Development of a web-app using AI for staging and risk prediction of pressure injuries

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Dedication / Acknowledgements

I would like to express my sincere gratitude to my supervisors, Professor Panagiotis Bamidis and Dr. Antonis Billis for their support for the development of this thesis.

I would also like to thank the members of the examination committee for their thoughtful evaluation.

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I dedicate this work to the memory of my beloved mother, Georgia, whose strength, values, and unwavering love continue to inspire me every day.

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Abstract

Introduction: Despite the existence of international guidelines, pressure injury (PI) staging and risk prediction remain a complex and subjective process in clinical practice. Variability staging accuracy, documentation gaps and organizational barriers indicate the need for a digital solution. Artificial intelligence (AI) has demonstrated promising diagnostic performance in PI assessment. However, healthcare professionals' acceptance and workflow integration affect the successful implementation.

Aim: The aim of this study was to explore nurses' experiences, perceived challenges and expectations regarding PI staging and risk assessment, in order to inform the development of an AI-assisted web application for staging and risk prediction.

Methodology: A qualitative study was conducted using semi-structured, face-to-face interviews with 12 nurses working in diverse settings, and data were analysed using thematic analysis. The Technology Acceptance Model was used as the theoretical framework of this study.

Results: The study highlighted 7 main themes: clinical complexity and organizational barriers in pressure injury staging, documentation and communication gaps, improvements, requirements, expectations, trust and AI acceptance and workflow integration. The determinants of intention to use which were expressed by the participants were conditional acceptance of AI, emphasizing perceived usefulness, ease of use, transparency, data security, and preservation of clinical authority.

Conclusion: According to the findings, such tools should prioritize usability, workflow compatibility, ethical safeguards, and support of clinical judgment. The user-centered design may enhance adoption and contribute to improved staging accuracy, documentation quality, and patient care.

Keywords: pressure injuries; artificial intelligence; nursing practice; technology acceptance model; digital health

JEL Classifications:

I100 Health: General

I190 Health: Other

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Introduction

The first terminology to appear for such injuries dates back to 1777, when Wohlleben used the term "decubitus", which was initially described as "gangraena per decubitum", meaning "dead tissue due to bedsores". At the same time, the terms "decubitus ulcers" and "ischemic ulcers" appeared, which, however, were not so precise. In 1859, Florence Nightingale used the term "bedsore", which became more popular in 1975, when the book "Bedsore Biomechanics" was published after a conference on the etiology of pressure ulcers in Glasgow. However, this term indicates the association of the injury with the bed, while injuries can be caused whenever soft tissues come into contact with supporting surfaces in combination with shear forces. Thus, in 1980 the term "pressure sore" appeared and in 1990 the term "pressure ulcer" became more widespread, which is still used today in Europe. Considering that the term "ulcer" refers to a superficial wound, this is not satisfactory either. The United States, Southeast Asia, Australia and New Zealand use the term "pressure injuries", according to the proposal of the US National Pressure Injury Advisory Panel, which we will use in this thesis. Finally, it is worth noting that the terminology remains a subject of ongoing debate (EPUAP, NPIAP & PPPIA, 2019).

In the latest version of the Mortality and Morbidity Statistics provided by the WHO (ICD-11), the official term is "EH90 Pressure ulceration" including pressure injury, pressure ulcer, and bedsore (EPUAP, NPIAP & PPPIA, 2025).

Pressure injuries are localized lesions of the skin and/or underlying tissue caused by pressure or a combination of pressure and shear. They usually occur over bony prominences such as the coccyx, heels, hips, or sacrum, and may be associated with the use of medical devices or other objects. Lesions may appear as either intact skin or an open ulcer and often cause significant pain to patients (EPUAP, NPIAP & PPPIA, 2019).

According to the International Guidelines of the European Pressure Ulcer Advisory Panel, the National Pressure Injury Advisory Panel and the Pan Pacific Pressure Injury Alliance (2019), the development of pressure and/or shear causes mechanical deformation and tissue ischemia, resulting in destruction of cellular structures, inflammation, edema, and tissue necrosis. The pathophysiology involves the combined effects of tissue strain, vascular dysfunction, and impaired removal of metabolic waste products.

The global epidemiology of pressure injuries varies considerably depending on the care setting. As highlighted by the guidelines, the prevalence ranges from 0% to 72.5% in different health systems and countries.

Pressure injuries have a serious impact on the quality of life of patients and their caregivers. Pain, reduced autonomy, depression, anxiety and social isolation are some of the most frequently reported problems. Patients often report pain as the most unpleasant aspect of their condition. At the same time, pressure injuries are associated with increased morbidity and mortality, longer hospital stays, higher readmission rates and a significant economic burden on health systems (EPUAP, NPIAP & PPPIA, 2019).

The economic cost of managing pressure injuries is particularly high worldwide. In the United States, the annual cost is $11.6 billion, while the cost per case ranges from $500 to $152,000, depending on the severity of the injury. Similar economic burdens are, also, recorded in other countries (EPUAP, NPIAP & PPPIA, 2019).

Staging of pressure injuries is a key tool in clinical practice, guiding the assessment and treatment strategy.

However, the staging process can present challenges, such as difficulty in recognizing early lesions, especially in individuals with dark skin, and variation in the accuracy of assessment by different healthcare professionals (EPUAP, NPIAP & PPPIA, 2019).

Predicting the risk of developing pressure injuries is fundamental to prevention. Key risk categories include limited mobility, reduced sensation, inadequate blood flow and oxygenation, nutritional status, skin moisture, and age and general health status.

The use of risk assessment tools, such as the Braden, Norton, and Waterlow scales, is widespread in clinical practice. However, these tools have limitations in terms of sensitivity and specificity and require combination with clinical judgment by healthcare professionals. Furthermore, continuous reassessment of risk is necessary as patients' conditions change (EPUAP, NPIAP & PPPIA, 2019).

Despite the existence of international clinical practice guidelines and validated risk assessment tools, pressure injury staging and risk prediction remain complex and partially subjective processes in everyday clinical practice. Variability in assessment accuracy, time constraints, and limitations of traditional risk scales highlight the need for supportive digital solutions. In recent years, artificial intelligence–based clinical decision support systems have emerged as promising tools to enhance diagnostic accuracy and standardization. However, the successful development of such tools requires a thorough understanding of the needs, expectations, and concerns of frontline nursing professionals.

Generative AI tools were used only for language polishing and all AI-assisted outputs were reviewed, edited, and finalized by the author, who remains fully responsible for the accuracy of the final wording of the thesis.

Chapter 1: Bibliographic Review

Clinical Challenges in Pressure Injury Staging

Evidence on inter-rater reliability in pressure injury staging indicates substantial variability across clinical contexts. Studies based on digital photographic assessment have reported only fair to moderate agreement among assessors, with kappa coefficients ranging from 0.39 to 0.58, suggesting meaningful inconsistencies in stage classification (Jesada et al., 2013). In contrast, controlled clinical trials such as the PRESSURE Trial have demonstrated very high levels of agreement among trained clinical research nurses, with agreement percentages ranging from 93.6% to 100% (Nixon et al., 2005). These findings suggest that staging reliability is highly dependent on contextual factors, including rater training, clinical setting, and assessment modality.

Misclassification errors in pressure injury staging represent a substantial clinical challenge in healthcare settings. Many clinicians struggle to accurately differentiate between stages, particularly between Stage I and Stage II injuries. A study reported that 41.2% of misclassified injuries were initially categorized as Stage II when they were later validated as non-pressure injuries, indicating a significant risk of diagnostic inaccuracy (Fulbrook & Lovegrove, 2023). Furthermore, injuries categorized as unstageable demonstrated low validation rates, with less than one third being correctly identified (Fulbrook & Lovegrove, 2023). Diagnostic errors also arise in the differential diagnosis of pressure injuries and other wound types. Clinicians frequently confuse pressure injuries with lesions caused by friction or maceration, which may result in inappropriate treatment strategies and misallocation of healthcare resources (Doughty et al., 2006; Bruce et al., 2012). The accuracy of staging is strongly influenced by the training and knowledge of healthcare professionals. A survey revealed that 75.3% of respondents believed that an improved staging system was needed, reflecting dissatisfaction with current classification methods (Stefanopoulos et al., 2023). The clinical consequences of misclassification are considerable. Inaccurate staging can lead to inappropriate or delayed interventions, potentially worsening the patient’s condition and increasing the risk of complications such as infection or chronic wounds (Visconti et al., 2023; Swerdlow et al, 2023). Additionally, incorrect staging may contribute to inefficient use of healthcare resources and increased costs due to unnecessary or misdirected treatments (Fulbrook & Lovegrove, 2023; Bruce et al., 2012). Efforts to address these challenges include the adoption of standardized assessment protocols, such as updated guidelines provided by the National Pressure Injury Advisory Panel (Kottner et al., 2020), as well as structured educational programs aimed at improving staging accuracy and patient outcomes (Kottner et al., 2020; Alshahrani et al., 2024). The above suggest that educational interventions may enhance diagnostic accuracy and reduce misclassification (Kottner et al., 2020).

