Leveraging Artificial Intelligence to Alleviate Nurse Workload and Improve Patient Care

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Abstract
The growing demand for healthcare services, coupled with global nursing shortages, has led to increased workloads and burnout among nurses, ultimately impacting patient care quality. Artificial intelligence (AI) presents a promising solution to alleviate these challenges by optimizing nursing workflows, reducing administrative burdens, and enhancing patient monitoring. This review explores how AI-driven technologies can support nurses by automating documentation, improving resource allocation, and facilitating real-time patient assessments. AI-powered predictive analytics and early warning systems enable proactive patient care by identifying critical conditions before they escalate, reducing response times and minimizing medical errors. Additionally, AI-enabled virtual assistants and chatbots streamline communication by handling routine inquiries, allowing nurses to focus on direct patient interactions. Robotic systems further contribute by assisting with patient lifting, medication dispensing, and supply management, reducing physical strain on nurses. Beyond workload reduction, AI enhances patient outcomes through personalized treatment recommendations and precision medicine applications. Wearable AI devices provide continuous health monitoring, improving early detection of complications and ensuring timely interventions. However, despite these benefits, AI implementation in healthcare faces challenges, including data privacy concerns, resistance to adoption, and integration complexities. Addressing these issues requires clear regulatory frameworks, adequate training for healthcare professionals, and ethical guidelines to ensure AI serves as a supportive tool rather than a replacement for human caregivers. Leveraging AI in nursing has the potential to improve efficiency, reduce stress on healthcare workers, and enhance patient safety and care quality. Future efforts should focus on refining AI algorithms, fostering nurse-AI collaboration, and implementing policies that promote responsible AI use in healthcare. By strategically integrating AI technologies, healthcare systems can better support nurses, optimize resources, and ultimately improve patient outcomes in an increasingly complex medical environment.

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1. Introduction

The healthcare industry is experiencing a growing crisis in nurse workload and burnout, exacerbated by rising patient demands, workforce shortages, and administrative burdens (Oliver and Care, 2019). Nurses play a crucial role in patient care, ensuring medical treatments, monitoring patient progress, and maintaining hospital safety standards. However, the increasing complexity of healthcare services, an aging population, and the recent impact of global health crises such as COVID-19 have placed unprecedented strain on nursing professionals (Zhu *et al*, 2022). Studies have shown that excessive workloads contribute to mental and physical exhaustion, reducing job satisfaction and increasing turnover rates. The consequences of nurse burnout extend beyond individual well-being, leading to diminished patient care quality, higher medical errors, and decreased healthcare

Efficiency (Kelly, 2020). Addressing this challenge is crucial to sustaining high-quality healthcare services and ensuring nurse retention in the workforce.

One of the primary challenges faced by nurses is the growing staff shortage, which results in increased patient-to-nurse ratios and extended working hours (Assaye *et al*, 2021). The demand for healthcare services continues to rise, but the supply of qualified nurses is not keeping pace, leading to exhaustion and reduced efficiency. Additionally, nurses are often burdened with non-clinical tasks such as documentation, patient record management, and administrative duties, which divert their focus from direct patient care. This administrative overload not only decreases productivity but also contributes to burnout and stress. The shortage of nursing staff, combined with the increasing complexity of healthcare delivery, requires innovative solutions to alleviate workload pressure and enhance patient care (Kurtzman *et al*, 2022).

The integration of artificial intelligence (AI) in healthcare has the potential to address many of the challenges associated with nurse workload and burnout. AI-driven technologies, such as machine learning algorithms, robotic process automation, and predictive analytics, can streamline nursing workflows, automate administrative tasks, and improve patient monitoring (Pandey *et al*, 2020; Clancy, 2020). By reducing the time spent on repetitive tasks, nurses can focus on their primary role delivering high-quality, compassionate care to patients. AI can also enhance decision-making through predictive models that identify patient deterioration, allowing for early intervention and improved health outcomes (Muralitharan *et al*, 2021). The objective of this study is to explore the role of AI in alleviating nurse workload and its impact on patient care quality, nurse well-being, and overall healthcare efficiency. Artificial intelligence has the potential to revolutionize nursing by optimizing workflows, reducing administrative burdens, and enhancing patient care (Dawoodbhoy *et al*, 2021). By automating routine documentation, scheduling, and data entry tasks, AI enables nurses to allocate more time to direct patient interactions, thus improving the quality of care. Additionally, AI-powered predictive analytics can assist in early diagnosis and personalized treatment planning, reducing medical errors and improving patient safety. By alleviating the stress and workload of nurses, AI can contribute to reducing burnout, increasing job satisfaction, and ultimately enhancing healthcare delivery (Alabi *et al*, 2021). This will examine the transformative role of AI in nursing, addressing both its potential benefits and challenges, and proposing strategies for its effective implementation in modern healthcare systems. The integration of AI in nursing has the potential to create a more sustainable and efficient healthcare environment. By addressing nurse workload challenges, AI can support healthcare professionals, improve patient outcomes, and ensure the long-term resilience of the nursing workforce (Flaubert *et al*, 2021).

2. The challenges in nursing workload

The nursing profession plays a vital role in healthcare delivery, ensuring patient safety, administering treatments, and coordinating care across multiple disciplines (Matthew *et al*, 2023). However, the increasing workload faced by nurses presents significant challenges that threaten the efficiency and sustainability of healthcare systems. From workforce shortages and administrative burdens to the direct impact on patient care quality, these challenges contribute to high levels of stress, burnout, and diminished job satisfaction (Long *et al*, 2020; Schlak *et al*, 2022). Understanding these issues is crucial for developing solutions to improve working conditions and enhance healthcare outcomes.

One of the primary challenges in nursing workload is the growing disparity between patient demand and the availability of nursing staff (Matthew *et al*, 2021). Due to a global shortage of qualified nurses, many healthcare facilities operate with insufficient personnel, leading to high patient-to-nurse ratios (Assaye *et al*, 2021). Studies have shown that when nurses are assigned an excessive number of patients, the quality of care declines, and the likelihood of adverse events increases. The lack of adequate staffing results in rushed procedures, reduced time for individualized patient care, and increased pressure on existing staff to meet high expectations despite limited resources. Extended shifts and overtime work are common among nurses due to staffing shortages and high patient volumes (Emmanuel *et al*, 2020). While the profession demands dedication, prolonged working hours contribute to significant physical and psychological strain. Nurses working 12-hour shifts or longer are at a higher risk of experiencing fatigue, sleep deprivation, and musculoskeletal issues. Additionally, the emotional toll of caring for critically ill patients, combined with overwhelming workloads, leads to high levels of stress, anxiety, and burnout. Burnout is characterized by emotional exhaustion, depersonalization, and a reduced sense of personal accomplishment, ultimately affecting both the well-being of nurses and the quality of care they provide (Dall'Ora *et al*, 2020; Piotrowska *et al*, 2022).

Nurses are required to complete extensive documentation to comply with hospital policies, regulatory requirements, and insurance guidelines (Tønnessen *et al*, 2020). While accurate record-keeping is essential for patient safety, the time spent on paperwork often detracts from direct patient care. A significant portion of a nurse's shift may be devoted to completing electronic health records (EHRs), charting vital signs, updating treatment plans, and submitting reports. This administrative burden can be overwhelming, reducing the time available for patient interaction and increasing stress levels among nursing staff. In addition to paperwork, nurses are responsible for continuous patient monitoring, which involves recording vital signs, tracking medication administration, and updating care plans. While these tasks are critical for ensuring patient safety, they often require manual data entry, further contributing to workload pressures (Mawuena and Mannion, 2022). The reliance on outdated documentation methods or inefficient hospital systems can make data management even more time-consuming. As a result, nurses struggle to balance administrative responsibilities with hands-on patient care, leading to frustration and decreased job satisfaction.

