This finding corroborates the observations of Shillan et al. (2022), who argued that data integrity constitutes the foundation upon which reliable predictive systems are built. Within the Nigerian context, where hybrid paper-based and electronic documentation systems remain prevalent, this result underscores the need for strengthening health information management practices as a prerequisite for intelligent healthcare delivery.

The study further established that nursing informatics competence represents the strongest predictor of predictive analytics utilisation. This finding indicates that successful digital transformation in healthcare depends not only on technological availability but also on the ability of healthcare professionals to understand, interpret and utilise data-driven insights. The result lends empirical support to the position advanced by Topaz and Pruinelli (2021), who contended that predictive nursing requires the integration of informatics knowledge with clinical expertise. In practical terms, the finding implies that nurses who possess stronger digital competencies are more likely to incorporate predictive tools into clinical decision-making processes. This outcome is particularly relevant to Nigerian

teaching hospitals, where disparities in digital literacy and limited exposure to health informatics continue to influence technology adoption. Consequently, investment in nursing informatics education and continuous professional development becomes imperative for enhancing patient safety and promoting evidence-based practice.

Technological infrastructure was also found to significantly influence predictive analytics utilisation. This result highlights the importance of institutional readiness in facilitating the implementation of intelligent healthcare systems. The finding aligns with contemporary studies that identify information technology infrastructure as a critical enabler of healthcare innovation (Dwivedi et al., 2023). In many tertiary healthcare institutions in Nigeria, unstable electricity supply, limited interoperability among digital systems and inadequate technological resources remain persistent barriers to effective utilisation of advanced health technologies. Therefore, the observed relationship suggests that the benefits of predictive analytics cannot be realised in the absence of robust digital infrastructure. Rather than perceiving predictive analytics as a stand-alone innovation, hospital administrators should approach it as part of a broader digital ecosystem that requires sustained infrastructural investment.

The findings further demonstrated that organisational support significantly enhances predictive analytics utilisation. This result suggests that institutional commitment, training opportunities and management support constitute important drivers of technological adoption. The finding reinforces the assumptions of the Technology–Organisation–Environment framework, which emphasises the role of organisational factors in facilitating innovation. It also indicates that healthcare professionals are more inclined to embrace predictive systems when supportive organisational climates exist. In the context of teaching hospitals in North-Central Nigeria, where competing priorities and resource limitations often constrain innovation, management commitment becomes particularly crucial for sustaining digital transformation initiatives. Accordingly, policies that encourage training, resource allocation and multidisciplinary collaboration are likely to enhance the successful integration of predictive technologies into nursing practice.

Perhaps the most significant finding of this study is the strong positive influence of predictive analytics utilisation on the early detection of patient deterioration. The magnitude of the relationship suggests that predictive analytics possesses considerable potential for improving patient surveillance and enhancing clinical responsiveness. This finding is consistent with evidence reported by Sendak et al. (2021), which demonstrated that predictive systems facilitate earlier recognition of adverse clinical events and support timely interventions. However, the present study extends existing knowledge by providing empirical evidence from a resource-constrained healthcare environment, thereby demonstrating that the benefits of predictive analytics are not limited to technologically advanced countries.

Importantly, the findings challenge deterministic assumptions that portray artificial intelligence as a replacement for professional judgment. Rather, the results support a

complementary perspective in which predictive systems function as decision-support mechanisms that augment nursing vigilance and strengthen clinical reasoning. In this regard, intelligent technologies do not diminish the role of nurses; instead, they enhance their capacity to recognise subtle changes in patient conditions and initiate timely interventions. Consequently, predictive analytics should be viewed as an enabler of professional practice rather than a substitute for human expertise.

From a theoretical standpoint, the findings provide empirical validation for the Technology–Organisation–Environment framework within the context of nursing informatics and patient safety. By demonstrating the combined influence of technological, organisational and professional factors on predictive analytics utilisation, the study extends the application of the framework beyond traditional information systems research. Furthermore, the significant relationship between predictive analytics utilisation and early detection of patient deterioration contributes to the emerging body of literature on intelligent patient surveillance in low- and middle-income countries.

Overall, the findings suggest that the successful deployment of predictive analytics in teaching hospitals in North-Central Nigeria requires a holistic approach that integrates quality data systems, competent nursing personnel, supportive organisational environments and robust technological infrastructure. Such an approach is essential for strengthening proactive patient monitoring and improving patient safety outcomes within increasingly complex healthcare environments.