Non-blanchable erythema (NBE) is a critical diagnostic indicator for Stage 1 pressure injuries and is characterized by skin discoloration that does not fade when pressure is applied. Distinguishing between Stage 1 and Stage 2 pressure injuries can be challenging due to the subtlety and variability of clinical signs. Empirical evidence indicates that non-blanchable erythema is a significant predictor of progression to Stage 2 or more severe pressure injuries. In a study involving 68,077 participants, individuals presenting with non-blanchable erythema had higher odds (OR 2.72) of developing Stage 2 pressure injuries within 28 days compared to those without this finding (Shi et al., 2020). The accuracy of diagnosing non-blanchable erythema may be affected by variability in the amount of pressure applied during clinical assessment. Studies have shown that blanchable erythema fades at pressures of 50–100 mmHg, whereas non-blanchable erythema persists under higher levels of applied pressure, indicating the need for standardized methods of pressure application during evaluation (Chen et al., 2022). Dermoscopic examination has identified specific features such as petechial dots and telangiectatic streaks in cases of non-blanchable erythema, which may assist in differentiating it from other forms of skin discoloration (Inui et al., 2011). In addition, subepidermal moisture measurement has demonstrated potential in the early detection of pressure injuries, providing consistent findings that can enhance clinical assessment (Scafide et al., 2020). Non-blanchable erythema may also be accompanied by additional skin changes, including induration, edema, pain, warmth, or discoloration, which have been associated with subsequent pressure injury development (Nixon et al., 2007). The variability of these clinical manifestations necessitates a comprehensive assessment approach to ensure accurate diagnosis and differentiation between stages.

Differentiating between Stage 2 and Stage 3 pressure injuries presents significant clinical challenges, particularly in relation to depth assessment and tissue loss. Stage 2 pressure injuries involve partial-thickness skin loss with exposed dermis and are characterized by a shallow open injury with a red-pink wound bed without slough. They may also present as intact or ruptured serum-filled blisters (Alderden et al., 2019; Tsukada, 2019). In contrast, Stage 3 pressure injuries involve full-thickness skin loss, with visible subcutaneous fat but without exposure of bone, tendon, or muscle. Slough may be present in Stage 3 injuries; however, it does not obscure the depth of tissue loss. These injuries may also include undermining and tunneling (Baker et al., 2016; Zhang et al., 2024). Clinical differentiation between these stages is often complicated by limitations in visual assessment. Clinicians may experience difficulty accurately determining wound depth, particularly when slough or necrotic tissue partially obscures the wound bed (Baker et al., 2016; Zhang et al., 2024). Although Stage 2 injuries typically present with a red-pink wound bed, the presence of slough or necrotic tissue in Stage 3 injuries may complicate visual distinction (Tsukada, 2019; Fecchio et al., 2024). Tissue involvement further contributes to diagnostic complexity. Stage 3 injuries may exhibit granulation tissue, which is not typically present in Stage 2 injuries, although identifying this feature requires careful examination

(Zhang et al., 2024; Fecchio et al., 2024). Additionally, undermining and tunneling are more commonly associated with Stage 3 injuries and may not be visible without probing, complicating accurate assessment (Baker et al., 2016; Zhang et al., 2024). Moderate inter-rater reliability has been reported among clinicians when categorizing pressure injuries, indicating variability in assessment and potential misclassification between Stage 2 and Stage 3 injuries (Fulbrook & Lovegrove, 2023). The complexity of differentiating these stages may also contribute to inaccuracies in clinical documentation, which can influence treatment planning and resource allocation (Fulbrook & Lovegrove, 2023; Chang et al., 2025). The distinction between these stages has direct implications for management. Stage 2 injuries are typically managed with protective dressings and interventions aimed at preventing further pressure and shear (Tsukada, 2019). In contrast, Stage 3 injuries often require more intensive treatment approaches, including debridement, negative pressure wound therapy, and in some cases surgical intervention (Zhang et al., 2024; Awad et al., 2023).

Ambiguity between Stage 3 and Stage 4 pressure injuries is influenced by several clinical and assessment-related factors. Both stages share common pathological characteristics, including intense oxidative stress, abnormal inflammatory responses, cell death, and impaired tissue remodeling, which limits differentiation based solely on biological features (Pan et al., 2023). Visual assessment remains the primary method of staging; however, it is inherently subjective and may vary considerably among clinicians, contributing to staging inconsistencies (Chao et al., 2025). The presence of necrotic tissue and the difficulty in accurately determining wound depth further complicate classification, increasing the risk of misclassification between Stage 3 and Stage 4 injuries (Awad et al., 2023). Technological limitations also contribute to ambiguity. Although advanced tools such as three-dimensional wound measurement systems and digital planimetry provide more precise assessments, their implementation is not universal and measurement variability may still occur (Sahbudak & Gunes, 2026; Jun et al., 2019). Machine learning models have demonstrated potential in improving staging accuracy, yet their performance may be inconsistent, particularly when trained on limited supervised datasets (Ikuta et al., 2024). In clinical practice, depth assessment is commonly performed using sterile cotton swabs, a method that is practical but may lack precision and is subject to human error (Sahbudak & Gunes, 2026). Manual measurements with rulers and transparent adhesive films are also used, although these approaches may not provide reliable three-dimensional analysis (Jun et al., 2019). Emerging techniques, including three-dimensional wound measurement systems and digital planimetry, offer non-contact assessment and reduce infection risk while improving measurement reliability (Sahbudak & Gunes, 2026; Jun et al., 2019). In some settings, combining traditional methods with advanced technologies is employed to enhance accuracy, and structured algorithms integrating clinical expertise with technological tools have been utilized to improve staging precision and depth assessment (Awad et al., 2023).

Identifying and classifying unstageable pressure injuries and deep tissue pressure injuries (DTPI/DTI) presents multiple challenges for healthcare professionals. Unstageable pressure injuries are characterized by a wound base obscured by slough or eschar, which prevents accurate assessment of the full extent of tissue damage without prior debridement (Zaratkiewicz et al., 2020). In the case of deep tissue pressure injuries, tissue damage often begins in the muscle adjacent to bone and may not be visible in the early stages, complicating timely detection and intervention (Preston et al., 2017; Wynn, 2021). Challenges also arise from limitations within classification systems. The omission of categories such as “unstageable/unclassified” and “suspected deep tissue injury under intact skin” in certain staging frameworks has been associated with difficulties in accurately describing and classifying these injuries (Briggs, 2011). The absence of clearly defined categories may contribute to overestimation of tissue damage and confusion in clinical decision-making and resource allocation (Briggs, 2011). Clinical practice further contributes to diagnostic variability. Moderate agreement has been reported between bedside clinicians and nurse experts when categorizing pressure injuries, with substantial discrepancies in identifying unstageable injuries and DTPI (Fulbrook & Lovegrove, 2023). Less than one third of initially reported unstageable pressure injuries were validated following expert review (Fulbrook & Lovegrove, 2023). Knowledge gaps among critical care nurses regarding pressure injury treatment have also been documented, potentially influencing the accuracy of identification and classification (Li et al., 2022). Technological and methodological limitations add additional complexity. Variability in reporting practices, as well as limitations in animal and computational models, hinders the understanding and classification of DTPI (Wynn, 2021). Although non-invasive imaging techniques and deep learning models demonstrate potential for improving classification accuracy, their implementation remains limited and may not yet be widely available in routine clinical practice (Chang et al., 2024; Fergus et al., 2023; Zahia et al., 2020).

Pressure injury assessment and staging present several documentation challenges for healthcare professionals, which can significantly impact patient care and outcomes. A study found that only 52.6% of patients with pressure injuries had their staging documented by healthcare providers, indicating a significant gap in consistent documentation practices (White-Chu & Kiely, 2012). This inconsistency can lead to inadequate treatment plans and poor patient outcomes. A study found that 69.7% of pressure injuries were inaccurately reported, with many misclassified as hospital-acquired when they were not, or misidentified in terms of stage and location (Barakat-Johnson et al., 2018). This misclassification can lead to inappropriate treatment plans and hinder effective patient management. Many healthcare professionals fail to document essential details, such as the depth of tissue involvement or the presence of infection, which are critical for effective treatment (Stefanopoulos et al., 2023). Inaccurate documentation can lead to delays in appropriate treatment, worsening patient outcomes. For instance, if a pressure injury is misclassified, the necessary interventions may not be implemented in a timely manner (Chavez et al., 2019; Dufrene, 2009).

Clinical Decision Support, Digital Imaging and Artificial Intelligence in Pressure Injury Management

Clinical Decision Support Systems (CDSS) have emerged as valuable tools in wound management and pressure injury care. One study reported that the implementation of a clinical nursing decision support system for pressure injuries led to an increase in the pressure injury healing rate from 89.1% to 97.2% and improved wound assessment accuracy from 90.8% to 97.2%. The defect rate in nursing records also decreased significantly, indicating enhanced documentation quality and care standardization (Zhang et al., 2026). A systematic review indicated that while CDSS tools improved clinician adherence to prevention practices, they did not consistently show significant reductions in pressure injury prevalence or incidence across various studies (Ting & Garnett, 2021). CDSS can be categorized into quantitative and qualitative models. Quantitative models often operate in the background, while qualitative models require user interaction. Both types have shown effectiveness in supporting healthcare professionals in managing chronic wounds (Schaarup et al., 2018). Some CDSS utilize machine learning to enhance decision-making capabilities. A study found that a machine learning-based CDSS improved nursing performance in pressure injury prevention, although clinical decision-making did not show significant differences (Kim et al., 2022).

Digital imaging technologies have significantly transformed wound assessment by enhancing measurement accuracy and enabling effective longitudinal monitoring of wound healing. Digital imaging technologies enhance precision in measuring wound size, depth, and volume, which are critical parameters for evaluating healing progression (Mehl et al., 2025; Jørgensen et al., 2020). The integration of artificial intelligence and machine learning into digital imaging systems has further expanded their potential applications. AI-driven tools can analyze large datasets of wound images to predict healing trajectories and evaluate treatment effectiveness (Anisuzzaman et al., 2022; Petkar et al., 2025). Machine learning applications may automate aspects of wound assessment, reducing clinician burden and supporting personalized treatment strategies by identifying patterns in wound progression that are not readily detectable through visual inspection alone (Nelson et al., 2025; Al-Akayleh et al., 2025). Despite these advantages, several challenges remain. Implementation barriers include the need for user-friendly interfaces and integration with existing healthcare systems. Many devices remain costly or bulky, limiting accessibility in routine clinical settings (Lucas et al., 2021; Romanelli et al., 2008). Additionally, a lack of standardized validation protocols for imaging technologies limits comparability across platforms and may hinder widespread adoption (Mehl et al., 2025; Shi et al., 2022).