High workloads and staffing shortages inevitably result in delays in responding to patient needs. When nurses are stretched too thin, they may struggle to attend to patients in a timely manner, leading to dissatisfaction and potential health complications (Sartini *et al*, 2022). Delays in administering medication, responding to call bells, or addressing patient discomfort can negatively impact patient recovery and overall hospital experience. Research indicates that longer response times in healthcare settings are associated with increased risks of complications, prolonged hospital stays, and reduced patient trust in the healthcare system. One of the

most concerning consequences of excessive nursing workloads is the heightened risk of medical errors. When nurses are overworked and fatigued, they are more prone to mistakes in medication administration, patient assessments, and documentation. Errors such as incorrect dosages, misinterpretation of patient symptoms, or missed treatments can have severe consequences, including life-threatening complications. Studies have linked high workloads to increased incidence of adverse patient events, reinforcing the need for workload management strategies to ensure safe and effective patient care (Labrague *et al*, 2020; Nurmeksela *et al*, 2021).

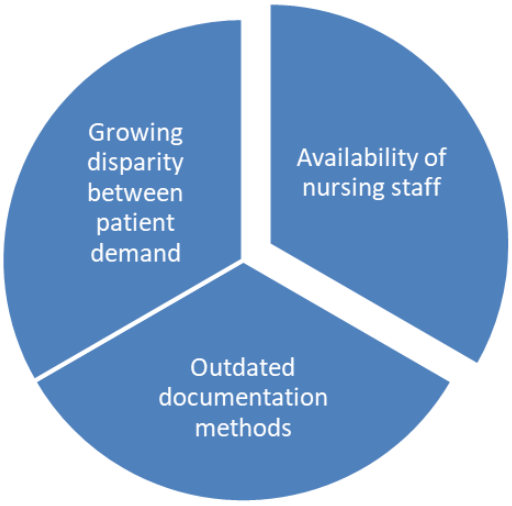

Fig 1: The challenges in nursing workload

The challenges associated with nursing workload, including workforce shortages, administrative burdens, and compromised patient care, highlight the urgent need for systemic changes in healthcare. Addressing these issues requires strategic workforce planning, technological advancements to streamline administrative tasks, and policies that support nurses' well-being (Wissemann *et al*, 2022). By implementing solutions such as artificial intelligence-driven automation, improved staffing ratios, and enhanced support systems, healthcare organizations can alleviate nurse workload and promote a safer, more efficient healthcare environment. Investing in the nursing workforce is essential to ensuring high-quality patient care and sustaining the future of healthcare systems worldwide (Rosa *et al*, 2022).

2.1 AI solutions for reducing nurse workload

The integration of artificial intelligence (AI) in healthcare has revolutionized nursing by streamlining workflows, reducing administrative burdens, and improving patient care as explain in figure 3 (Xu *et al*, 2021). Nurses often face increasing workloads due to staff shortages, extensive documentation requirements, and the need for continuous patient monitoring. AI-driven technologies offer solutions by automating administrative tasks, enhancing predictive analytics, assisting in patient interactions, and introducing robotic support systems (Habuza *et al*, 2021; Ponnusamy *et al*, 2022). These advancements enable nurses to focus more on direct patient care while minimizing burnout and operational inefficiencies.

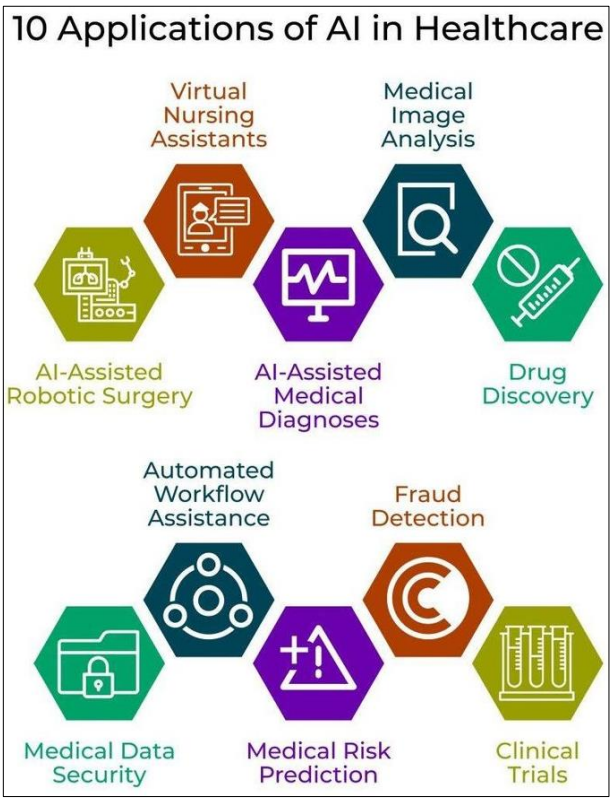

Fig 2: Application of Artificial intelligence in healthcare (Xu *et al*, 2021)

One of the most time-consuming aspects of nursing is the management of electronic health records (EHRs). Nurses must record patient data, update treatment plans, and complete regulatory documentation, which takes time away from direct patient interactions (Bjerkan *et al*, 2021). AI-powered automation tools streamline this process by automatically inputting patient data, reducing the need for manual entry. Advanced EHR systems utilize AI algorithms to extract relevant information from patient records, organize data efficiently, and generate real-time updates, ensuring accuracy and compliance while minimizing the workload for nurses (Mahmoud *et al*, 2020; Wani *et al*, 2022).

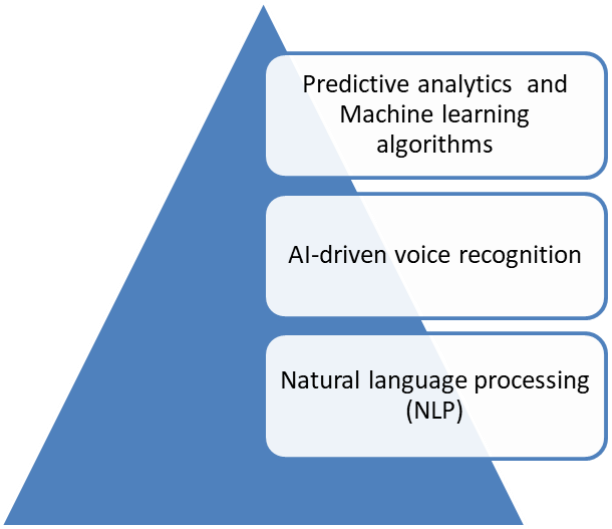

Fig 3: Software's on reducing nurse workload

AI-driven voice recognition and natural language processing (NLP) technologies further enhance documentation efficiency by allowing nurses to dictate notes rather than type them manually (Ognjanovic, 2020). AI-powered speech-to-text systems can accurately transcribe patient assessments, progress reports, and treatment recommendations, significantly reducing the time spent on paperwork. These systems can also integrate with EHR platforms, allowing seamless documentation without disrupting patient care. By leveraging NLP, nurses can focus more on patient engagement and less on administrative tasks, leading to improved efficiency and reduced cognitive burden (Tanniru *et al*, 2021).