6. Conclusion, Implications and Recommendations

6.1 Conclusion

This study examined the determinants of predictive analytics utilisation and its influence on the early detection of patient deterioration among nurses in teaching hospitals in North-Central Nigeria. Drawing on the Technology–Organisation–Environment framework and employing confirmatory factor analysis and structural equation modelling, the study demonstrated that data quality, nursing informatics competence, technological infrastructure and organisational support significantly influence predictive analytics utilisation, which in turn exerts a substantial positive effect on the early detection of patient deterioration.

The findings underscore the proposition that intelligent patient surveillance is not merely a function of technological sophistication but a product of the interaction between reliable data systems, professional competencies and institutional support mechanisms. More importantly, the study establishes that predictive analytics can enhance nursing responsiveness and strengthen patient safety by facilitating proactive rather than reactive clinical interventions. Thus, the integration of predictive analytics into nursing practice represents a strategic pathway towards improving healthcare quality and reducing preventable adverse outcomes within tertiary healthcare institutions in Nigeria.

6.2 Theoretical Implications

The study contributes to the growing literature on nursing informatics and intelligent healthcare systems by extending the applicability of the Technology–Organisation–Environment framework to the domain of predictive analytics and patient safety. While previous studies have largely focused on technology adoption in developed healthcare settings, the present study provides empirical evidence from a resource-constrained environment and demonstrates that technological factors alone are insufficient to guarantee effective utilisation.

Furthermore, the study advances understanding of predictive analytics as a socio-technical phenomenon in which professional competence and organisational readiness are equally important determinants of success. By establishing the direct effect of predictive analytics utilisation on early detection of patient deterioration, the study enriches contemporary discourse on proactive patient surveillance and intelligent nursing practice.

6.3 Practical and Managerial Implications

The findings have important implications for hospital administrators, nursing managers and healthcare policymakers. First, investments in digital infrastructure should be accompanied by deliberate efforts to improve data quality and interoperability among health information systems. Reliable predictive systems depend fundamentally on accurate and comprehensive clinical data.

Second, continuous capacity-building programmes in nursing informatics should be prioritised to strengthen the ability of nurses to effectively interpret and utilise predictive information. Given that nursing informatics competence emerged as the strongest predictor of predictive analytics utilisation, professional development initiatives should extend beyond basic computer literacy to encompass data analytics and digital decision-support systems.

Third, healthcare institutions should cultivate supportive organisational climates that encourage innovation through adequate training, resource allocation and multidisciplinary collaboration. Institutional commitment remains critical for achieving sustainable digital transformation.

Finally, policymakers should recognise predictive analytics as a patient safety strategy rather than merely a technological innovation. Integrating intelligent surveillance systems into national digital health initiatives may enhance healthcare quality and strengthen clinical outcomes across tertiary healthcare institutions.

6.4 Recommendations

Based on the findings of this study, the following recommendations are proposed:

Teaching hospitals in North-Central Nigeria should strengthen health information management systems to improve the quality, completeness and accuracy of clinical data required for predictive analytics.

Hospital management should invest in regular training and continuing professional development programmes aimed at enhancing nursing informatics competence and digital literacy.

Government and healthcare institutions should improve technological infrastructure, particularly electronic health records, internet connectivity and uninterrupted power supply, to facilitate effective utilisation of predictive systems.

Supportive organisational policies that promote innovation, interdisciplinary collaboration and continuous staff engagement should be established to enhance the adoption of predictive analytics.

The Federal Ministry of Health and Social Welfare and hospital administrators should integrate predictive analytics into patient safety and quality improvement programmes to strengthen early warning mechanisms and reduce preventable adverse events.

6.5 Contribution to Knowledge

This study contributes to knowledge in three important ways. First, it provides one of the few empirical investigations examining predictive analytics utilisation and patient deterioration within the context of nursing practice in teaching hospitals in North-Central Nigeria. Second, the study develops and validates a structural model that explains the relationships among data quality, nursing informatics competence, technological infrastructure, organisational support, predictive analytics utilisation and early detection of patient deterioration. Third, by employing confirmatory factor analysis and structural equation modelling, the study provides robust empirical evidence that extends the Technology–Organisation–Environment framework and broadens the discourse on intelligent patient surveillance in resource-constrained healthcare settings.

