

Article Review

***Factors Influencing and Information Technology Interventions for Nurse Compliance on Patient Safety: A Systematic Review***

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**ABSTRACT**

*Patient safety is a critical global issue, prevalent in many countries. This research aims to review publications and literature regarding the factors and interventions that aid in nurse compliance with patient safety measures. Due to limited published studies on this topic, we conducted a systematic review to identify these factors and interventions based on existing literature. We searched databases including Scopus, Science Direct, PubMed, and ClinicalKey Nursing, using specific keywords, filtering 1918 articles down to 22 articles for analysis. The study reveals that nurse implementation of patient safety is influenced by organizational culture and leadership, resource accessibility, physical facilities, communication and collaboration, workload and job satisfaction, nurses' knowledge and skills, demographic factors, and their attitudes and perceptions. Interventions for enhancing nurse compliance in patient safety include providing training and education through technological approaches, and health service delivery via information technology systems. This review offers insights into resolving nurse compliance issues in patient safety, highlighting the importance of not only individual nurses but also hospital management and the healthcare delivery system. Effective management strategies to increase nurse compliance in patient safety should involve hospital authorities and improvements in the nursing service system.*

**Keywords:** *Influencing Factors, Information Technology Interventions, Nurse Compliance, Patient Safety.*

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**INTRODUCTION**

Patient safety refers to efforts to prevent incidents causing adverse effects on patients, potentially leading to injuries or complications, through the use of high-quality practices that result in optimal healthcare<sup>1</sup>. It is a global issue prevalent in various countries. Hospitals, being

environments rich in labor, capital, technology, and problems with various procedures, professions, and standards, are particularly susceptible to patient safety incidents<sup>2</sup>. A patient safety incident is any unintended occurrence that could cause injury to a patient and is preventable<sup>3</sup>. In Indonesia, among 2,877

accredited hospitals, there is a 12% incidence of patient safety incidents, totaling 7,465 reports. These incidents include 171 deaths, 80 severe injuries, 372 moderate injuries, 1,183 minor injuries, and 5,659 without injury, categorized as 38% Near Miss events, 31% No Harm events, and 31% Adverse events <sup>4</sup>.

Compliance with patient safety is influenced by various factors, including nurses' knowledge, skills, workload, job satisfaction, communication, and collaboration <sup>5,6</sup>. Factors such as individual discipline, high work pressure, poor team communication and relationships, fatigue, stress, and unfavorable work environments affect the implementation of patient safety strategies in hospitals <sup>5</sup>. The impact of nurses' non-compliance in implementing patient safety can lead to long-term or permanent physical, mental, or social effects on patients, reducing life expectancy or causing death due to incorrect diagnosis and initial management <sup>7</sup>.

The Indonesian Government's efforts to reduce patient safety incidents include standardizing hospitals through the Hospital Accreditation Commission (HAC) in 2018. This includes six Patient Safety Goal Indicators (PSGI), such as accurate patient identification, enhancing effective communication, improving the safety of high-alert medications, ensuring correct patient, site, and procedure in surgery; reducing healthcare-associated infection risks, and minimizing patient injury risks from falls <sup>8</sup>. Increasing nurse compliance in fall prevention interventions can be enhanced through nurse compliance monitoring, audits, feedback, leadership, staff education, and information technology systems <sup>9</sup>.

Information technology is a technology used for managing information, whereas an information system is a combination of information technology and its users <sup>10</sup>. Information technology can be leveraged through electronic devices to assist nurses in accessing information, communicating, and monitoring swiftly <sup>11</sup>. The enhancement of patient care quality, reduction of errors, and decrease in care costs can be achieved by utilizing information technology <sup>12</sup>.