Predictive analytics plays a crucial role in improving patient monitoring and reducing the pressure on nurses. AI-driven early warning systems analyze patient vital signs, laboratory results, and historical health data to detect signs of deterioration before they become critical (Haick and Tang, 2021). These systems provide real-time alerts to nursing staff, enabling timely interventions that can prevent complications and reduce hospital readmissions. AI-powered monitoring reduces the need for constant manual checks, allowing nurses to allocate their time more effectively while ensuring patient safety. Machine learning algorithms can anticipate patient needs based on historical data and current health conditions (Alanazi, 2022). By analyzing patterns in patient behavior, medication responses, and clinical histories, AI models can predict when a patient may require additional care, medication adjustments, or specialized interventions. This predictive capability allows nurses to proactively manage their workload, prioritize high-risk patients, and reduce the likelihood of emergency situations. AI-driven decision support systems also assist in optimizing treatment plans, ensuring evidence-based care while reducing the burden on nursing staff (Kalusivalingam *et al*, 2021; Li *et al*, 2022).

Nurses frequently handle routine patient inquiries, such as medication schedules, appointment reminders, and post-discharge care instructions. AI-powered chatbots alleviate this workload by providing instant responses to common patient questions, freeing nurses to focus on more complex tasks (Haleem *et al*, 2022). These virtual assistants operate through hospital websites, mobile applications, or messaging platforms, ensuring patients receive timely information without overwhelming nursing staff. AI chatbots also assist in triaging patient concerns, directing them to the appropriate resources or escalating urgent issues to healthcare professionals. Optimizing nurse scheduling and resource allocation is a challenging administrative task that affects workload distribution and patient care quality. AI-powered scheduling systems analyze staff availability, patient acuity levels, and workload distribution to generate optimized shift schedules. These systems ensure balanced workloads, prevent excessive overtime, and enhance overall efficiency. Additionally, AI-driven resource allocation tools predict supply usage, ensuring that nurses have the necessary medications, equipment, and personnel support to perform their duties effectively (Adly *et al*, 2020; Debnath *et al*, 2020). By automating scheduling and resource management, AI minimizes staffing inefficiencies and reduces nurse fatigue.

Physical strain from lifting and repositioning patients is a major contributor to nurse injuries and fatigue. AI-powered robotic assistants are designed to assist nurses in safely lifting, repositioning, and transporting patients, reducing the risk of musculoskeletal injuries (Ebers and Navas, 2020). These robotic systems use advanced sensors and machine learning algorithms to assess patient movement needs, ensuring safe and efficient handling. By incorporating robotics into patient mobility tasks, healthcare facilities can enhance workplace safety, reduce nurse strain, and improve patient comfort. Ensuring accurate medication administration is a critical nursing responsibility, but it can be time-consuming and prone to errors (Alblowi *et al*, 2021). AI-driven robotic systems streamline medication dispensing and delivery, reducing the likelihood of misadministration. Automated medication dispensing units ensure precise dosing and distribution, while robotic couriers transport medications to patient rooms, minimizing delays and freeing nurses from non-clinical tasks. These AI-driven solutions enhance medication safety, optimize workflow efficiency, and allow nurses to focus on direct patient care. AI-driven solutions offer transformative opportunities to alleviate nurse workload and enhance patient care. From automating administrative tasks to predictive analytics, virtual assistants, and robotics, AI technologies streamline nursing workflows, reduce burnout, and improve healthcare efficiency (Prasad *et al*, 2021). As AI continues to evolve, its integration into nursing practice will play a crucial role in addressing workforce shortages, optimizing resource allocation, and enhancing overall patient outcomes. Investing in AI-driven healthcare innovations is essential for creating a sustainable and effective nursing workforce in the future.

2.2 Improving patient care with AI

Artificial intelligence (AI) is transforming healthcare by enhancing patient monitoring, personalizing treatment plans, and reducing medical errors (Bohr and Memarzadeh, 2020). As healthcare systems face increasing demands due to aging populations, chronic diseases, and workforce shortages, AI-driven solutions provide a way to improve patient care while optimizing nursing efficiency. AI technologies such as predictive analytics, machine learning algorithms, and automation tools enable more precise and timely interventions, ultimately improving patient safety, treatment outcomes, and overall healthcare quality (Ahmed *et al*, 2020; Sahu *et al*, 2022).

The integration of wearable AI devices in patient care has significantly improved real-time monitoring and early detection of health deterioration. Wearable sensors equipped with AI algorithms can continuously track vital signs such as heart rate, oxygen levels, and blood pressure, providing clinicians with real-time health data as explain in figure 4 (Huang *et al*, 2022; Selvaraju *et al*, 2022). These devices are particularly useful for managing chronic diseases, post-operative monitoring, and elderly care. AI-driven analytics can detect anomalies in vital signs and predict potential health risks, enabling early intervention and reducing hospital readmissions. AI-based systems enhance patient safety by generating automated alerts for critical conditions, ensuring timely interventions. These systems analyze patient data from electronic health records (EHRs), wearable sensors, and bedside monitors to detect early signs of deterioration. If a patient's vital signs deviate from normal ranges, AI-powered alert systems notify nurses and physicians immediately. By reducing response times, these automated alerts improve patient outcomes, decrease mortality rates, and minimize the risk of medical emergencies (Zhang *et al*, 2022). AI-powered monitoring also optimizes nurse workload by prioritizing

high-risk patients, ensuring timely and effective care.

Personalized healthcare is one of the most promising applications of AI, as it enables customized treatment plans tailored to individual patient needs. AI algorithms analyze vast amounts of patient data, including medical history, genetic information, lifestyle factors, and lab results, to generate personalized care recommendations (Subramanian *et al*, 2020; Vadapalli *et al*, 2022). These AI-driven insights allow nurses and healthcare providers to offer precise and effective care, reducing trial-and-error approaches in treatment planning. Moreover, AI-generated care recommendations help in predicting disease progression, enabling early interventions and preventive measures. AI plays a crucial role in integrating precision medicine into routine clinical practice. Precision medicine focuses on tailoring treatments to individual genetic, environmental, and lifestyle factors, and AI enhances this approach by analyzing complex datasets (Ho *et al*, 2020). Machine learning models can identify the most effective treatments for specific patient subgroups, improving the accuracy of medical interventions. This level of precision not only enhances treatment efficacy but also minimizes adverse effects. By integrating AI into precision medicine, healthcare providers can optimize treatment strategies, reduce unnecessary procedures, and improve patient satisfaction (Mulukuntla and Pamulaparthyvenkata, 2022; Quazi, 2022).