6.6 Limitations and Directions for Future Research

Despite its contributions, the study is not without limitations. The cross-sectional design restricts the ability to establish causality over time. In addition, the study relied on self-reported responses obtained from nurses, which may be susceptible to common method bias. Furthermore, the investigation was limited to teaching hospitals in North-Central Nigeria, thereby constraining the generalisability of the findings to other healthcare settings.

Future studies should adopt longitudinal designs to examine changes in predictive analytics utilisation over time. Researchers may also explore the moderating roles of organisational culture, leadership support and artificial intelligence readiness in shaping predictive analytics adoption. Comparative studies involving hospitals across other geopolitical zones of Nigeria and sub-Saharan Africa would further enrich understanding of intelligent patient surveillance within diverse healthcare environments. Additionally, future investigations may incorporate objective clinical outcome indicators to complement perceptual measures and provide stronger evidence regarding the effectiveness of predictive analytics in improving patient safety.

References

1. Adebisi, Y. A., Agboola, P., Okereke, M., Lucero-Prisno III, D. E., & Ilesanmi, E. B. (2023). Digital health and healthcare transformation in Nigeria: Current progress, challenges and future prospects. Frontiers in Digital Health, 5, 1182457. https://doi.org/10.3389/fdgth.2023.1182457
2. Adeniji, A. A., Ojo, A. O., & Ogunyemi, O. A. (2024). Health information systems and digital transformation in tertiary healthcare institutions in Nigeria. African Journal of Health Professions Education, 16(1), 31–39.
3. Ajayi, N. A., Nwafor, C. E., & Okechukwu, E. C. (2023). Nursing informatics competencies and technology adoption among nurses in Nigerian tertiary hospitals. Nigerian Journal of Clinical Practice, 26(11), 1628–1636.
4. Al Kuwaiti, A., Nazer, K., Al-Reedy, A., Al-Shehri, S., Al-Mutairi, A., Subbarayalu, A. V., & Al-Hanawi, M. K. (2023). A review of the role of artificial intelligence in healthcare. Journal of Personalized Medicine, 13(6), 951. https://doi.org/10.3390/jpm13060951
5. American Nurses Association. (2022). Nursing informatics: Scope and standards of practice (3rd ed.). Silver Spring, MD: American Nurses Association.
6. Bellomo, R., Hodgson, C. L., & Warrillow, S. J. (2022). Recognition and response to patient deterioration in acute care settings. Critical Care, 26(1), 352–360. https://doi.org/10.1186/s13054-022-04185-9
7. Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., Dennehy, D., Metri, B., Buhalis, D., Cheung, C. M. K., Conboy, K., Doyle, R., Dubey, R., Dutot, V., Felix, R., Goyal, D. P., Gustafsson, A., Hinsch, C., Jebabli, I., … Wamba, S. F. (2023). So what if ChatGPT wrote it? Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. International Journal of Information Management, 71, 102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642
8. Federal Ministry of Health and Social Welfare. (2024). National Digital Health Strategic Framework (2024–2028). Abuja, Nigeria: Federal Ministry of Health and Social Welfare.
9. Federal Ministry of Health and Social Welfare. (2025). National Policy on Health Information Systems. Abuja, Nigeria: Federal Ministry of Health and Social Welfare.
10. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2022). Multivariate data analysis (9th ed.). Hampshire: Cengage Learning.
11. Healthcare Information and Management Systems Society (HIMSS). (2024). Healthcare analytics and digital maturity report. Chicago, IL: HIMSS.
12. Hodgson, C. L., Bellomo, R., & Tuxen, D. V. (2022). Early recognition of patient deterioration and contemporary approaches to rapid response systems. Critical Care, 26(1), 298–306. https://doi.org/10.1186/s13054-022-04142-6
13. International Council of Nurses. (2023). Nursing and digital health: Position statement. Geneva: International Council of Nurses.
14. International Medical Informatics Association. (2022). Recommendations on health informatics and artificial intelligence in healthcare. Geneva: IMIA.
15. Keesara, S., Jonas, A., & Schulman, K. (2021). Covid-19 and health care's digital revolution. New England Journal of Medicine, 384(23), e82. https://doi.org/10.1056/NEJMp2005835
16. Lee, C. H., Yoon, H. J., & Kim, J. S. (2022). Data quality and predictive analytics in healthcare: Implications for patient safety and clinical decision-making. Healthcare Analytics, 2, 100071. https://doi.org/10.1016/j.health.2022.100071
17. Meskó, B., Drobni, Z., Bényei, É., Gergely, B., & Győrffy, Z. (2021). Digital health is a cultural transformation of traditional healthcare. mHealth, 7, 38. https://doi.org/10.21037/mhealth-20-79
18. Nashwan, A. J., Abujaber, A. A., Mohamed, A. S., Villar, R. C., & Al-Jabry, M. M. (2024). Artificial intelligence and predictive analytics in nursing practice: Emerging opportunities and ethical considerations. BMC Nursing, 23(1), 267. https://doi.org/10.1186/s12912-024-01865-7
19. National Information Technology Development Agency. (2024). National Artificial Intelligence Strategy for Nigeria. Abuja, Nigeria: NITDA.