The integration of artificial intelligence in the classification and staging of pressure injuries represents a rapidly evolving area with demonstrated potential to enhance diagnostic accuracy and improve patient outcomes. Various machine learning algorithms, including decision trees, logistic regression, neural networks, and random forest models, have been applied to predict and classify pressure injuries. A systematic review reported that random forest algorithms achieved the highest predictive accuracy, with an area under the curve (AUC) of 0.95, outperforming logistic regression and neural network approaches (Qu et al., 2022). Deep learning techniques, particularly convolutional neural networks, have also been employed in wound image analysis, with reported accuracy rates reaching up to 97% in detecting and classifying pressure injuries (Yilmaz et al., 2021). AI-based image analysis models have been developed to classify necrotic tissue and support staging decisions. A binary classification model demonstrated an accuracy of 87.11% in distinguishing between different stages of necrosis (Kimura et al., 2025), while another convolutional neural network model achieved an overall accuracy of 93.71% in classifying various stages of pressure injuries (Lei et al., 2025). The integration of AI into mobile health applications has further extended its applicability in real-world settings, with one smartphone-based application reporting an accuracy of 63.2% for pressure injury assessment and staging (Lau et al., 2022). Empirical evidence supports the diagnostic performance of AI systems in this field. A meta-analysis of 21 studies reported that AI models for pressure injury diagnosis demonstrated a sensitivity of 0.74 and specificity of 0.93, with an area under the summary receiver operating characteristic curve of 0.92, indicating strong overall performance across different pressure injury stages (Wei et al., 2025a). Clinical deployments of AI tools have also been associated with reductions in nursing workload and decreases in the prevalence of hospital-acquired pressure injuries (Alves et al., 2025). The use of AI in pressure injury classification has implications for both patient outcomes and healthcare systems. AI-powered systems may facilitate earlier and more accurate interventions and can support less experienced nurses in staging assessments, thereby contributing to improved care quality (Kirkland-Kyhn et al., 2025). Studies have also indicated that AI applications may reduce healthcare costs by lowering the incidence of pressure injuries and associated complications in clinical settings (Yang et al., 2024). Despite these advantages, the implementation of AI in pressure injury management raises ethical and practical considerations. Concerns related to data privacy, transparency in decision-making processes, and potential algorithmic bias have been reported. Nurses have expressed reservations regarding the accuracy and reliability of AI systems and emphasized the necessity of integrating AI outputs with clinical judgment (Kirkland-Kyhn et al., 2025). The need for ongoing education and training of healthcare professionals has also been highlighted to ensure appropriate use of AI tools while maintaining patient safety and care quality (Kirkland-Kyhn et al., 2025).

Workflow Integration and Organizational Readiness

The integration of artificial intelligence technologies into nursing practice presents both opportunities and significant barriers that affect workflow efficiency and patient care. A frequently reported challenge concerns insufficient training and education in AI applications. Nurses have indicated limited preparedness to use AI tools effectively, and evidence shows that confidence in AI use increases significantly following structured simulation-based training, underscoring the importance of comprehensive educational programs (Benfatah et al., 2025; Qutishat & Shakman, 2025).

Integration challenges also arise when AI systems are introduced into existing healthcare infrastructures. Nurses report difficulties related to data quality, system compatibility with established workflows, and concerns regarding potential increases in workload associated with the implementation of new technologies (Abdelwanis et al., 2026; Wei et al., 2025b). Ethical concerns related to data privacy and security further complicate adoption. Nurses have expressed apprehension regarding the protection of sensitive patient information and the broader implications of AI-driven clinical decisions for confidentiality and accountability (Alnawafleh et al., 2025; Rony et al., 2024). Resistance to change has also been observed among nursing staff, often linked to concerns about job displacement and a preference for traditional models of patient care (Benfatah, 2025; George & Peirce, 2025).

Organizational culture and leadership play a significant role in shaping AI adoption. A supportive environment characterized by strong leadership endorsement and a culture that promotes innovation has been identified as a key facilitator of successful AI integration. Perceived benefits for patient care, combined with institutional support, contribute substantially to nurses' willingness to engage with AI technologies (Benfatah, 2025; Ramadan et al.,2024). Active involvement of nurses in decision-making processes related to AI implementation has been associated with reduced skepticism and increased acceptance, fostering a sense of ownership and professional responsibility (Akter et al., 2025; El Arab et al., 2025).

Ethical considerations further influence organizational readiness. Concerns regarding patient autonomy and informed consent have been raised, with nurses expressing apprehension that excessive reliance on AI may diminish the human dimension of care and negatively affect the patient experience (Alnawafleh et al., 2025; Badawy et al., 2025; Amin et al., 2026). Algorithmic bias has also been identified as a significant concern, with the potential to produce inequitable care outcomes. Nurses emphasize the necessity of transparency in AI decision-making processes to ensure fairness and accountability (Amin et al., 2026; Mohammed et al., 2025).

Training and education have a direct impact on nurses' capacity to integrate AI into clinical practice. Comprehensive educational initiatives that address both technical competencies and ethical dimensions have been shown to enhance confidence and readiness for AI adoption (Benfatah et al., 2025; Qutishat & Shakman, 2025; Shelke et al., 2025). Targeted interventions, including AI-focused curricula and simulation-based training, prepare nurses to manage the complexities associated with digital health technologies, while also addressing ethical and interpersonal considerations (Wei et al., 2025b; Akter et al., 2025; El Arab et al., 2025).

Chapter 2: Theoretical framework

Technology Acceptance Model – TAM

The acceptance and adoption of technological systems in the healthcare sector is a critical success factor for any digital innovation. The Technology Acceptance Model (TAM), developed by Davis (1989), is based on the Theory of Reasoned Action and the Theory of Planned Behavior and seeks to explain the factors that influence the intention to use a technology. According to the TAM, two main perceptual variables determine the intention to use an information system: (1) Perceived Usefulness (PU), (2) Perceived Ease of Use (PEOU). Perceived usefulness refers to the extent to which an individual believes that using a system will improve their professional performance. Perceived ease of use refers to the extent to which an individual believes that using a system will be effortless. These two variables directly influence Intention to Use, which is the strongest predictor of actual use of a system.

TAM has been applied extensively in healthcare systems, including nursing information systems, electronic patient records, and clinical decision support systems. Pai and Huang's (2011) study applied TAM to a hospital setting and found that: (1) Information quality positively influences perceived usefulness, (2) System quality significantly influences perceived ease of use, (3) Perceived ease of use positively influences perceived usefulness, (4) Both variables (PU & PEOU) significantly influence intention to use. These findings confirm that the success of a healthcare information system does not only depend on its technical excellence, but also on the way healthcare professionals perceive it.

DeLone and McLean (2003), suggested that the success of an information system is determined by: (1) System Quality, (2) Information Quality, and (3) Service Quality. These factors influence satisfaction and use of the system.

Application of TAM to the current research

The development of a web-app using AI for staging and risk prediction of pressure injuries constitutes a form of Clinical Decision Support System (CDSS). The adoption of such a tool by nurses is not a given, because clinical practice is characterized by high workload, lack of time and the need for simple and quick solutions. Therefore, if the tool is considered complex, then the PEOU will be low. If it is considered that it does not improve clinical judgment, the PU will be low. Finally, if there is no trust in the algorithm, then there will be a reduced intention to use. The present qualitative study investigates precisely these factors, in order to identify the needs and expectations of nurses before the development of the system.

The choice of TAM as a theoretical framework for this study is substantiated by its extensive application in health information systems, its ability to predict intent to use, and its focus on perceptual variables that are directly relevant to healthcare professionals. Given that the study does not evaluate an existing system but explores the needs prior to the development of an AI tool, TAM functions as a conceptual lens for understanding nurses' expectations, perceived barriers, and characteristics that will enhance acceptance.

Chapter 3: Methodology

This qualitative interview study consisted of interviews with 12 nurses from the clinical and in academic field, which were analyzed using thematic analysis.

Sampling and recruitment

The sample of the study was obtained by convenience sampling. The number of interviews (n=12) conducted was determined after data saturation was reached.

Data collection

To collect the data, a qualitative study was conducted with audio-recorded, face-to-face, semi-structured interviews lasting an average of 20 minutes.

The interview guide included the following questions:

1. What challenges do you face when staging pressure injuries? What are the main difficulties you encounter when staging pressure injuries, especially distinguishing between different stages?
2. What barriers do you encounter when implementing staging protocols?
3. How do you document pressure injury staging and communicate findings with other professionals?
4. What improvements would you like to see in this process?
5. In your opinion, what technical features do you want to make the app convenient and easy to use? Do you have any special preferences regarding the application's appearance, such as a font size that is not too small or contrasting colors to make it easier to read the data?
6. Regarding the database in the application, what information do you expect to be available to support the pressure injuries staging? Do you need a complete database including data processing information such as the Norton Scale elements?
7. In your opinion, if an application is developed to assist the staging of pressure injuries, how should this application be designed so that its use is not too complicated and does not require a lot of time to learn?
8. What are your expectations regarding the reporting system in this application?
9. What expectations do you have regarding data security, privacy, and user access control in such an application?
10. How comfortable would you feel using an AI-assisted application for pressure injury staging in clinical practice, and what would influence your trust in such a system?
11. How would you like the AI tool to fit into your existing workflow? What information should it provide before, during, or after your decision-making process?