Fig 4: Wearable sensors equipped with AI algorithms (Selvaraju *et al*, 2022)

Medical errors, particularly diagnostic errors, remain a significant challenge in healthcare. AI-driven diagnostic tools enhance clinical decision-making by analyzing medical images, pathology slides, and patient data to provide highly accurate assessments (Addimulam *et al*, 2022). Deep learning algorithms in radiology, for example, can detect abnormalities in X-rays, MRIs, and CT scans with accuracy comparable to or even surpassing that of human radiologists. In dermatology, AI-powered systems identify skin cancer by analyzing digital images, reducing misdiagnosis rates and ensuring early detection. Similarly, AI-enhanced diagnostic platforms help identify pneumonia, tuberculosis, and other conditions in medical imaging, improving diagnostic efficiency and patient outcomes (Fitzpatrick *et al*, 2020). By assisting healthcare professionals in making accurate diagnoses, AI reduces human error and enhances the overall quality of care. Medication errors are a common cause of adverse patient outcomes, often resulting from incorrect dosages, drug interactions, or prescribing errors. AI-driven decision-support systems enhance medication safety by cross-referencing patient records, allergies, and current medications to identify potential risks before prescriptions are finalized. Additionally, AI-powered robotic dispensing systems in hospitals reduce the risk of human error by automating medication preparation and distribution. These technologies not only improve patient safety but also alleviate the burden on nurses, who often manage complex medication regimens. AI has become an essential tool in enhancing patient care by improving monitoring, personalizing treatment, and reducing medical errors (Bates *et al*, 2021). Wearable AI devices and automated alert systems ensure continuous patient safety, while AI-driven care recommendations and precision medicine integration optimize treatment plans. Furthermore, AI-assisted diagnostics and medication safety systems minimize errors, enhancing overall healthcare quality. By leveraging AI, healthcare providers can deliver more efficient, accurate, and patient-centered care, ultimately improving health outcomes while alleviating the workload on nurses and clinicians (Bakken *et al*, 2021; Meissen *et al*, 2022).

2.3 Challenges and ethical considerations in AI implementation

Artificial intelligence (AI) has the potential to transform healthcare by alleviating nurse workloads, improving patient outcomes, and enhancing operational efficiency (Kocakoç, 2022). However, its successful implementation is hindered by several challenges and ethical considerations. Key concerns include data privacy and security risks, resistance to AI adoption among healthcare professionals, and financial and infrastructural barriers. Addressing these challenges is essential for ensuring that AI technologies are effectively integrated into healthcare systems while maintaining ethical and regulatory compliance.

One of the most critical challenges in AI implementation in healthcare is ensuring the privacy and security of patient data. AI systems rely on vast amounts of sensitive medical information, including electronic health records (EHRs), diagnostic images, and genomic data, to generate insights and recommendations (Panayides *et al*, 2020; Johnson *et al*, 2021). However, the collection, storage, and processing of such data must comply with strict healthcare data protection regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the General Data Protection Regulation (GDPR) in Europe. Non-compliance with these regulations can lead to significant legal and financial consequences for healthcare institutions. Furthermore, data breaches or unauthorized access to AI-driven healthcare systems can expose patients to identity theft, discrimination, and other risks (Griffin, 2021). To mitigate these concerns, healthcare organizations must implement robust encryption protocols, access controls, and secure cloud storage solutions to protect patient data while leveraging AI for improved clinical decision-making. AI systems in healthcare are only as reliable as the data they are trained on. If training datasets contain biases such as underrepresentation of certain demographics or healthcare conditions AI algorithms may produce inaccurate or discriminatory results (Norori *et al*, 2021; Varona and Suárez, 2022). To address this issue, AI developers must ensure that training datasets are diverse, representative, and regularly updated to reflect the latest medical knowledge and population demographics. Additionally, healthcare institutions should implement continuous monitoring and

validation processes to detect and correct biases in AI predictions. Transparency in AI decision-making, including explainable AI (XAI) models, can further enhance trust in AI-driven healthcare systems (Srinivasu *et al*, 2022).

The integration of AI technologies in healthcare has raised concerns among nurses and other healthcare professionals about potential job displacement (Chikhaoui *et al*, 2022). AI-driven automation of administrative tasks, patient monitoring, and even clinical decision-making may be perceived as a threat to traditional nursing roles. While AI can enhance efficiency, it cannot replace the critical thinking, empathy, and hands-on care that nurses provide. Addressing these concerns requires a shift in perspective, emphasizing AI as a tool that supports rather than replaces nursing roles (Charow *et al*, 2021). Healthcare organizations must actively involve nurses in the AI implementation process, ensuring that technology is designed to complement their expertise. By reducing repetitive administrative tasks, AI allows nurses to focus more on direct patient care, ultimately improving job satisfaction and patient outcomes.

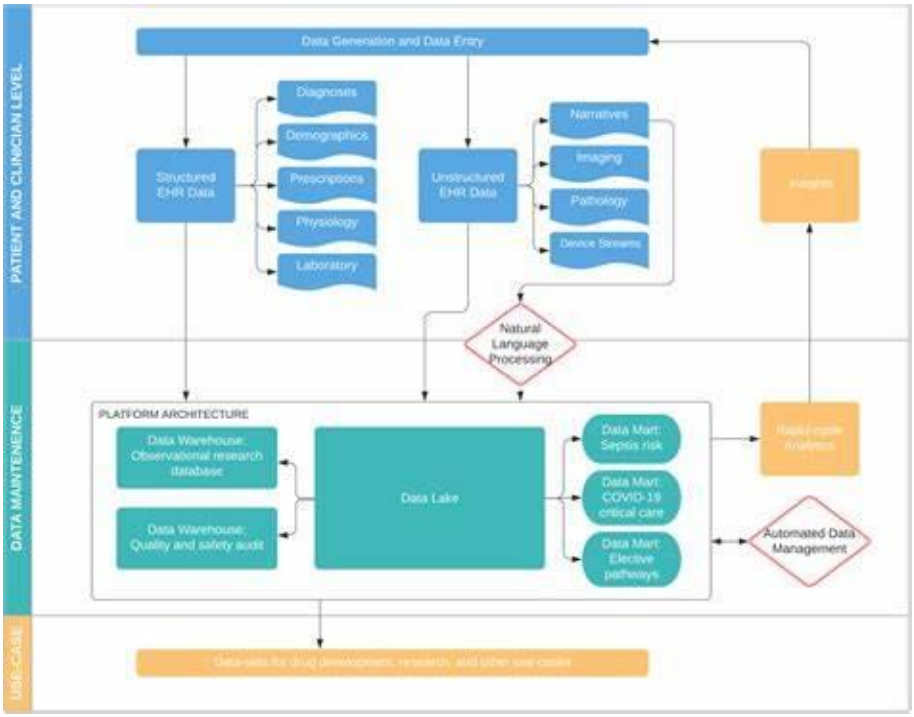

Fig 5: General component of HER system (Giordano *et al*, 2021)

A significant barrier to AI adoption is the lack of training and education among nurses regarding AI tools and applications (Chew and Achananuparp, 2022). Many healthcare professionals are unfamiliar with how AI systems function, leading to skepticism and reluctance to integrate these technologies into daily practice. To facilitate a smooth transition, healthcare institutions must invest in AI literacy programs for nurses and other staff members. Training should include hands-on workshops, continuing education courses, and interdisciplinary collaboration between nurses and AI developers (Bergendahl *et al*, 2020; Ronquillo *et al*, 2021). By empowering nurses with the knowledge and skills to use AI effectively, healthcare organizations can foster a culture of acceptance and innovation in AI-driven healthcare solutions.