Based on the above research, patient

safety remains a significant global health issue. A systematic review is needed to conclude the factors and interventions contributing to nurse compliance in implementing patient safety. These factors and interventions can significantly influence healthcare service delivery. A detailed analysis of these factors and interventions affecting nurse compliance in implementing patient safety has not been previously reviewed. Existing research typically addresses only one of these factors or interventions. This study aims to provide an overview of the barriers to nurse compliance in patient safety and interventions that can enhance such compliance.

## **METHOD**

A systematic literature review was conducted following the principles of the PRISMA statement <sup>(13)</sup>.

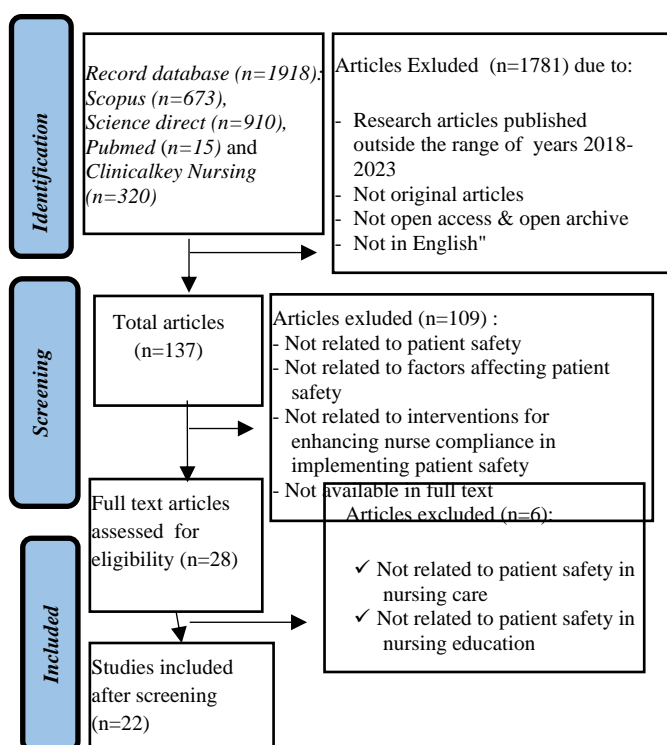
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### **Nurse and intervention involvement**

The systematic review focuses on factors Influencing and Information Technology Interventions for nurse compliance on patient safety.

### **Search Strategy and selection criteria**

We searched electronic databases including Scopus, Science Direct, PubMed, and Clinical Key Nursing, using keywords: factor AND influencing AND nurse OR nurses AND Information Technology OR technology AND Interventions OR Information Technology Interventions AND compliance OR adherence AND patient safety. From 1918 articles, 137 were initially identified based on the inclusion criteria of being from 2018-2023, original articles, open access & open archive, and in English. After further refinement, excluding those unrelated to patient safety, influencing factors, interventions, and with available full texts, 28 articles were selected, with 22 ultimately analyzed. service delivery via information technology systems.



**Figure 1. Prisma Flowchart**

**RESULTS**

**Table 1. Factors Influencing and Information Technology Interventions for Nurse Compliance on Patient Safety**

No	Title, Author, Year, Journal and DOI	Research methods	Result
1	Effects of Nurses' Perceptions of Patient safety Rules and Procedures on Their Patient safety Performance: The Mediating Roles of Communication about Errors and Coworker Support <sup>14</sup> Journal of Nursing Management  doi:10.1155/2023/2403986	Cross-Sectional	Nurses' perception of the usefulness and effectiveness of rules and procedures regarding patient safety, communication with colleagues, and support from coworkers positively correlates with patient safety performance.

2 The Effects of a Simulation Based Patient Safety Education Program on Compliance with Patient safety, Perception of Patient safety Culture, and Educational Satisfaction of Operating Room Nurses Healthcare<sup>15</sup>  
doi:10.3390/healthcare11212824

3 Mediating roles of patient safety knowledge and motivation in the relationship between safety climate and nurses' patient safety behaviors: a structural equation modeling analysis <sup>16</sup> BMC Nursing  
doi:10.1186/s12912-022-01123-6

4 Experiencing and witnessing disruptive behaviors toward nurses in COVID-19 teams, patient safety, and errors in care <sup>17</sup> Journal of Nursing Scholarship  
doi:10.1111/jnu.