Data analysis

We used thematic analysis methods to identify common themes among participants. Each interview which was first audio-recorded and then transcribed, it was read. After familiarization with the data, coding began in the text. These codes were grouped together to create themes. Themes are conceptual constructs more abstract and general than codes. They arise from the processing, comparison, merging of the codes and correspond to a recurring pattern of meaning. The themes are autonomous conceptual entities and can function as versions of the answer to the research question we are examining (Braun & Clarke, 2006).

Initial coding and theme development were independently conducted by the two researchers. Discussions followed until the achievement of consensus.

Ethical considerations

This qualitative study adhered to established ethical standards for research involving human participants. Participation was voluntary, and informed consent was obtained prior to data collection. Participants were informed of their right to withdraw at any stage without consequences. Explicit consent was obtained for audio recording of the interviews (Annex B). To minimize the risk of indirect identification, contextual details that could reveal participants' identity were omitted or modified during data reporting. Participants were also informed that they could decline to answer any question or interrupt the interview if they experienced discomfort. Data were stored securely and were accessible only to the researcher.

Chapter 4: Research findings

Participants

The demographic information of the participants is presented in Table 4.1.

Table 4.1. Participant demographics

Participant ID	Gender	Age	Years of service	Educational level*	Additional Studies**	Working Department
P1	M	34	12	T	M	School nurse
P2	F	47	21	T	P	University
P3	F	26	6	U	S	ICU
P4	F	45	20	U	M	ICU
P5	F	58	35	T	M	Nursing Administration
P6	M	33	8	T	M	Oncology ward
P7	F	48	25	U	PD	Operating room
P8	F	46	18	T	M	Operating room
P9	F	26	1	U	P	Oncology ward
P10	F	51	25	U	P	Operating room
P11	F	49	30	U	P	Surgical ward
P12	F	53	38	U	M	University

*U-University level, T-Technological Institution level
** S-Nursing Specialty, M-Msc, P-PhD, PD-PostDoc

The sample consisted of 12 participants. The majority of them were female (83.3%), with a mean age of 43 years old and approximately 20 years of service. The majority (n=7) held a university degree and most had pursued additional studies.

Overview of findings

There were several themes identified and listed in Table 4.2.

Table 4.2 Themes and subthemes

Themes	Subthemes
Clinical complexity and organizational barriers in pressure injury staging	Diagnostic complexity Structural and organizational constraints
Documentation and communication gaps	Fragmented documentation

	Informal communication practices
Improvements	Digitalization Staff training
Requirements	Interface and usability Database integration User-friendliness
Expectations	Automated Reporting system Security and Access
Trust and AI acceptance	AI as a supportive tool Determinants of trust Gradual adoption
Workflow integration	Pre-assessment and post assessment support Preservation of clinical authority

Theme 1: Clinical complexity and organizational barriers in pressure injury staging

1.1. Diagnostic complexity

The dominant finding is the difficulty in accurately staging pressure ulcers, with the main challenge being the assessment of wound depth and the differentiation between adjacent stages (I–II and II–III), particularly when the clinical presentation is unclear or when necrotic tissue is present.

P6: "When staging pressure ulcers, the main challenge is to clearly distinguish between stages, especially between Stages I–II and II–III when the wound picture is not clear".

P8: "Mainly in the differentiation of stage and correct assessment of the depth of the damage".

1.2. Structural and organizational constraints

This difficulty appears to be further exacerbated by organizational constraints in clinical practice, such as the lack of standardized assessment tools and adequate training.

Lack of time and increased workload, combined with insufficient and non-systematic staff training, are further intensified by organizational dysfunctions, a lack of interdisciplinary consensus, resistance to change, and limited nursing autonomy, leading to inconsistent or fragmented implementation of protocols in clinical practice.

P3: "The main barriers to the implementation of pressure ulcer staging protocols are inadequate training, subjectivity, limited resources (time, staffing, tools), and insufficient organizational support. Addressing these barriers requires continuous education, standardization of procedures, interdisciplinary collaboration, and the integration of protocols into everyday clinical practice".

P5: "Difficulty in changing the team's mindset. Resistance from the Medical Service".

P10: "Lack of time, heavy workload, an inappropriate skill mix among nursing staff, heterogeneous levels of training, as well as medical dominance—which may limit nurses' autonomy in decision-

making—constitute barriers to the implementation of protocols. In addition, professional burnout among nursing staff, which reduces the quality and consistency of care, represents a further obstacle to protocol implementation".

Theme 2. Documentation and communication gaps

2.1. Fragmented documentation

The staging of pressure ulcers is primarily documented through descriptive recording in the nursing record, using protocols or standardized forms where available.

P6: "Recording of wound depth, presence or absence of erythema, skin color, tissue loss, and any exudate. The documentation of findings is recorded in the patient's medical record and communicated to the interdisciplinary team during handover and medical rounds".

2.2. Informal communication practices

However, communication of findings among healthcare professionals occurs mainly verbally, during shift handovers or medical rounds, indicating limited use of structured and standardized communication mechanisms, which may affect continuity and safety of care.

P10: "Using risk assessment scales such as the Norton Scale, and communicating the findings to other healthcare professionals through comprehensive documentation in the nursing record".

P11: "Through the nursing record in the electronic system, with a brief description of the stage and the location of the lesion. Communication with other healthcare professionals occurs mainly verbally during shifts or rounds, and of course our documentation is also visible in the system when someone reviews the patient's record".

Theme 3. Improvements

3.1. Digitalization

The primary desired improvement identified is the digitalization and standardization of the pressure ulcer staging process, through the use of clinical decision support tools that incorporate the ability to upload photographic material for the systematic monitoring of wound progression.

P10: "Standardization of protocols and guidelines, as well as digitalization of the process through the use of photographs and their comparative monitoring to assess the progression of pressure ulcers".

3.2. Staff training

In parallel, participants emphasized the need for continuous and systematic staff training, as well as the implementation of shared protocols and common terminology, in order to reduce subjectivity, enhance collaboration, and improve the quality and safety of care delivery.

P8: "Greater implementation of protocols, enhanced staff training, and increased use of digital tools".

Theme 4. Requirements

4.1. Interface and usability

The analysis of responses highlighted the development of a simple, fast, and guidance-oriented application as the primary requirement, characterized by a high level of usability and strong visual support. Participants emphasized the importance of using images, photographic documentation, and automated or semi-automated support for staging. Design, readability, and compatibility with mobile devices were identified as critical factors for the acceptance and effective use of the application.

P3: "An ideal application should be simple, guidance-oriented, adaptable, readable, and secure, with a design that takes into account the daily pressures of clinical practice. Appearance (font size, contrast, clear structure) is not merely an aesthetic detail, but a fundamental element of safety and effectiveness".

P10: "Easy navigation and clear indication of core functions, reminders for periodic reassessment of pressure ulcers, standardized checklists, compatibility with existing electronic records and mobile devices, the ability to include photographic documentation, and comparative monitoring over time".

P11: "To be truly user-friendly, I would like data entry to be quick, ideally requiring only a few clicks. It should of course feature a large, readable font and strong color contrasts, so that no time is wasted figuring out which field needs to be completed. If the application could run on a tablet or smartphone, it would be ideal to perform the documentation at the exact moment of the assessment".

4.2. Database integration

A key finding that emerged is the need for a comprehensive database that integrates patient clinical characteristics, risk assessment scales—most notably the Norton Scale—and structured data for pressure ulcer staging. Participants emphasized that automated data processing, the use of images and examples, and the ability to monitor wound progression and evaluate interventions are essential prerequisites for a modern, reliable, and clinically meaningful application.

P5: "Definitely yes, there is a need for a comprehensive database capable of processing risk assessment scales and key patient condition information, such as nutritional status, diabetes mellitus, septic factors, and similar clinical parameters".

P10: "Patient demographic and clinical data, wound characteristics and risk assessment scales, as well as the therapeutic interventions applied, so that wound progression can be monitored and the effectiveness of interventions can be evaluated".

4.3. User-friendliness

The analysis indicated that an application supporting pressure ulcer staging should be designed with a simple, step-by-step, and visually guided approach that reflects the natural flow of clinical assessment. Participants emphasized that the use of images, checklists, and preselected options, combined with clear and concise terminology, can significantly reduce the learning curve and enable the immediate integration of the application into everyday clinical practice.

P3: "An application that is not complex and does not require a learning curve should be simple, guidance-oriented, fast, and visually clear, with a design that reflects the natural clinical workflow. If the user can open it and use it correctly from the very first time, then the goal has been achieved".

P10: "To have a user-friendly interface with easy navigation, standardized checklists and forms for rapid documentation, in-app usage guidance and reminders, compatibility with mobile devices, and the ability to include photographic documentation and comparative monitoring, so that the learning curve is reduced and everyday use in clinical practice is facilitated".

Theme 5. Expectations

5.1. Automated Reporting system

Healthcare professionals expect a reporting system that operates automatically, reliably, and in support of clinical judgment, without increasing workload. Reports should be generated in parallel with the assessment process, be standardized and easily shareable, integrated into the patient record, and support longitudinal monitoring and interdisciplinary collaboration. Reporting is recognized as a critical tool for continuity of care, prevention of deterioration, and quality improvement.

P6: "Automatic recording of key assessment parameters, with easy data export for sharing with the interdisciplinary team".