Implementing AI in healthcare requires significant financial investment in software development, hardware infrastructure, and staff training. Many hospitals and healthcare facilities, particularly those in resource-limited settings, may struggle to allocate funds for AI adoption (Ismail and Kumar, 2021). The costs associated with AI include licensing fees for AI software, maintenance of AI-powered systems, and hiring data scientists and IT specialists to oversee implementation. To overcome financial constraints, healthcare organizations should explore partnerships with AI technology providers, government grants, and research funding opportunities. Additionally, a phased approach to AI integration starting with small-scale pilot programs before full-scale implementation can help manage costs while demonstrating AI's benefits in improving healthcare efficiency (Munoz and Naqvi, 2021; Norton, 2021). AI technologies must be seamlessly integrated into existing healthcare IT systems, such as EHRs and clinical decision-support tools as explain in figure 5 (Giordano *et al*, 2021). However, interoperability challenges often arise due to differences in data formats, software architectures, and proprietary systems used by different healthcare providers. Without standardized protocols, AI solutions may struggle to access and analyze patient data across multiple platforms, limiting their effectiveness. To address this issue, healthcare organizations and technology developers must work towards standardized data exchange frameworks, such as the Fast Healthcare Interoperability Resources (FHIR) standard, which facilitates seamless integration between AI and existing healthcare IT systems (Spanakis *et al*, 2021; Xiao *et al*, 2021). Additionally, collaboration between healthcare providers, AI developers, and regulatory bodies is essential to establish interoperability guidelines that ensure AI-driven solutions can be effectively deployed across diverse healthcare environments. While AI holds immense potential to enhance patient care and alleviate nurse workload, its implementation is accompanied by significant challenges and ethical considerations (Aung *et al*, 2021). Ensuring data privacy and security, addressing AI biases, and complying

with healthcare regulations are essential for maintaining trust in AI-driven healthcare systems. Additionally, overcoming resistance to AI adoption among nurses through education and reassurance can facilitate a smoother transition. Finally, addressing financial and infrastructural barriers will enable broader AI integration across healthcare settings. By proactively addressing these challenges, healthcare organizations can maximize the benefits of AI while upholding ethical standards and improving healthcare delivery (Bhuyan *et al*, 2020).

2.4 Future Directions

The integration of artificial intelligence (AI) in nursing presents significant opportunities to reduce workload, improve patient outcomes, and optimize healthcare efficiency (Yang *et al*, 2022). However, to maximize these benefits, a strategic approach is necessary. Future directions should focus on enhancing AI-nurse collaboration, establishing comprehensive policy and regulatory frameworks, and fostering research and innovation (Sallstrom *et al*, 2019; Thomas *et al*, 2019). These measures will ensure AI is effectively leveraged while maintaining ethical standards and addressing healthcare-specific challenges.

One of the major concerns surrounding AI in nursing is the fear that automation may replace human roles, leading to job displacement (Willcocks, 2020). However, AI should be positioned as a complementary tool that enhances nurses' efficiency rather than replacing their expertise. AI technologies can automate routine administrative tasks, analyze vast amounts of patient data, and provide clinical decision support. This allows nurses to dedicate more time to direct patient care, which remains an irreplaceable human-centered responsibility. To facilitate AI-nurse collaboration, hospitals and healthcare institutions should involve nurses in AI implementation discussions, ensuring that their insights shape the development and adoption of AI technologies (Kim *et al*, 2022; Bhat *et al*, 2022). Additionally, fostering a positive perspective on AI as an aid rather than a competitor can help alleviate concerns about job security and encourage greater acceptance among nursing professionals. Decision-support systems powered by AI can enhance clinical decision-making by providing real-time recommendations based on patient data. These systems use machine learning algorithms to identify patterns in patient histories, predict potential complications, and suggest optimal interventions. To optimize the use of AI decision-support tools, healthcare institutions should integrate them into existing nursing workflows while ensuring that nurses receive adequate training (Withall *et al*, 2022). AI models should also be designed to provide interpretable recommendations, allowing nurses to understand the rationale behind AI-generated insights and maintain clinical oversight.

The ethical implementation of AI in nursing requires the development of clear guidelines that ensure responsible AI deployment (Naik *et al*, 2022). These guidelines should address key ethical concerns such as patient privacy, informed consent, and algorithmic fairness. Regulatory bodies, such as the World Health Organization (WHO) and national healthcare agencies, should collaborate with AI experts and nursing professionals to establish standardized frameworks for AI usage in clinical settings (Matheny *et al*, 2019; Morley *et al*, 2022). Ethical guidelines should emphasize that AI systems must operate within human-centered healthcare models, where nurses and other professionals maintain authority over clinical decisions. This will help prevent over-reliance on AI and ensure that human judgment remains a critical component of patient care. Transparency in AI decision-making is crucial for ensuring trust and reliability in healthcare applications. AI models should be designed to provide clear explanations for their recommendations, allowing nurses to verify AI-generated insights before acting upon them. Additionally, mechanisms for accountability should be established to address potential errors or biases in AI algorithms (Cooper *et al*, 2022). Regulatory frameworks should also mandate rigorous validation and testing of AI systems before deployment. Continuous auditing and monitoring of AI performance in healthcare settings will help detect biases, errors, or unintended consequences that could impact patient safety. Furthermore, healthcare organizations should implement AI governance structures that oversee compliance with ethical and regulatory standards (Roski *et al*, 2021).

AI applications in healthcare are rapidly evolving, but many existing models are primarily designed for physician use rather than nursing-specific tasks. To fully realize AI's potential in nursing, research efforts should focus on developing AI tools that address the unique challenges faced by nurses (Stoke and Palmer, 2020). This includes AI-driven workflow optimization, predictive analytics for patient deterioration, and automation of time-consuming administrative tasks. Interdisciplinary research initiatives should be encouraged, bringing together AI developers, data scientists, and nursing professionals to co-design AI solutions that align with real-world nursing needs. Additionally, AI models should be trained on diverse and representative datasets to ensure they cater to a wide range of patient populations and healthcare environments (Al Hasan *et al*, 2024; Matthew *et al*, 2024). The successful integration of AI into nursing requires strong collaboration between technology developers and healthcare professionals. Interdisciplinary teams consisting of nurses, AI engineers, healthcare administrators, and policymakers should work together to ensure AI solutions are practical, effective, and aligned with clinical workflows (Shneiderman, 2020; Gama *et al*, 2022). Hospitals and research institutions should facilitate partnerships with AI technology companies to co-develop AI applications tailored for nursing practice. Additionally, nursing schools should integrate AI education into their curricula, preparing future nurses to work with AI-driven tools and fostering a culture of innovation within the profession.

The future of AI in nursing depends on a balanced approach that prioritizes AI-nurse collaboration, ethical policy frameworks, and continuous research and innovation (Adegoke *et al*, 2022; Nnagha *et al*, 2023). AI should be positioned as a supportive tool that enhances nursing efficiency rather than replacing human expertise. Regulatory frameworks must ensure AI transparency, accountability, and ethical usage to maintain trust in AI-driven healthcare. Additionally, ongoing research should focus on developing AI models tailored specifically for nursing needs while promoting interdisciplinary collaboration. By implementing these strategies, healthcare systems can harness the full potential of AI to improve nursing workflows, enhance patient care, and optimize overall healthcare efficiency (Matthew *et al*, 2024).

3. Conclusion

Artificial intelligence (AI) is rapidly transforming healthcare, particularly in nursing, where it offers solutions to alleviate workload, optimize workflows, and enhance patient care. This review has explored key aspects of AI integration in nursing, including its role in reducing administrative burdens, improving patient monitoring, and minimizing medical errors. Challenges such as workforce shortages, burnout, and administrative overload significantly impact nurses, leading to increased stress and reduced quality of patient care. AI-driven solutions, including predictive analytics, virtual assistants, and robotic automation, have the potential to support nurses by streamlining tasks and allowing them to focus more on direct patient care. However, concerns regarding data privacy, ethical considerations, cost barriers, and resistance to AI adoption must be addressed for successful implementation.