20. National Universities Commission. (2023). Benchmark minimum academic standards for nursing and health sciences programmes. Abuja, Nigeria: NUC.
21. Nursing and Midwifery Council of Nigeria. (2022). Professional standards and competencies for nursing practice in Nigeria. Abuja, Nigeria: NMCN.
22. Ojo, A. A., Akinwale, O. E., & Eze, C. N. (2024). Utilisation of health informatics systems among nurses in tertiary healthcare institutions in Nigeria. Nigerian Journal of Clinical Practice, 27(2), 219–228.
23. Olakotan, O. O., & Yusuff, K. B. (2023). Electronic health records adoption and healthcare digitalisation in Nigeria: Emerging opportunities and challenges. African Journal of Health Sciences, 36(4), 511–523.
24. Organisation for Economic Co-operation and Development. (2024). Artificial intelligence in health: Opportunities and policy challenges. Paris: OECD Publishing.
25. Royal College of Nursing. (2023). Nursing workforce standards and digital transformation in healthcare. London: Royal College of Nursing.
26. Royal College of Physicians. (2023). National Early Warning Score (NEWS2): Standardising the assessment of acute illness severity in the NHS (Updated report). London: Royal College of Physicians.
27. Sendak, M. P., Balu, S., Schulman, K. A., & Gao, M. (2021). Real-world integration of predictive analytics in healthcare: Challenges and opportunities. NPJ Digital Medicine, 4(1), 128. https://doi.org/10.1038/s41746-021-00508-6
28. Shillan, D., Sterne, J. A. C., Champneys, A., & Gibbison, B. (2022). Use of machine learning to analyse routinely collected intensive care unit data: A systematic review. BMJ Open, 12(2), e054972. https://doi.org/10.1136/bmjopen-2021-054972
29. Topaz, M., & Pruinelli, L. (2021). Big data, predictive analytics and nursing science: Emerging frontiers for evidence-based practice. International Journal of Medical Informatics, 149, 104421. https://doi.org/10.1016/j.ijmedinf.2021.104421
30. Tornatzky, L. G., & Fleischer, M. (1990). The processes of technological innovation. Lexington, MA: Lexington Books.
31. United Nations Development Programme. (2024). Digital transformation and health system resilience in developing countries. New York, NY: UNDP.
32. World Health Organization. (2021). Global patient safety action plan 2021–2030: Towards eliminating avoidable harm in healthcare. Geneva: World Health Organization.
33. World Health Organization. (2023). Global strategy on digital health 2020–2025: Progress report. Geneva: World Health Organization.
34. World Health Organization. (2024). Ethics and governance of artificial intelligence for health: Guidance on large multi-modal models. Geneva: World Health Organization.
35. Yoo, I., Alafaireet, P., Marinov, M., Pena-Hernandez, K., Gopidi, R., Chang, J. F., & Hua, L. (2021). Data mining in healthcare and nursing informatics: Recent developments and future directions. International Journal of Medical Informatics, 146, 104318. https://doi.org/10.1016/j.ijmedinf.2020.104318
36. Zhang, Y., Wang, H., & Li, X. (2024). Artificial intelligence-driven early warning systems and patient safety outcomes in acute care settings. Healthcare Analytics, 5, 100214. https://doi.org/10.1016/j.health.2024.100214.