P8: "Automatic recording of the key assessment elements, concise and clear reports, easy export to PDF format, a timeline of assessments, assurance of accuracy, and support for team communication to enable comprehensive clinical documentation".

P10: "The reporting system should automatically capture the key elements of the assessment and present them in a standardized and concise format, in order to facilitate documentation, monitoring of pressure ulcer progression, and communication with other healthcare professionals. The application should allow nurses to automatically record the information in the patient's records".

5.2. Security and Access

The analysis highlighted as a primary requirement the presence of robust data security and privacy protection mechanisms, comparable to those of the electronic health record. Participants emphasized the need for strict role-based access control, full compliance with the applicable legal framework (GDPR), and the assurance of user action traceability. Data security is recognized as a prerequisite for trust, acceptance, and the sustainable implementation of the digital tool in clinical practice.

P3: "Such an application must ensure a high level of security, absolute respect for privacy, and clear role-based access control. The goal is for both healthcare professionals and patients to feel that their data are secure, controlled, and used exclusively to improve care".

P5: "High-level protection is required. The application and its data cannot be considered of lesser importance than the medical record itself. A key issue concerns whether data will be stored and where *this storage will take place. User access should be role-based, meaning that login should occur using authenticated credentials assigned with proper authorization".*

P11: "The data should be secure and compliant with personal data protection regulations. Access should be structured so that each healthcare professional can view only what is necessary according to their role in patient management, and it should be recorded who entered each piece of information".

Theme 6. Trust and AI acceptance

6.1. AI as a supportive tool

Healthcare professionals are generally positive toward the use of an artificial intelligence–assisted application for pressure ulcer staging, provided that it functions in a supportive role and does not replace clinical judgment.

P3: "I would be positive but cautious about using an AI-assisted application for pressure ulcer staging. My trust would depend on whether the AI operates in a supportive rather than a substitutive manner, is explainable, reliable, and controllable, and fully respects clinical responsibility and privacy. When AI enhances clinical judgment instead of bypassing it, it can become a valuable ally in everyday practice".

6.2. Determinants of trust

Trust in the system is mainly influenced by the accuracy and reliability of the results, the transparency of the decision-making process, the quality of the data, and the assurance of privacy protection.

P5: "I can say that I would feel comfortable, as if I had an assistant. However, I would never forget that any decision concerning the patient ultimately rests on my own judgment and knowledge. Therefore, I would be very concerned about transparency in the decision-making process, issues of inaccuracy, data protection, and access control to the application".

6.3. Gradual adoption

Acceptance of AI is expected to increase gradually through practical use and the confirmation of its clinical value.

P11: "Any application that uses AI should function in a supportive manner and not replace clinical judgment. Within this framework, I would feel very comfortable. My trust would be mainly influenced by seeing in practice that it helps me reduce errors and uncertainty".

Theme 7. Workflow Integration

7.1. Pre-assessment and post assessment support

Healthcare professionals wish for the integration of an artificial intelligence tool into pressure ulcer staging to occur smoothly and without disrupting existing workflows. The tool is expected to function supportively at all stages of clinical decision-making: before the assessment, by providing risk-related information and reminders; during the assessment, by guiding evaluation and enhancing accuracy; and after the assessment, by facilitating documentation, monitoring of progression, and interdisciplinary communication.

P11: “Ideally, I would like it to be integrated into the existing workflow. Before making a decision, it would be useful to remind me of key risk factors. During the process, it should function supportively by suggesting a possible stage. Afterwards, it should facilitate documentation and monitoring of progression”.

7.2. Preservation of clinical authority

Maintaining clinical responsibility with the healthcare professional is recognized as a non-negotiable prerequisite for the acceptance of AI.

P6: “To be integrated smoothly, without creating the impression that it adds additional workload. Before decision-making, it should remind users of key assessment criteria, and during the process, it should provide guidance cues based on clinical data”.

Conclusion

Interpretation of main findings and comparison with existing Literature

The present qualitative study explored nurses' experiences, perceived barriers, and expectations regarding pressure injury staging and the prospective implementation of an AI-assisted web-based application. The findings reveal a strong convergence between frontline clinical experiences and the challenges documented in the existing literature.

Participants consistently highlighted diagnostic complexity, particularly in differentiating between adjacent stages (I–II and II–III) and in assessing wound depth when necrotic tissue is present. These findings directly align with the literature documenting moderate inter-rater reliability and substantial staging variability (Jesada et al., 2013; Fulbrook & Lovegrove, 2023). The difficulty reported by nurses in depth assessment and stage differentiation reflects previously described limitations of visual assessment and the subjectivity inherent in staging processes (Baker et al., 2016; Zhang et al., 2024). Moreover, the participants' emphasis on ambiguity between stages reinforces empirical evidence that staging inconsistencies contribute to misclassification and inappropriate interventions (Fulbrook & Lovegrove, 2023). The concern regarding unclear wound presentation is consistent with findings that necrotic tissue and partial tissue loss obscure accurate classification (Awad et al., 2023).

Beyond diagnostic difficulty, participants emphasized organizational barriers such as insufficient training, heavy workload, lack of interdisciplinary consensus, medical dominance, and limited nursing autonomy. These findings extend the literature by illustrating how structural and cultural factors intensify staging challenges. Previous studies have identified inadequate training and lack of standardized procedures as contributors to inconsistent staging (Stefanopoulos et al., 2023; Kottner et al., 2020). However, the present study provides deeper insight into how resistance to change and hierarchical structures affect protocol implementation. This finding complements literature indicating that successful digital tool adoption requires supportive organizational culture and leadership engagement (Benfatah, 2025; Ramadan et al., 2024).

Participants described fragmented documentation and predominantly verbal communication during handovers. The reliance on informal communication mechanisms mirrors documented risks to continuity of care and patient safety (Chavez et al., 2019; Dufrene, 2009). The findings confirm that documentation is not merely a clerical task but a critical safety process. Importantly, nurses did not merely identify documentation problems—they explicitly linked them to workflow inefficiencies and system limitations, reinforcing the need for structured digital solutions.

A central theme was the demand for digitalization, photographic documentation, comparative monitoring, and standardized checklists. These expectations are directly supported by literature on digital imaging technologies and longitudinal monitoring systems, which enhance measurement precision and reproducibility (Mehl et al., 2025; Jørgensen et al., 2020). The desire for automated reporting and structured outputs corresponds with evidence that CDSS implementation improves documentation quality and healing rates (Zhang et al., 2026). However, the participants' emphasis on workflow compatibility reflects systematic review findings that CDSS tools improve adherence but do not always reduce prevalence unless properly integrated (Ting & Garnett, 2021).

One of the most important findings concerns nurses' conditional acceptance of AI. Participants expressed openness toward AI-assisted staging provided that: (1) it supports rather than replaces clinical judgment, (2) it ensures transparency, (3) it protects data privacy, and (4) it preserves professional autonomy. These views are fully consistent with published concerns regarding explainability, algorithmic bias, and ethical implementation of AI in nursing practice (Kirkland-Kyhn et al., 2025; Amin et al., 2026).

A strong contribution of the present study is the articulation of how nurses expect an artificial intelligence–assisted tool to be integrated into their existing workflow. They strongly emphasized that such a system must not increase workload or add procedural complexity. This finding highlights a practical dimension that is often underemphasized in technically oriented studies, namely the centrality of time efficiency and workflow compatibility in real-world clinical environments. Equally important was the preservation of clinical authority, which emerged as a non-negotiable condition for acceptance. Nurses consistently stressed that AI should function in a supportive capacity and not replace professional judgment.

A particularly important dimension of the findings concerns their strong alignment with the Technology Acceptance Model (TAM). Participants' emphasis on simplicity, speed, clear interface design, and minimal learning curve directly reflects the construct of Perceived Ease of Use (PEOU) as described by Davis (1989). Nurses repeatedly highlighted that the application must be intuitive, visually clear, and compatible with their natural workflow in order to avoid additional workload. This finding is consistent with TAM literature suggesting that ease of use significantly influences both perceived usefulness and intention to use (Pai & Huang, 2011). Similarly, the expectation that the AI tool should enhance staging accuracy, reduce uncertainty, support documentation, and improve interdisciplinary communication corresponds to the construct of Perceived Usefulness (PU). Participants indicated that they would adopt the system only if it demonstrably improved clinical performance without undermining professional autonomy. This mirrors findings in healthcare information systems research showing that usefulness is a primary determinant of adoption (Pai & Huang, 2011). Importantly, the insistence on preserving clinical authority and ensuring that AI operates in a supportive rather than substitutive role adds a nuanced ethical layer to TAM application. While TAM traditionally focuses on cognitive perceptions of usefulness and ease, the present findings suggest that professional identity, autonomy, and trust function as critical contextual mediators influencing intention to use in high-responsibility clinical environments. Therefore, this study extends TAM by demonstrating that, in nursing practice, perceived usefulness is inseparable from the preservation of clinical responsibility and ethical accountability.

From Qualitative Findings to MVP Development

The development of the Minimum Viable Product (MVP) was directly informed by the findings of the qualitative phase of this study. The thematic analysis of nurses' perceptions regarding pressure injury staging and risk assessment revealed specific clinical, organizational, and usability-related needs that guided the functional and structural design of the web-based application.

Participants emphasized the need for: (a) rapid and structured documentation, (b) integration of standardized risk assessment tools in routine workflow, (c) visual support for staging accuracy, (d) clear identification of high-risk cases, and (e) secure management of patient data within a clinically oriented environment. These themes were systematically translated into design requirements that shaped the architecture and interface of the MVP.