AI should be viewed as a tool that complements rather than replaces nurses. By enhancing efficiency in patient monitoring, care planning, and decision-making, AI can empower nurses to provide safer and more personalized healthcare. Ethical guidelines, regulatory frameworks, and adequate training are essential to ensure AI is deployed responsibly and effectively. Additionally, fostering interdisciplinary collaboration between AI developers and healthcare professionals will ensure that AI solutions are tailored to the real-world needs of nurses and patients.

As healthcare systems continue to evolve, it is crucial to prioritize AI integration in a way that supports nurses and enhances patient outcomes. Policymakers, healthcare institutions, and technology developers must work together to ensure AI is implemented ethically and efficiently. Investment in AI-driven nursing tools, combined with education and regulatory oversight, will pave the way for a future where AI enhances nursing practice without compromising the human touch that is fundamental to quality healthcare. Now is the time to embrace AI as a strategic ally in nursing, ensuring that it is harnessed to alleviate workload pressures while improving patient care.

4. Reference

1. Addimulam S, Mohammed MA, Karanam RK, Ying D, Pydipalli R, Patel B, *et al* Deep learning-enhanced image segmentation for medical diagnostics. Malaysian Journal of Medical and Biological Research. 2020;7(2):145–52.
2. Adegoke SA, Oladimeji OI, Akinlosotu MA, Akinwumi AI, Matthew KA. HemoTypeSC point-of-care testing shows high sensitivity with alkaline cellulose acetate hemoglobin electrophoresis for screening hemoglobin SS and SC genotypes. Hematology, Transfusion and Cell Therapy. 2022;44(3):341–5.
3. Adly AS, Adly AS, Adly MS. Approaches based on artificial intelligence and the internet of intelligent things to prevent the spread of COVID-19: Scoping review. Journal of Medical Internet Research. 2020;22(8):e19104.
4. Ahmed Z, Mohamed K, Zeeshan S, Dong X. Artificial intelligence with multi-functional machine learning platform development for better healthcare and precision medicine. Database. 2020;2020: baaa010.
5. Al Hasan SM, Matthew KA, Toriola AT. Education and mammographic breast density. Breast Cancer Research and Treatment. 2024;1–8.
6. Alabi RO, Hietanen P, Elmusrati M, Youssef O, Almangush A, Mäkitie AA. Mitigating burnout in an oncological unit: A scoping review. Frontiers in Public Health. 2021;9:677915.
7. Alanazi R. Identification and prediction of chronic diseases using machine learning approach. Journal of Healthcare Engineering. 2022;2022(1):2826127.
8. Alblowi F, Alaidi H, Dakhilallah H, Alamrani A. Nurses' perspectives on causes and barriers to reporting medication administration errors. Health Science Journal. 2021;15(9):1–7.
9. Assaye AM, Wiechula R, Schultz TJ, Feo R. Impact of nurse staffing on patient and nurse workforce outcomes in acute care settings in low- and middle-income countries: A systematic review. JBI Evidence Synthesis. 2021;19(4):751–93.
10. Aung YY, Wong DC, Ting DS. The promise of artificial intelligence: A review of the opportunities and challenges of artificial intelligence in healthcare. British Medical Bulletin. 2021;139(1):4–15.
11. Bakken S, Dykes PC, Rossetti SC, Ozbolt JG. Patient-centered care systems. In: Biomedical Informatics: Computer Applications in Health Care and Biomedicine. Cham: Springer International Publishing; 2021. p. 575–612.
12. Bates DW, Levine D, Syrowatka A, Kuznetsova M, Craig KJT, Rui A, *et al* The potential of artificial intelligence to improve patient safety: A scoping review. NPJ Digital Medicine. 2021;4(1):54.
13. Bergendahl L, Werner F, Schmidt A, Ronicke M, Renner R, Erfurt-Berge C. Development and evaluation of an interprofessional teaching concept for modern wound management. JDDG: Journal der Deutschen Dermatologischen Gesellschaft. 2020;18(9):977–82.
14. Bhat JR, Alfandi O, Abugabah A, Sheu JP. Case studies on implementation of smart healthcare across global smart cities. In: Smart and Secure Internet of Healthcare Things. CRC Press; 2022. p. 175–98.
15. Bhuyan SS, Kabir UY, Escareno JM, Ector K, Palakodeti S, Wyant D, *et al* Transforming healthcare cybersecurity from reactive to proactive: Current status and future recommendations. Journal of Medical Systems. 2020;44:1–9.
16. Bjerkan J, Valderaune V, Olsen RM. Patient safety through nursing documentation: Barriers identified by healthcare professionals and students. Frontiers in Computer Science. 2021;3:624555.
17. Bohr A, Memarzadeh K. The rise of artificial intelligence in healthcare applications. In: Artificial Intelligence in Healthcare. Academic Press; 2020. p. 25–60.
18. Charow R, Jeyakumar T, Younus S, Dolatabadi E, Salhia M, Al-Mouaswas D, *et al* Artificial intelligence education programs for healthcare professionals: Scoping review. JMIR Medical Education. 2021;7(4): e31043.
19. Chew HSJ, Achananuparp P. Perceptions and needs of artificial intelligence in healthcare to increase adoption: Scoping review. Journal of Medical Internet Research. 2022;24(1): e32939.
20. Chikhaoui E, Alajmi A, Larabi-Marie-Sainte S. Artificial intelligence applications in healthcare sector: ethical and legal challenges. Emerging Science Journal. 2022;6(4):717–38.
21. Clancy TR. Technology solutions for nurse leaders.