5	A Mixed Methods Sequential Explanatory Study of the Factors That Impact Nurses' Perspectives toward Nurse Practitioners' Roles in Saudi Arabia <sup>18</sup> Healthcare  doi:10.3390/healthcare11010146	A Mixed-Methods	Effective collaboration with other staff
6	Association between Hospital Nurses' Perception of Patient safety Management and Standard Precaution Adherence: A Cross-Sectional Study <sup>19</sup> International Journal of Environment Research and Public Health (IJERPH) doi:10.3390/ijerph16234744	Cross-Sectional	Participants' perception of patient safety management.
7	Teamwork, psychological safety, and patient safety competency among emergency nurses <sup>20</sup> International Emergency Nursing  doi:10.1016/j.ienj.2020.100892	Cross-Sectional	Situation monitoring, reporting of patient safety side effects, number of night shifts per month, and psychological safety are significant factors affecting patient safety competence

8	Privacy, confidentiality, security and patient safety concerns about electronic health records. <sup>21</sup> International Nursing Review  doi:10.1111/inr.12585	Mixed-Method	Ethical code policies, training, and awareness
9	Nurses' knowledge and deliberations crucial to Barcoded Medication Administration technology in a Dutch hospital: Discovering nurses' agency inside ruling. <sup>22</sup> Sage Journals  <a href="https://doi.org/10.1177/1363459318800155">https://doi.org/10.1177/1363459318800155</a>	Qualitative	Factors such as nurses' knowledge and experience in medication administration, effective communication and collaboration among healthcare professionals, appropriate staffing levels and workload management, a supportive organizational culture and leadership, the availability of user-friendly and efficient technology systems, and a reporting and identification system that encourages nurses to identify and report potential patient safety risks.
10	Use, Perceived Usability, and Barriers to Implementation	Cluster Randomized Stepped	Insights into risks and information.

	n of a Patient safety Dashboard Integrated within a Vendor HER. <sup>23</sup> Applied Clinical Informatics	Wedge Trial		acute care setting: A quasi-experimental study. <sup>26</sup> Nursing and Health Sciences	content and processes, leadership support, and the use of structured handover modules
	doi:10.1055/s-0039-3402756			doi:10.1111/nhs.12836	
11	Patient safety Competency and its Related Aspects in Professional Education among Nursing Students of Two Nursing Schools in Iran: A Comparative Study. <sup>24</sup> Applied Clinical Informatics	Cross-Sectional	Nursing education, safety culture in healthcare organizations, effective communication and teamwork, continuous evaluation and improvement	14 Nurses' Compliance with Patient safety Standards in an Accredited Hospital. <sup>27</sup> Egyptian Journal of Health Care	Routine work experience, leadership training, hospital accreditation
	doi:10.1055/s-0039-3402756			doi:10.21608/ejhc.2019.26753	
12	Factors Related with Nurse Compliance in The Implementation of Patient safety Indicators at Hospital. <sup>25</sup> Jurnal Keperawatan Indonesia	Cross-Sectional	The leadership style of head nurses, nurse motivation, and other factors such as age, marital status, resources, and perceptions can also affect compliance	15 Efficacy of observational hand hygiene audit with targeted feedback on doctors' hand hygiene compliance: A retrospective time series analysis. <sup>28</sup> Journal of Infection Preventions	Audits and feedback, training and education, visual reminders, educating about institutional safety climate, support from senior management, and collaboration with management teams
	doi:10.7454/jki.v23i3.975			doi:10.1177/1757177419833165	
13	Translating evidence-based nursing clinical handover practice in an	Quasi-Experimental	Effective information transfer, improvements in handover	16 Effectiveness of a virtual reality application-based education programme on patient safety management for nursing students: A pre-test-post-test study <sup>29</sup>	Mobile app-based education using virtual reality is effective in enhancing patient safety management in nursing education.