More specifically, the need for structured clinical assessment led to the incorporation of a stepwise assessment workflow (Patient Profile → Image Upload → Norton Scale → Review), facilitating logical sequencing consistent with clinical reasoning. The expressed importance of standardized tools resulted in the integration of the Norton Scale for risk prediction, enabling automated score calculation and risk stratification. Furthermore, nurses' concerns regarding staging accuracy and inter-observer variability informed the development of the AI-based image classification module, designed to support clinical judgment, accompanied by explicit disclaimers emphasizing clinical confirmation.

The theme of early detection and prioritization of high-risk patients translated into the implementation of a dashboard with real-time indicators (e.g., high-risk cases overview, recent activity, assessment history), allowing rapid identification and monitoring of vulnerable individuals. Detailed screenshots of the developed interface are provided in Annex A.

Strengths and Limitations

The present study provides in-depth qualitative insights into nurses' real-world experiences, perceptions, and expectations regarding pressure injury staging and the potential integration of an AI-assisted clinical decision support tool. While much of the existing literature focuses on technical accuracy metrics of AI systems or quantitative evaluation of staging reliability, this study captures frontline clinical perspectives prior to system development. This pre-implementation exploration constitutes a significant contribution, as it allows the identification of user needs before technological design decisions are finalized.

Second, the study included participants from diverse clinical and academic settings, including intensive care units, oncology wards, operating rooms, surgical wards, administration, and academia. This diversity enhances the breadth of perspectives and strengthens the transferability of findings across different clinical contexts.

Third, the use of thematic analysis following Braun and Clarke (2006), combined with independent coding by two researchers, enhances methodological rigor and credibility. The process of data familiarization, systematic coding, and theme development ensured that findings were grounded in participants' narratives rather than imposed theoretical assumptions.

Fourth, the integration of a theoretical framework (Technology Acceptance Model) strengthens the interpretive depth of the findings. By linking emergent themes to perceived usefulness, perceived ease of use, and intention to use, the study moves beyond descriptive reporting and contributes to theory-informed system design considerations.

Despite its contributions, the study has certain limitations that should be acknowledged. First, the sample was obtained through convenience sampling, and although data saturation was reported, the limited number of participants may restrict the generalizability of findings. The perspectives captured reflect those of a specific group of nurses and may not represent all healthcare professionals involved in pressure injury management.

Second, the majority of participants had substantial professional experience, which may influence the thematic emphasis observed.

Third, this stage of the study explores anticipated acceptance of an AI tool and does not evaluate an existing system. Therefore, responses reflect expectations and perceptions rather than actual behavioral adoption.

Finally, as with all qualitative research, findings are context-dependent. Organizational culture, national healthcare structures, and institutional policies may influence perceptions of AI integration differently in other settings.

Recommendations for Future Research

Future studies should evaluate the impact of such a system on staging accuracy, inter-rater reliability, documentation quality, workflow efficiency, and patient outcomes. Longitudinal implementation research is needed to examine real-world adoption over time. While the present study explored anticipated acceptance, actual behavioral use may differ once the system is integrated into daily practice. Future research should investigate changes in perceived usefulness, perceived ease of use, trust, and intention to use across different phases of implementation, drawing on theoretical models such as the Technology Acceptance Model. Larger multi-center studies including diverse healthcare settings would enhance generalizability and allow comparison of organizational readiness, cultural factors, and structural barriers. Finally, research exploring patient perspectives on AI-assisted pressure injury management would provide a more comprehensive understanding of acceptance and trust at the healthcare system level.

Final Conclusions

In conclusion, the findings of this study demonstrate that the successful integration of artificial intelligence into pressure injury staging is not primarily a technological challenge, but a clinical, organizational, and ethical one. Nurses do not reject innovation; rather, they demand tools that respect workflow realities, enhance diagnostic confidence, standardize documentation, and preserve professional autonomy. By grounding system development in frontline clinical perspectives and aligning design principles with established theoretical frameworks such as the Technology Acceptance Model, this research provides a user-informed pathway toward the development of an AI-assisted tool that is not only technically robust, but also clinically meaningful. Ultimately, artificial intelligence in pressure injury management can become a trusted ally in nursing practice—provided that it strengthens, rather than replaces, human clinical judgment and supports safer, more standardized, and higher-quality patient care.