Nursing Administration Quarterly. 2020;44(4):300–15.
22. Cooper AF, Moss E, Laufer B, Nissenbaum H. Accountability in an algorithmic society: Relationality, responsibility, and robustness in machine learning. In: Proceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency. 2022. p. 864–76.
23. Dall'Ora C, Ball J, Reinius M, Griffiths P. Burnout in nursing: A theoretical review. Human Resources for Health. 2020;18:1–17.
24. Dawoodbhoy FM, Delaney J, Cecula P, Yu J, Peacock I, Tan J, *et al* AI in patient flow: Applications of artificial intelligence to improve patient flow in NHS acute mental health inpatient units. Heliyon. 2021;7(5).
25. Debnath S, Barnaby DP, Coppa K, Makhnevich A, Kim EJ, Chatterjee S, *et al* Machine learning to assist clinical decision-making during the COVID-19 pandemic. Bioelectronic Medicine. 2020;6:1–8.
26. Ebers M, Navas S, eds. Algorithms and Law. Cambridge University Press; 2020.
27. Emmanuel T, Dall'Ora C, Ewings S, Griffiths P. Are long shifts, overtime and staffing levels associated with nurses' opportunity for educational activities, communication and continuity of care assignments? A cross-sectional study. International Journal of Nursing Studies Advances. 2020;2:100002.
28. Fitzpatrick F, Doherty A, Lacey G. Using artificial intelligence in infection prevention. Current Treatment Options in Infectious Diseases. 2020;12:135–44.
29. Flaubert JL, Le Menestrel S, Williams DR, Wakefield MK, National Academies of Sciences, Engineering, and Medicine. Supporting the health and professional well-being of nurses. In: The Future of Nursing 2020–2030: Charting a Path to Achieve Health Equity. National Academies Press (US); 2021.
30. Gama F, Tyskbo D, Nygren J, Barlow J, Reed J, Svedberg P. Implementation frameworks for artificial intelligence translation into healthcare practice: Scoping review. Journal of Medical Internet Research. 2022;24(1):e32215.
31. Giordano C, Brennan M, Mohamed B, Rashidi P, Modave F, Tighe P. Accessing artificial intelligence for clinical decision-making. Frontiers in Digital Health. 2021;3:645232.
32. Griffin F. Artificial intelligence and liability in healthcare. Health Matrix. 2021;31:65.
33. Habuza T, Navaz AN, Hashim F, Alnajjar F, Zaki N, Serhani MA, *et al* AI applications in robotics, diagnostic image analysis, and precision medicine: Current limitations, future trends, guidelines on CAD systems for medicine. Informatics in Medicine Unlocked. 2021;24:100596.
34. Haick H, Tang N. Artificial intelligence in medical sensors for clinical decisions. ACS Nano. 2021;15(3):3557–67.
35. Haleem A, Javaid M, Singh RP, Suman R. Medical 4.0 technologies for healthcare: Features, capabilities, and applications. Internet of Things and Cyber-Physical Systems. 2022;2:12–30.
36. Ho D, Quake SR, McCabe ER, Chng WJ, Chow EK, Ding X, *et al* Enabling technologies for personalized and precision medicine. Trends in Biotechnology. 2020;38(5):497–518.
37. Huang JD, Wang J, Ramsey E, Leavey G, Chico TJ, Condell J. Applying artificial intelligence to wearable sensor data to diagnose and predict cardiovascular disease: A review. Sensors. 2022;22(20):8002.
38. Ismail A, Kumar N. AI in global health: The view from the front lines. In: Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems. 2021. p. 1–21.
39. Johnson KB, Wei WQ, Weeraratne D, Frisse ME, Misulis K, Rhee K, *et al* Precision medicine, AI, and the future of personalized healthcare. Clinical and Translational Science. 2021;14(1):86–93.
40. Kalusivalingam AK, Sharma A, Patel N, Singh V. Enhancing patient care through IoT-enabled remote monitoring and AI-driven virtual health assistants: Implementing machine learning algorithms and natural language processing. International Journal of AI and ML. 2021;2(3).
41. Kelly L. Burnout, compassion fatigue, and secondary trauma in nurses: Recognizing the occupational phenomenon and personal consequences of caregiving. Critical Care Nursing Quarterly. 2020;43(1):73–80.
42. Kim I, Nepomuceno A, Jamison S, Michel J, Kesavadas T. Extensive simulation of human-robot interaction for critical care telemedicine. In: 2022 Annual Modeling and Simulation Conference (ANNSIM). IEEE; 2022. p. 329–40.
43. Kocakoç ID. The role of artificial intelligence in health care. In: The Impact of Artificial Intelligence on Governance, Economics and Finance, Volume 2. Singapore: Springer Nature Singapore; 2022. p. 189–206.
44. Kurtzman ET, Ghazal LV, Girouard S, Ma C, Martin B, McGee BT, *et al* Nursing workforce challenges in the postpandemic world. Journal of Nursing Regulation. 2022;13(2):49.
45. Labrague LJ, De los Santos JAA, Tsaras K, Galabay JR, Falguera CC, Rosales RA, *et al* The association of nurse caring behaviours on missed nursing care, adverse patient events and perceived quality of care: A cross-sectional study. Journal of Nursing Management. 2020;28(8):2257–65.
46. Li L, Diouf F, Gorkhali A. Managing outpatient flow via an artificial intelligence-enabled solution. Systems Research and Behavioral Science. 2022;39(3):415–27.
47. Long L, Moore D, Robinson S, Sansom A, Aylward A, Fletcher E, *et al* Understanding why primary care doctors leave direct patient care: A systematic review of qualitative research. BMJ Open. 2020;10(5):e029846.
48. Mahmoud N, El-Sappagh S, El-Bakry HM, Abdelrazek S. A real-time framework for patient monitoring systems based on a wireless body area network. International Journal of Computer Applications. 2020;176(27):12–21.
49. Matheny M, Israni ST, Ahmed M, Whicher D. Artificial intelligence in health care: The hope, the hype, the promise, the peril. Washington, DC: National Academy of Medicine; 2019.
50. Matthew KA, Akinwale FM, Opia FN, Adenike A. The relationship between oral contraceptive use, mammographic breast density, and breast cancer risk.
51. Matthew KA, Getz KR, Jeon MS, Luo C, Luo J, Toriola AT. Associations of vitamins and related cofactor metabolites with mammographic breast density in premenopausal women. The Journal of Nutrition. 2024;154(2):424–34.
52. Matthew KA, Opia FN, Matthew A. Policy solutions for