Nursing Open			s.12836		
doi:10.1002/no p2.2001			20	Internet of things in health-care for patient safety: an empirical study <sup>32</sup> BMC Health Services Research	
17	The Influence of Human Factors Training in Air Rescue Service on Patient safety in Hospitals: Results of an Online Survey <sup>30</sup> Medicines	A quantitative test procedure was performed using the modified questionnaire on team work and patient safety	KSskills acquired in Crew Resource Management (CRM) training are highly beneficial for routine healthcare tasks in hospitals to enhance the implementation of patient safety.	Internet of things (iot) intervention in a hospital unit	doi:10.1186/s12913-022-07620-3
doi:10.3390/medicines10010002			21	Understanding Mental Health Nurses' Perceptions of Barcode Medication Administration: A Qualitative Descriptive Study <sup>33</sup> Issues in mental Health Nursing	
18	Sustaining a culture of safety and optimising patient outcomes while implementing zero harm programme: a 2-year project of the nursing services – SBAHC <sup>31</sup> BMJ Open Quality	The concept of zero harm was introduced to test the effectiveness of the interventions.	The concept of zero harm, incorporating the just culture into electronic reporting systems, has been proven to motivate nursing staff to uphold a higher standard of patient safety culture.	Utilizing Barcode Medication Administration (BCMA) technology to improve nurse compliance as healthcare providers	doi:10.1080/01612840.2018.1528321
doi:10.1136/bmjopen-2022-002063			22	Impact of using data from electronic protocols in nursing performance management: A qualitative interview study <sup>34</sup> Journal of Nursing Management	
19	Translating evidence-based nursing clinical handover practice in an acute care setting: A quasi-experimental study <sup>26</sup>	A quasi-experimental study	Integrated electronic Medical Records (IeMR), computerized provider order entry systems Decision support systems, and the ottawa model for research use	The use of healthcare services through Automated electronic systems.	doi:10.1111/jonm.12858
Nursing and Health Sciences					
doi:10.1111/nh					

Factors influencing nurses' compliance in implementing patient safety include:

1. **Organizational Culture and Leadership:** An organizational culture that promotes patient safety and commitment from leadership can contribute to increased patient safety compliance. A supportive environment that encourages reporting and learning from safety events is also vital.
2. **Resources and Accessibility:** Availability of resources and access to necessary equipment, tools, and information for patient safety practices can impact compliance. Limited resources or restricted access can become barriers in implementing safety practices.
3. **Physical Facilities:** Factors such as healthcare facility design, cleanliness, and the availability of necessary medical equipment and materials can influence patient safety compliance. Facilities designed with patient safety in mind can improve compliance.
4. **Communication and Collaboration:** Effective communication and collaboration between nurses and other healthcare team members are crucial for patient safety compliance. Good communication ensures a clear understanding of safety practices and encourages cooperative teamwork.
5. **Workload and Job Satisfaction:** High workload, fatigue, and lack of job satisfaction among nurses can negatively impact patient safety compliance. Efforts to reduce excessive workload and increase nurse job satisfaction can enhance their compliance.
6. **Nurses' Knowledge and Skills:** Nurses' knowledge and skills in patient safety practices play a significant role in patient safety compliance. Nurses with a good understanding of safety practices and who can apply them consistently can improve patient compliance.
7. **Demographic Factors:** Factors such as age, education, and work experience can also influence nurses' compliance in implementing patient safety.
8. **Nurses' Attitudes and Perceptions:** Nurses' attitudes and perceptions

towards patient safety practices can affect their compliance level. Nurses with a positive attitude and correct perception of the importance of safety are more likely to comply with patient safety practices.

Interventions to enhance nurse compliance in implementing patient safety include:

1. **Mobile App-Based Education Using Virtual Reality:** Mobile app-based education using virtual reality is effective in improving patient safety management in nursing education.
2. **Crew Resource Management (CRM) Training:** Skills acquired in CRM training are highly beneficial for routine healthcare tasks in hospitals to enhance the implementation of patient safety.
3. **Zero Harm with Just Culture Model in Electronic Reporting Systems:** The concept of zero harm, incorporating the just culture model into electronic reporting systems, has been proven to motivate nursing staff to uphold a higher standard of patient safety culture.
4. **Health Information Systems and Electronic Health Records (EHRs):** Effective integration and use of Electronic Health Records and other health information systems can facilitate clinical processes, reduce errors, and support safe patient discharge. For example, integrating EHRs and investigation order procedures in emergency patient discharge can clarify roles in the discharge process and improve the safety of discharged patients.
5. **Bar-coded Medication Administration (BCMA):** Implementing and adopting BCMA technology can reduce medication errors and improve patient safety, especially in mental health inpatient care settings. Successful adoption of this technology requires proper practice, education, and strategies to ensure effective adoption and support clinical workflow and accountability.
6. **Internet of Things (IoT) in Healthcare:** IoT devices, such as patient monitoring devices and asset management

solutions, can provide real-time data and insights that help improve clinical decisions, reduce errors, and enhance patient safety.

This systematic review research still finds limitations in not covering the influence or role of patient families in achieving patient condition improvement and efforts to enhance patient safety aspects.

## DISCUSSION

This research indicates that nurses' compliance in implementing patient safety is influenced by factors such as organizational culture and leadership, resources and accessibility, physical facilities, communication and collaboration, workload and job satisfaction, nurses' knowledge and skills, demographic factors, and nurses' attitudes and perceptions<sup>35-41</sup>. Leadership in hospitals significantly contributes to nurses' adherence to patient safety guidelines<sup>39</sup>. Support from leaders is crucial in optimizing patient safety in healthcare services<sup>39</sup>. Healthcare leaders are responsible and accountable for strengthening the healthcare system by enhancing infrastructure, providing adequate support and resources, and conducting comprehensive monitoring and evaluation of patient safety<sup>42,43</sup>. Opportunities for hand hygiene training and higher education by leaders can also enhance understanding of infection prevention, impacting patient care<sup>44</sup>.

Other studies mention that patient safety is a responsibility of nurses, divided into civil and criminal responsibilities<sup>45</sup>. Organizational structure is closely related to nurses' compliance in implementing patient safety. The quality and safety of care, influenced by various factors within the system, organization, and work environment, affect the quality and safety of clients<sup>46</sup>. The organizational structure of client safety units or teams in hospitals significantly impacts client safety<sup>47</sup>.

Supervision encourages nurses in applying patient safety goals. Furthermore, stating a relationship between supervision and the implementation of patient safety in inpatient wards<sup>48</sup>. Interprofessional collaboration also enhances patient safety. Doctor-nurse collaboration is significantly positively correlated with all levels of patient safety culture ( $P < 0.01$ )<sup>49</sup>. Another finding states that

interprofessional collaboration positively impacts patient safety<sup>50</sup>.

Understanding is the fundamental basis for forming good behavior, especially in maintaining patient safety. Inadequate understanding of patient safety concepts can hinder the improvement of processes and practices in the healthcare service system<sup>51</sup>. Defining and clarifying aspects of patient safety regularly to nurses can enhance their understanding and perception of patient safety<sup>52</sup>.

Demographic characteristics in this study indicate age as a factor affecting nurses' implementation of patient safety. Age determines a person's ability to work, including how they respond to stimuli. Age is the duration of a human's life since birth<sup>53</sup>. Age is a factor in nurses' implementation of patient safety goals in hospitals<sup>53,54</sup>, as it reflects nurses' behavior, views, and responsibilities in implementing these goals effectively. This is supported by other research showing that age positively influences the implementation of patient safety programs<sup>55</sup>. Another study shows that increasing healthcare worker age is accompanied by a decrease in patient safety incidents, as healthcare workers in hospitals become wiser, more cautious, and adhere to policies, procedures, and SPOs in providing healthcare<sup>56</sup>.

Attitude is the tendency to react to something, a person, or an object with liking, disliking, or indifference<sup>57</sup>. Attitude has a positive influence on the implementation of patient safety<sup>58</sup>. A higher attitude score leads to higher patient safety implementation. Nurses' attitudes towards patient safety are related to education level, experience, and frequency of attending patient safety training<sup>58</sup>. Nurses implementing patient safety poorly tend to have negative attitudes, such as impatience, non-compliance, and irresponsibility<sup>59</sup>.

Research states that there is an influence of knowledge on the behavior of implementing patient safety goals in hospitals<sup>60,61</sup>. This is supported by other research showing that among 16 nurses with good knowledge, 13 implement patient safety well<sup>61</sup>. In this regard, nurses are expected to thoroughly understand the Concept of Hospital Patient Safety (CHPS) the six patient safety goals, and the six Patient Safety Goals (PSG)<sup>62</sup>. Knowledge is the result of knowing, occurring after a person senses an object<sup>63</sup>.



This result indicates that motivation is a factor affecting the implementation of patient safety. Motivation is the process of needs driving a person to engage in activities leading to a specific goal <sup>64</sup>. This aligns with other research showing a significant influence of motivation variables on the implementation of patient safety programs <sup>55</sup>. The influence of motivation on the behavior of implementing the six PSG found a p-value = 0.007, meaning there is an influence of motivation on this behavior <sup>61</sup>. Nurses with high motivation to implement patient safety goals are internally driven to achieve this, conscientiously implementing these goals even in environments without reward and punishment systems.

Nurses' length of service, the duration since officially employed in a hospital or other healthcare facility, is associated with increased skills and knowledge, challenging work, recognition, and rewards <sup>65</sup>. A significant influence of length of service on behavior in implementing the 6 PSG in Inpatient Wards <sup>61</sup>. Nurses implementing patient safety goals well mostly have over five years of service. Relating to the other research where the average nurse work duration is over 5 years, it implies increased skills in implementing the six patient safety goals and habitual application <sup>66</sup>. Nurses need adequate work experience to understand specific client needs.

Education level is an individual characteristic influencing nurses' skills and knowledge <sup>36</sup>. Higher educated nurses can think rationally in performing nursing actions, impacting client safety <sup>35,67</sup>. These studies indicate that educational background influences nurses' compliance in implementing patient safety guidelines <sup>35,36,67</sup>.

Patient safety is crucial for nurses in providing healthcare services. This study shows that efforts to enhance nurses' compliance in implementing patient safety include providing training and education using technological approaches and healthcare services using information technology systems. Training nurses using mobile apps positively impacts implementing Patient Safety <sup>68</sup>. Therefore, reveals that implementing PATRICIA, mCARE, iAMP, and mHAL can enhance patient safety in general mental health situations <sup>69</sup>. PATRICIA, observed as an app using avatars and wearable sensors to record skin temperature, heart rate, acceleration, and respiratory rate during exercises, facilitates

healthcare providers in enhancing patient safety by enabling them to track and review individual exercise performance <sup>69</sup>.

In Indonesia, devices and mobile apps are widely used by different health institutions with varied instructions, resulting in beneficial outcomes, including improved healthcare conditions for patients and better safety maintenance in clinical settings <sup>70</sup>. Additionally, these devices and apps are used to reduce medical care costs; enhance the productivity of medical professionals involved in healthcare service delivery; and decrease hospital congestion levels <sup>71</sup>. Various medical apps, including clinical handbook Epocrates, Medscape, PubMed mobile, and Oxford, are used to enhance patient safety in different healthcare institutions in Indonesia <sup>72</sup>.

The eMoods Bipolar Mood Tracker app can be considered for evaluating the effectiveness of using mobile devices. This device aims to provide information to enhance patient safety <sup>73</sup>. This specific mobile app involves a daily tracking mechanism, allowing patients to check their subjective mood ratings and monitor medication use and anxiety levels, thus ensuring enhanced safety in clinical settings <sup>73</sup>. Secondary research findings highlight certain potential ways in which patient safety in healthcare can be improved using devices and smart mobiles, including allowing patients to directly access health information through drug guide apps or dosage calculator apps <sup>74</sup>.

In the healthcare context, ensuring patient safety under any clinical setting is guaranteed by maintaining the confidentiality of patient health records <sup>75</sup>. It also focuses on allowing only responsible medical professionals to access it. Thus, some hospitals, nursing homes, and other healthcare units more effectively use specific barcodes/ QR codes to ensure that the personal health information of patients is not accessible to everyone. Barcodes/ QR codes not only contribute to maintaining overall patient safety but also aid in enhancing the quality of care along with individual care. These specific codes can be operated with the support of smartphone (mobile) devices and their apps, easily downloadable from the internet <sup>76</sup>. Research findings presented indicate that the Translation app has been introduced and supports healthcare institutions and medical professionals in ensuring patient safety by obtaining accurate and clear care assessments

and plans, including voice recognition and conversion mode <sup>76</sup>.

The development of Fall Prevention Patient Information System (FPPIS) is an innovation developed to improve nurse compliance in fall prevention. Nurse compliance assessment in the FPPIS app is immediately displayed (real-time) in the e-compliance menu after filling in the monitoring <sup>77</sup>. Direct feedback is a strategy to enhance nurse compliance <sup>78</sup>.

To maximize patient safety compliance, continuous education and training on patient safety practices and the use of innovative and effective information technology are necessary. This requires a coordinated effort from healthcare authorities, educational institutions, healthcare service providers, and healthcare professionals to develop and implement strategies and interventions aimed at increasing awareness, knowledge, and competence in patient safety. Careful implementation of information technology, considering specific needs and clinical contexts, is also crucial in addressing challenges and barriers that may arise during the process of integrating technology into clinical practice.

## LIMITATION

This research has limitations. First, despite the effortful data collection process to identify and collect all studies relevant from the period 2018 to 2023 in digital libraries (Scopus, Science Direct, PubMed, and ClinicalKey Nursing), some studies are relevant and has the potential to cause publication bias.

Determination of inclusion and exclusion criteria in systematic review only studies that use the language English, and does not consider research that published in other languages, as well as the text of articles that are not easy to obtain so it has the potential to cause bias. However, by combining all relevant evidence available in English, research collects thousands of articles worthy of providing insight into decision-making managerial.

Article taken from the digital library in this research does not pay attention to journal rankings Scimago Journal & Country Rank, this addition is felt, it is important to know whether a journal has a ranking Q1, Q2, Q3, Q4, so that there is no garbage in garbage out.

## CONCLUSION

The review of various articles indicates that nurses' implementation of patient safety is influenced by factors such as organizational culture and leadership, resources and accessibility, physical facilities, communication and collaboration, workload and job satisfaction, nurses' knowledge and skills, demographic factors, and nurses' attitudes and perceptions. Additionally, this research identifies interventions to enhance nurse compliance in implementing patient safety, including training and education using technological approaches and healthcare services using information technology systems. This review provides insights into resolving nurse compliance issues in implementing patient safety, not only from individual nurses but also from hospitals, management, and the nursing service system used. However, further and more comprehensive research is needed to confirm these findings so that patient safety is more assured and achievable. Management strategies to enhance nurse compliance in implementing patient safety should involve hospital parties and improvements in the healthcare service system.

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