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Annexes

Annex A

WEB APPLICATION MAIN SCREENS

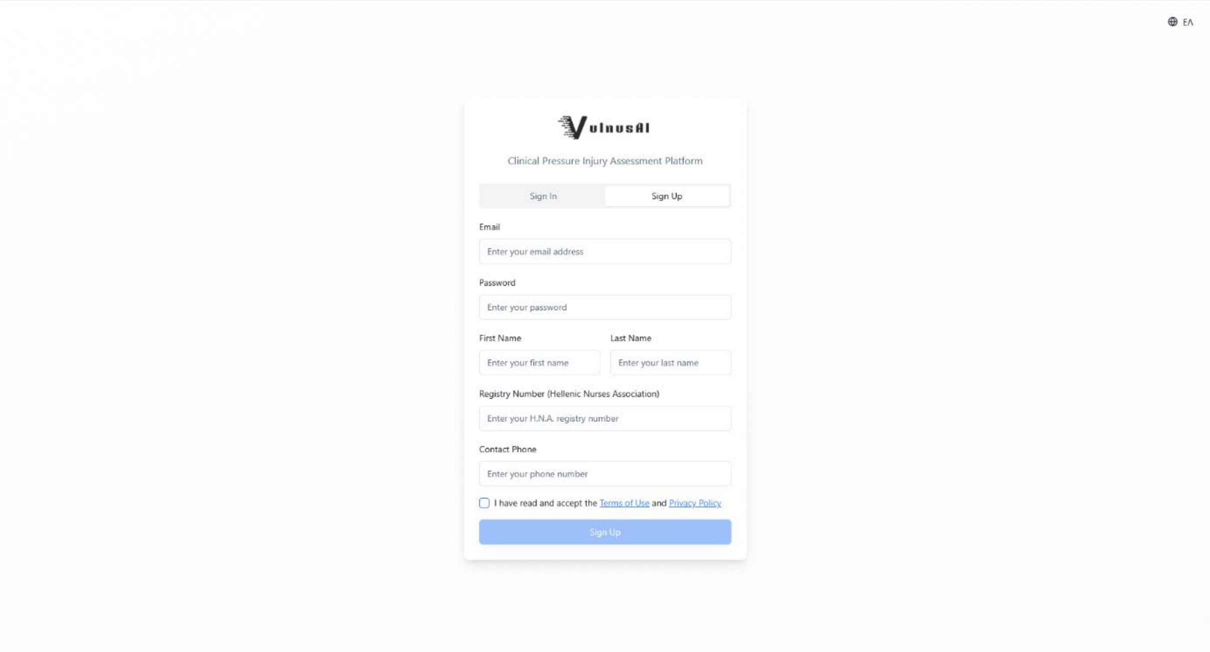

Figure A.1. Sign up

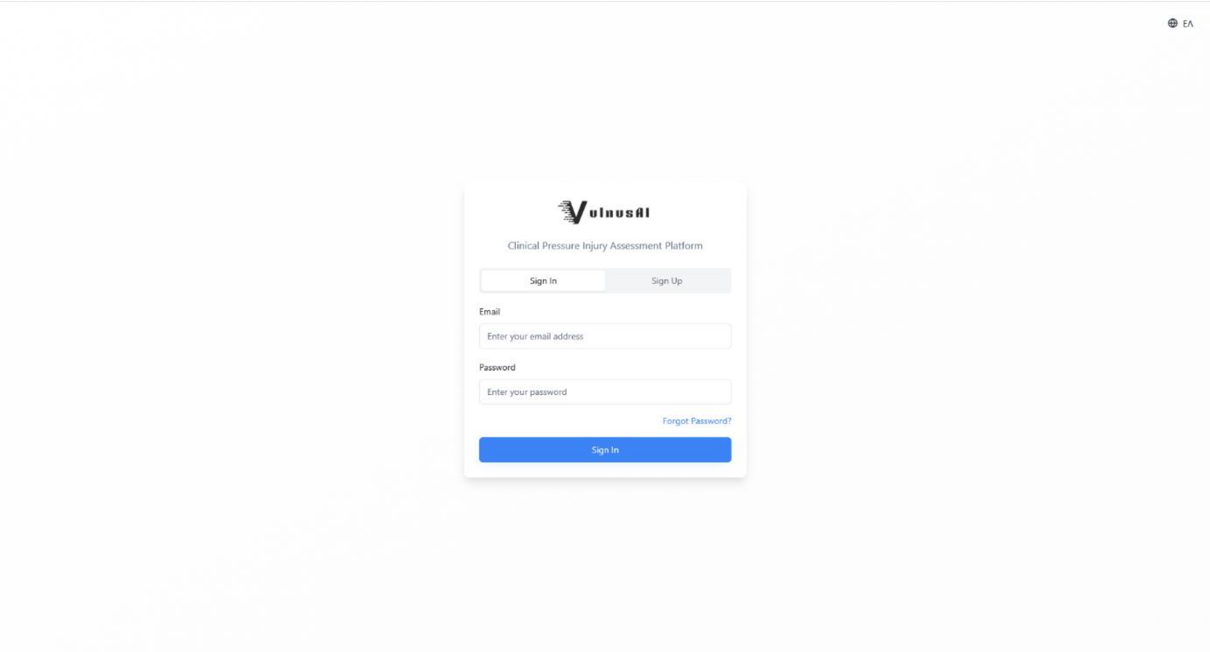

Figure A.2. Sign in

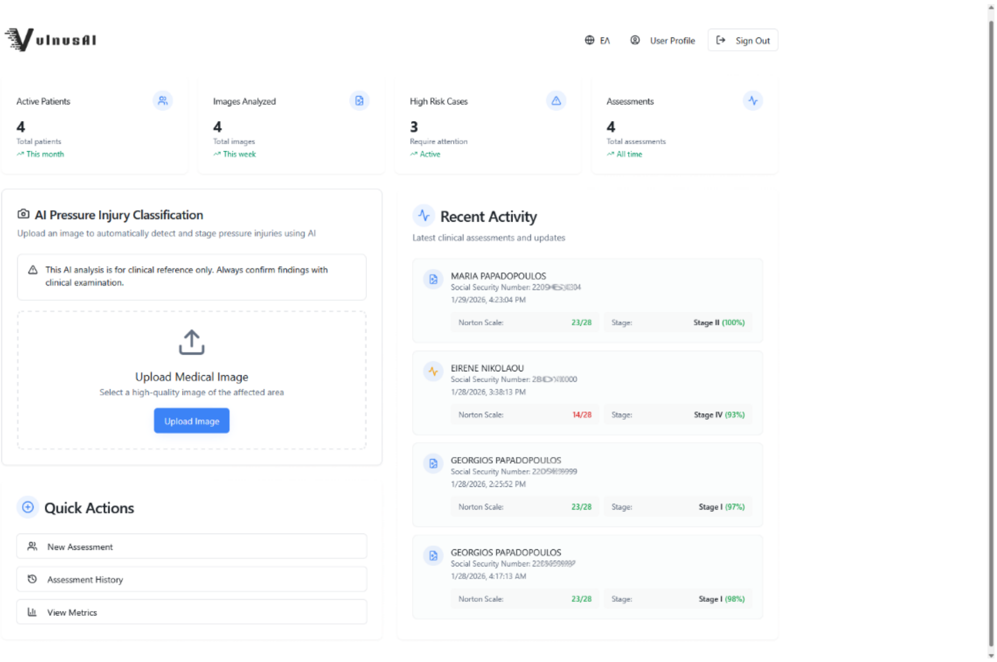

Figure A.3. Dashboard

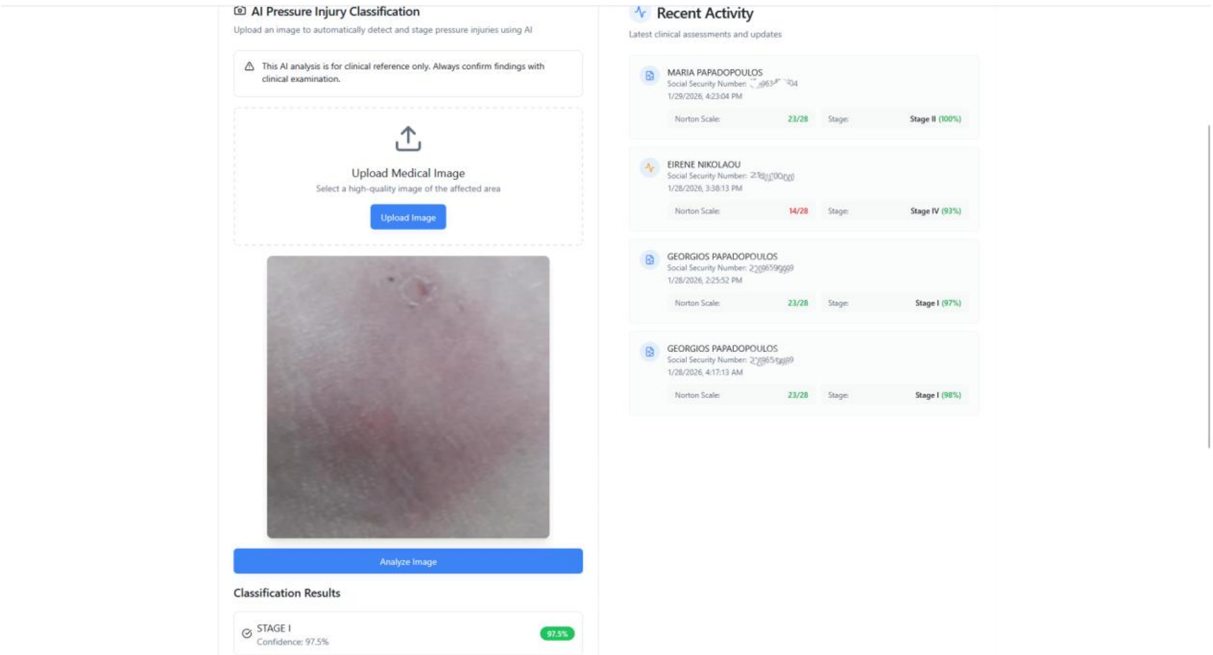

Figure A.4. Example of a classification results

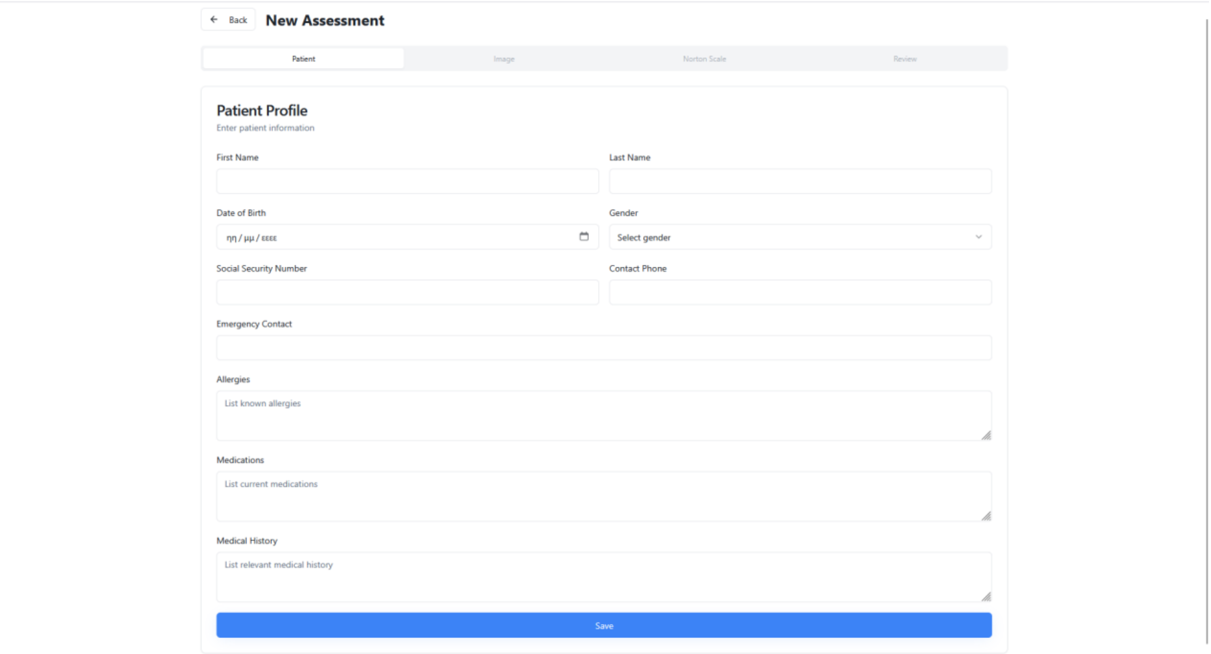

Figure A.5. Patient profile of new assessment screen

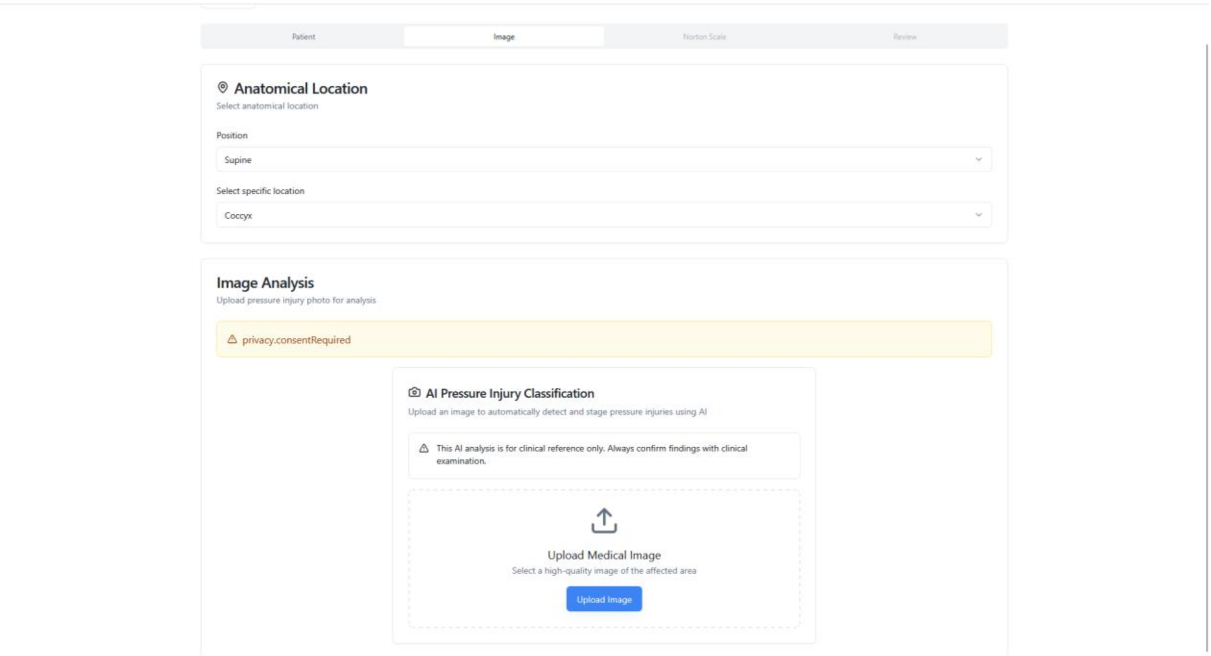

Figure A.6. Image analysis of new assessment screen

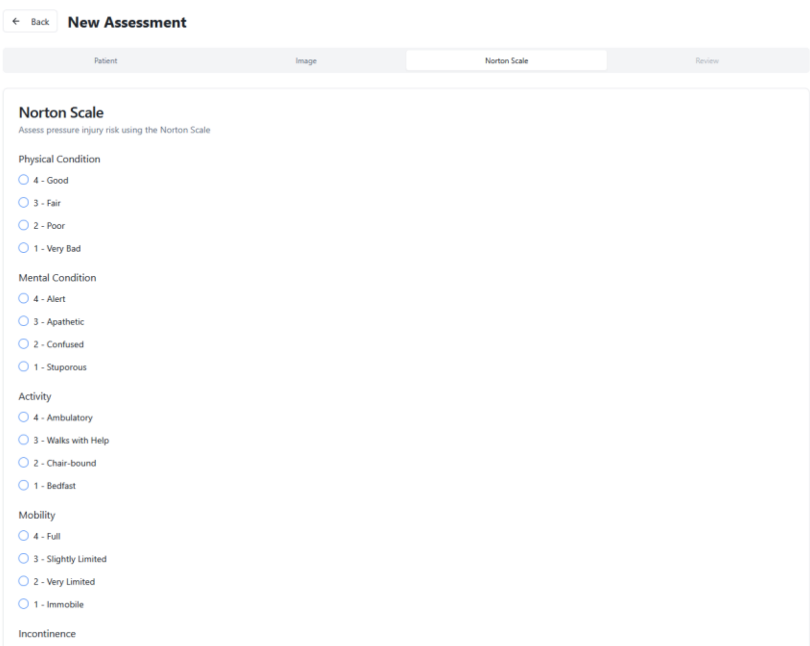

Figure A.7. Norton scale integration in new assessment screen

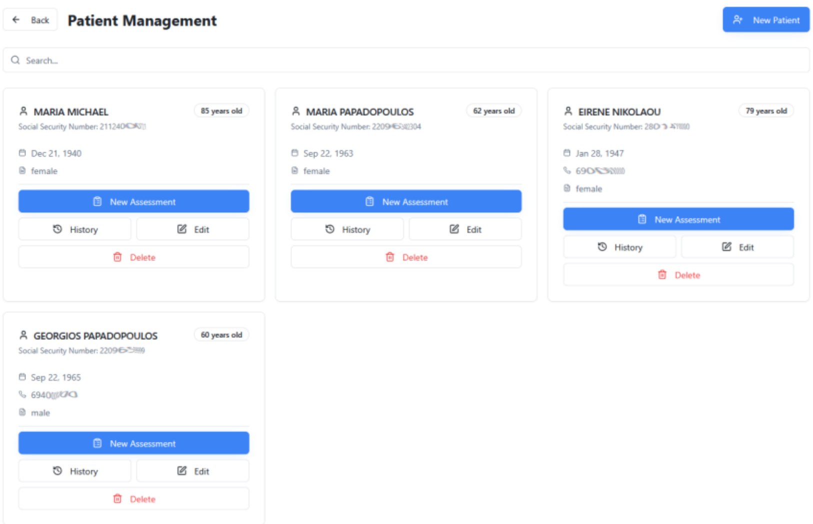

Figure A.8. Patient management screen

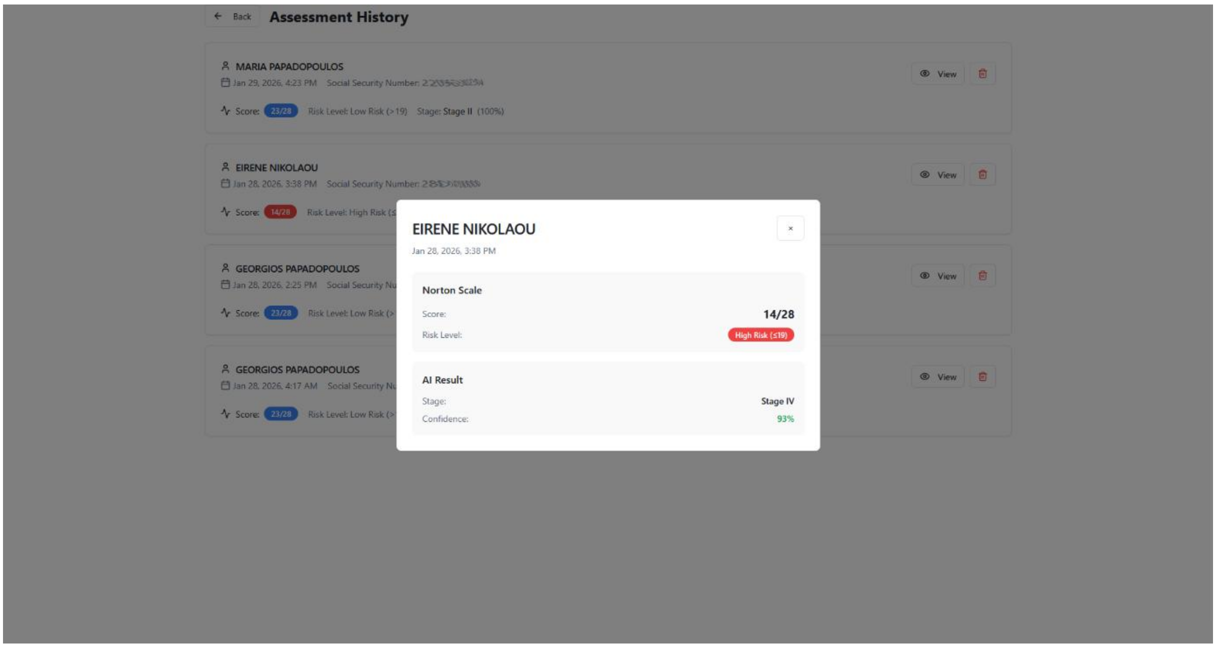

Figure A.9. Assessment history screen

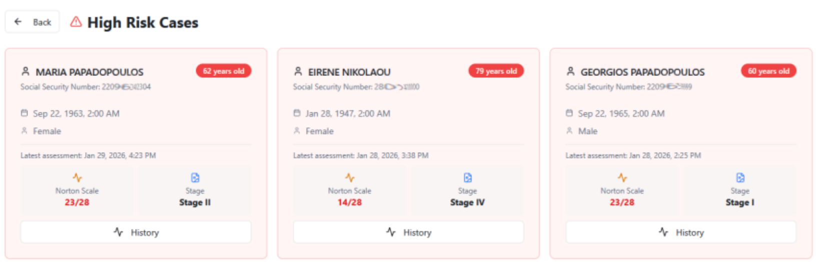

Figure A.10. High risk cases screen

Annex B

PARTICIPANT INFORMATION SHEET & INFORMED CONSENT FORM

Study Title

Development of a web-app using AI for staging and risk prediction of pressure injuries

1. Purpose of this Study

The aim of this study is to explore nurses' experiences, perceived challenges, and expectations regarding pressure injury staging and risk assessment, in order to inform the development of an AI-assisted web-based application for staging and risk prediction. Participants are invited to respond based on their personal clinical experience, focusing on:

- Daily clinical practices related to pressure ulcer staging
- Challenges encountered in routine care
- Features considered important for usability, safety, and workflow integration of an AI-assisted application

There are no right or wrong answers. All perspectives are valuable for the purposes of this research.

2. Study Procedures

Participation involves participation in a semi-structured interview (approximately 20 minutes). Explicit permission is requested for audio recording solely for transcription and research analysis purposes.

3. Voluntary Participation