reducing racial and ethnic disparities in cancer mortality. Journal of Advance Multidisciplinary Research. 2023;2(2):77–85.
53. Matthew KA, Vanapali GK, Getz KR, Jeon MS, Luo C, Guo X, *et al* Steroid hormone metabolites and mammographic breast density in premenopausal women. Cancer Research. 2024;84(6_Supplement):4431–1.
54. Mawuena EK, Mannion R. Implications of resource constraints and high workload on speaking up about threats to patient safety: A qualitative study of surgical teams in Ghana. BMJ Quality & Safety. 2022;31(9):662–9.
55. Meissen H, Gong MN, Wong AKI, Zimmerman JJ, Nadkarni N, Kane-Gil SL, *et al* The future of critical care: Optimizing technologies and a learning healthcare system to potentiate a more humanistic approach to critical care. Critical Care Explorations. 2022;4(3):e0659.
56. Morley J, Murphy L, Mishra A, Joshi I, Karpathakis K. Governing data and artificial intelligence for healthcare: Developing an international understanding. JMIR Formative Research. 2022;6(1):e31623.
57. Mulukuntla S, Pamulaparthyvenkata S. Realizing the potential of AI in improving health outcomes: Strategies for effective implementation. ESP Journal of Engineering and Technology Advancements. 2022;2(3):32–40.
58. Munoz JM, Naqvi A. The AI Leader. Anthem Press; 2021.
59. Muralitharan S, Nelson W, Di S, McGillion M, Devereaux PJ, Barr NG, *et al* Machine learning–based early warning systems for clinical deterioration: Systematic scoping review. Journal of Medical Internet Research. 2021;23(2):e25187.
60. Naik N, Hameed BM, Shetty DK, Swain D, Shah M, Paul R, *et al* Legal and ethical consideration in artificial intelligence in healthcare: Who takes responsibility? Frontiers in Surgery. 2022;9:862322.
61. Nnagha EM, Ademola MK, Izevbizua EA, Uwishema O, Nazir A, Wellington J. Tackling sickle cell crisis in Nigeria: The need for newer therapeutic solutions in sickle cell crisis management–short communication. Annals of Medicine and Surgery. 2023;85(5):2282–6.
62. Norori N, Hu Q, Aellen FM, Faraci FD, Tzovara A. Addressing bias in big data and AI for healthcare: A call for open science. Patterns. 2021;2(10).
63. Norton P. Autonorama: The illusory promise of high-tech driving. Island Press; 2021.
64. Nurmeksela A, Mikkonen S, Kinnunen J, Kvist T. Relationships between nurse managers' work activities, nurses' job satisfaction, patient satisfaction, and medication errors at the unit level: A correlational study. BMC Health Services Research. 2021;21:1–13.
65. Ognjanovic I. Artificial intelligence in healthcare. In: Health Information Management: Empowering Public Health. IOS Press; 2020. p. 189–205.
66. Oliver C, Care FC. Global shortage of nurses. Montreal (QC): McGill University Health Centre; 2019.
67. Panayides AS, Amini A, Filipovic ND, Sharma A, Tsaftaris SA, Young A, *et al* AI in medical imaging informatics: Current challenges and future directions. IEEE Journal of Biomedical and Health Informatics. 2020;24(7):1837–57.
68. Pandey MR, Jain MR, Jain MR, Verma MNK. The role of artificial intelligence in enhancing nursing workflows. In: The Role of Science and Technology in Modern Nursing Practices. 2020. p. 324.
69. Piotrowska A, Lisowska A, Twardak I, Włostowska K, Uchmanowicz I, Mess E. Determinants affecting the rationing of nursing care and professional burnout among oncology nurses. International Journal of Environmental Research and Public Health. 2022;19(12):7180.
70. Ponnusamy V, Vasuki A, Clement JC, Eswaran P. AI-driven information and communication technologies, services, and applications for next-generation healthcare system. In: Smart Systems for Industrial Applications. 2022. p. 1–32.
71. Prasad PS, Gunjan VK, Pathak R, Mukherjee S. Applications of artificial intelligence in biomedical engineering. In: Handbook of Artificial Intelligence in Biomedical Engineering. Apple Academic Press; 2021. p. 125–45.
72. Quazi S. Artificial intelligence and machine learning in precision and genomic medicine. Medical Oncology. 2022;39(8):120.
73. Ronquillo CE, Peltonen LM, Pruinelli L, Chu CH, Bakken S, Beduschi A, *et al* Artificial intelligence in nursing: Priorities and opportunities from an international invitational think-tank of the Nursing and Artificial Intelligence Leadership Collaborative. Journal of Advanced Nursing. 2021;77(9):3707–17.
74. Rosa WE, de Campos AP, Abedini NC, Gray TF, Huijer HAS, Bhadelia A, *et al* Optimizing the global nursing workforce to ensure universal palliative care access and alleviate serious health-related suffering worldwide. Journal of Pain and Symptom Management. 2022;63(2):e224–36.
75. Roski J, Maier EJ, Vigilante K, Kane EA, Matheny ME. Enhancing trust in AI through industry self-governance. Journal of the American Medical Informatics Association. 2021;28(7):1582–90.
76. Sahu M, Gupta R, Ambasta RK, Kumar P. Artificial intelligence and machine learning in precision medicine: A paradigm shift in big data analysis. Progress in Molecular Biology and Translational Science. 2022;190(1):57–100.
77. Sallstrom L, Morris O, Mehta H. Artificial intelligence in Africa's healthcare: Ethical considerations. ORF Issue Brief. 2019;312:1–11.
78. Sartini M, Carbone A, Demartini A, Giribone L, Oliva M, Spagnolo AM, *et al* Overcrowding in emergency department: Causes, consequences, and solutions—a narrative review. Healthcare. 2022;10(9):1625.
79. Schlak AE, Poghosyan L, Liu J, Kueakomoldej S, Bilazarian A, Rosa WE, *et al* The association between health professional shortage area (HPSA) status, work environment, and nurse practitioner burnout and job dissatisfaction. Journal of Healthcare for the Poor and Underserved. 2022;33(2):998–1016.
80. Selvaraju V, Spicher N, Wang J, Ganapathy N, Warnecke JM, Leonhardt S, *et al* Continuous monitoring of vital signs using cameras: A systematic review. Sensors. 2022;22(11):4097.
81. Shneiderman B. Bridging the gap between ethics and practice: Guidelines for reliable, safe, and trustworthy human-centered AI systems. ACM Transactions on

Interactive Intelligent Systems (TiiS). 2020;10(4):1–31
82. Spanakis EG, Sfakianakis S, Bonomi S, Ciccotelli C, Magalini S, Sakkalis V. Emerging and established trends to support secure health information exchange. Frontiers in Digital Health. 2021;3:636082.
83. Srinivasu PN, Sandhya N, Jhaveri RH, Raut R. From blackbox to explainable AI in healthcare: Existing tools and case studies. Mobile Information Systems. 2022;2022(1):8167821.
84. Stokes F, Palmer A. Artificial intelligence and robotics in nursing: Ethics of caring as a guide to dividing tasks between AI and humans. Nursing Philosophy. 2020;21(4):e12306.
85. Subramanian M, Wojtusciszyn A, Favre L, Boughorbel S, Shan J, Letaief KB, *et al* Precision medicine in the era of artificial intelligence: Implications in chronic disease management. Journal of Translational Medicine. 2020;18:1–12.
86. Tanniru MR, Agarwal N, Sokan A, Hariri S. An agile digital platform to support population health—A case study of a digital platform to support patients with delirium using IoT, NLP, and AI. International Journal of Environmental Research and Public Health. 2021;18(11):5686.
87. Thomas PL, Roussel L, Harris JL, Bender M, Baker P, Hites L, *et al* The state of the clinical nurse leader knowledge base: Foundations, theories, and evidence. Career, Connection, Community. 2019;77.
88. Tønnessen S, Christiansen K, Hjaltadóttir I, Leino-Kilpi H, Scott PA, Suhonen R, *et al* Visibility of nursing in policy documents related to healthcare priorities. Journal of Nursing Management. 2020;28(8):2081–90.
89. Vadapalli S, Abdelhalim H, Zeeshan S, Ahmed Z. Artificial intelligence and machine learning approaches using gene expression and variant data for personalized medicine. Briefings in Bioinformatics. 2022;23(5):bbac191.
90. Varona D, Suárez JL. Discrimination, bias, fairness, and trustworthy AI. Applied Sciences. 2022;12(12):5826.
91. Wani SUD, Khan NA, Thakur G, Gautam SP, Ali M, Alam P, *et al* Utilization of artificial intelligence in disease prevention: Diagnosis, treatment, and implications for the healthcare workforce. In: Healthcare. MDPI; 2022. Vol. 10, No. 4, p. 608.
92. Willcocks L. Robo-apocalypse cancelled? Reframing the automation and future of work debate. Journal of Information Technology. 2020;35(4):286–302.
93. Wissemann AK, Pit SW, Serafin P, Gebhardt H. Strategic guidance and technological solutions for human resources management to sustain an aging workforce: Review of international standards, research, and use cases. JMIR Human Factors. 2022;9(3):e27250.
94. Withall JB, Schwartz JM, Usseglio J, Cato KD. A scoping review of integrated medical devices and clinical decision support in the acute care setting. Applied Clinical Informatics. 2022;13(5):1223–36.
95. Xiao D, Song C, Nakamura N, Nakayama M. Development of an application concerning fast healthcare interoperability resources based on standardized structured medical information exchange version 2 data. Computer Methods and Programs in Biomedicine. 2021;208:106232.
96. Xu L, Sanders L, Li K, Chow JC. Chatbot for healthcare and oncology applications using artificial intelligence and machine learning: Systematic review. JMIR Cancer. 2021;7(4):e27850.
97. Yang Y, Siau K, Xie W, Sun Y. Smart health: Intelligent healthcare systems in the metaverse, artificial intelligence, and data science era. Journal of Organizational and End User Computing (JOEUC). 2022;34(1):1–14.
98. Zhang Z, Chen L, Xu P, Wang Q, Zhang J, Chen K, *et al* Effectiveness of automated alerting system compared to usual care for the management of sepsis. NPJ Digital Medicine. 2022;5(1):101.
99. Zhu Y, Liu Y, Jiang H. Geriatric healthcare during the COVID-19 pandemic: Managing the health crisis. Clinical Interventions in Aging. 2022:1365–78.