Participation in this study is entirely voluntary. You have the right to withdraw at any time without any consequences. You may also decline to answer any question you do not wish to respond to. If you choose to withdraw, any data you have provided may be deleted upon request, provided that analysis has not yet been completed.

4. Confidentiality and Anonymity

No personal identifiers will be collected. Participants will not be asked to disclose confidential patient information or institutionally sensitive data. Any contextual details that could potentially lead to indirect identification will be omitted or modified in research reporting. Findings will be presented in aggregated or anonymized form.

5. Data Protection

All data will be handled in accordance with applicable data protection regulations, including the General Data Protection Regulation (EU 2016/679), where applicable. Audio recordings will be stored securely and deleted after transcription. Transcripts and research data will be stored in password-protected files. Only the researcher will have access to the raw data.

The data will be retained for academic purposes until the completion of the researcher's studies in the joint postgraduate program "Managidith", for as long as necessary if scientific publications in international scientific journals arise, and will then be permanently deleted.

6. Risks and Benefits

No foreseeable risks are anticipated from participation. There is no financial compensation for participation. However, your contribution may support the development of digital tools aimed at improving clinical decision-making and patient safety.

7. Contact Information

If you have any questions about the study, please contact:

Ioannis Kouroutzis

Email: iksso@iscte-iul.pt

Supervisor: Professor (Full) Panagiotis Bamidis, Aristotle University of Thessaloniki

CONSENT STATEMENT

I confirm that:

I have read and understood the information provided above.

I have had the opportunity to ask questions and received satisfactory answers.

I understand that my participation is voluntary and that I may withdraw at any time without consequences.

I agree to participate in this study.

☐ I consent to participate in this study.

☐ I consent to audio recording of the interview.

Participant Name:

Signature:

Date: