



# A Systematic Review of Nurses' Perceptions of Electronic Health Record Usability Based on the Human Factor Goals of Satisfaction, Performance, and Safety

Suhyun Park, MSN, RN, Jenna Marquard, PhD, Robin R. Austin, PhD, DNP, DC, RN-BC, FAMIA, FNAP, David Pieczkiewicz, PhD, Ratchada Jantraporn, MSN, RN, Connie White Delaney, PhD, RN, FAAN, FACMI, FNAP

The poor usability of electronic health records contributes to increased nurses' workload, workarounds, and potential threats to patient safety. Understanding nurses' perceptions of electronic health record usability and incorporating human factors engineering principles are essential for improving electronic health records and aligning them with nursing workflows. This review aimed to synthesize studies focused on nurses' perceived electronic health record usability and categorize the findings in alignment with three human factor goals: satisfaction, performance, and safety. This systematic review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis. Five hundred forty-nine studies were identified from January 2009 to June 2023. Twenty-one studies were included in this review. The majority of the studies utilized reliable and validated questionnaires ( $n = 15$ ) to capture the viewpoints of hospital-based nurses ( $n = 20$ ). When categorizing usability-related findings according to the goals of good human factor design, namely, improving satisfaction, performance, and safety, studies used performance-related measures most. Only four studies measured safety-related aspects of electronic health record usability. Electronic health record redesign is necessary to improve nurses' perceptions of electronic health record usability, but future efforts should systematically address all three goals of good human factor design.

**KEY WORDS:** Electronic health records, Electronic medical records, Nurse, Software design, Systematic review

Nurses rely on electronic health records (EHRs) for clinical decision-making, documentation, and care coordination.<sup>1</sup> Clinical nurses spend 17% to 27% of

their work time on EHR-related work,<sup>1–3</sup> which surpasses the time dedicated to communication or direct/indirect patient care activity.<sup>1,2</sup> The large amount of time spent on EHRs is often considered a contributing factor to nurses' burnout and work-related stress.<sup>3</sup> Despite the widespread use of EHRs, nurses' documentation needs within the EHR are not well supported.<sup>4</sup>

The poor usability of EHRs has emerged as a major barrier to their effective use by nurses, particularly when considering the substantial amount of work they undertake.<sup>3,4</sup> The impact of poor EHR usability on nurses' workload burden and burnout is well known.<sup>5–7</sup> The time required to perform EHR tasks, the difficulty of these tasks, and the overall usability of the system directly impact the mental workload experienced by nurses.<sup>8</sup> Previous research also found that the poor EHR usability leads nurses to conduct frequent workarounds, as nursing workflows often do not match the EHR workflows.<sup>9–11</sup> Such workarounds can result in unintended negative consequences, including work interruptions, increased workload, workflow changes, and altered communication patterns.<sup>4</sup> These unintended consequences derived from workarounds could threaten patient safety.<sup>4</sup> Consequently, aligning EHRs with nursing workflow has become increasingly crucial to support patient safety and achieve better patient outcomes.<sup>4</sup>

An in-depth understanding of nurses' perceptions of EHR usability is required in order to design EHRs that support their work.<sup>12</sup> When nurses develop negative perceptions of EHR usability, it is difficult for them to use EHRs to their full capacity.<sup>13</sup> Several studies describe EHR usability as perceived by nurses and its impacts on nurses and patient outcomes.<sup>6,7,14</sup> However, limited knowledge exists evaluating EHR usability from the perspective of known human factor outcomes, namely, satisfaction, performance, and safety.

Human factors aim to improve humans' interactions with systems—such as EHRs—by enhancing end-user satisfaction, system performance, and system safety.<sup>15</sup> Improving satisfaction increases user acceptance, comfort, and well-being; improving performance increases productivity, quality, and efficiency; and improving safety reduces the risk of human error.<sup>15</sup> We use these three goals to thematically categorize the studies identified in this systematic review. This

**Author Affiliations:** School of Nursing (Mss Park and Jantraporn and Drs Marquard, Austin, and Delaney) and Institute for Health Informatics (Drs Marquard, Pieczkiewicz, and Delaney), University of Minnesota, Minneapolis.

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**Corresponding author:** Suhyun Park, MSN, RN, School of Nursing, University of Minnesota, 5-140 Weaver-Densford Hall, 308 Harvard St SE, Minneapolis, MN 55455 (park2450@umn.edu).

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Table 1. Keywords Used in the Literature Search

Concept	EHR	Nurse	Usability
Keywords	electronic health records, electronic medical records, electronic documentation, computerized documentation, and computerized record	nurse	usability, utility, ease of use, usefulness, satisfaction, efficiency, error, effectiveness, memorability, and learnability

review therefore aims to systematically synthesize the current state of research on EHR usability from nurses' perspectives and categorize the findings in alignment with the three human factor goals of satisfaction, performance, and safety.

METHODS

Data Sources and Search Strategy

We performed the literature search in collaboration with an experienced health science librarian at the University of Minnesota and followed the standards set forth by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.<sup>16</sup> We searched two electronic databases (Ovid MEDLINE and CINAHL) for articles published from January 2009 to June 2023, identifying articles that contained keywords and the variants of “electronic health record,” “usability,” and “nurse” (Table 1). Our initial search yielded 549 records. Duplicates (n = 132) were removed automatically using the online systematic review screening software Rayyan (Rayyan Systems, Inc, Cambridge, MA, USA), resulting in 417 articles for screening.

Institutional Review and Human Subject Determination

The study was exempted from approval by the University of Minnesota institutional review board because it did not involve active human subject research. No individual or patient data were included in this study.

Inclusion and Exclusion Criteria

We included studies that addressed the use of EHRs by RNs who provide direct nursing care to patients/clients. Included studies were written in English and published after 2009, when EHRs began to proliferate because of the federal Health Information Technology for Economic and Clinical Health Act that created incentives to drive the adoption of EHRs.

We excluded usability studies addressing (1) personal health records, mobile Health applications, telehealth, or medical devices; (2) development or prototype testing studies; (3) quality improvement projects; (4) editorials or reviews; and (5) studies that encompassed a diverse group of interprofessional healthcare professionals, not focusing on nurses' role-specific perspectives.

Article Selection

One of the authors (S.P.) screened the titles and abstracts of the articles (n = 417) based on the aforementioned inclusion

and exclusion criteria to determine whether an article was relevant. After an initial screening of titles and abstracts, 48 studies were considered potentially relevant. Two of the authors (S.P. and R.J.) independently reviewed each of the 48 studies' full-text to determine if they pertained to nurses' perceptions of EHR usability, resulting in 22 relevant articles. Articles with wrong outcomes (n = 18), wrong population (n = 6), and wrong publication (n = 2) were excluded from the 48 studies. Any conflicts that arose in the article selection process were resolved by discussion between the two reviewers (Figure 1).

Study Quality Appraisal

Study quality was assessed using the Joanna Briggs Critical Appraisal tool, an online software for systematic reviews in order to assess the trustworthiness, relevance, and results of published articles.<sup>17</sup> One study used a mixed-methods design; thus, it was appraised using both an analytical cross-sectional and qualitative appraisal tool. The quality assessment was performed by two of the authors (S.P., R.J.) independently. If there was a disagreement, the article was reassessed and discussed until a consensus was reached. Among the 22 studies reviewed, four studies had a moderate risk of bias, and 18 studies had a low risk of bias. One study with a high risk of bias was excluded. As a result, 21 studies were included for data analysis.

Data Abstraction

Comprehensive data extraction was performed by two of the authors (S.P., R.J.) on the articles that passed the full screening review. Data were collected relating to authors, title, year, country of origin, study design, study setting, sample, usability-related variables, measures, EHR usability-related findings, and alignment with human factor goals.

RESULTS

Characteristics of Included Studies

The majority of the studies stated a single focus on overall EHRs (n = 10). The other 10 studies focused on electronic medical record (EMR) systems (n = 5), an electronic patient record (EPR) system (n = 2), electronic documentation systems (EDSs) (n = 2), and electronic medication administration record (eMAR) (n = 1). One study assessed the usability of overall EHR, computerized provider order entry (CPOE), eMAR, and nursing flowsheet. Most studies were analytical cross-sectional designs (n = 14) and conducted in hospitals

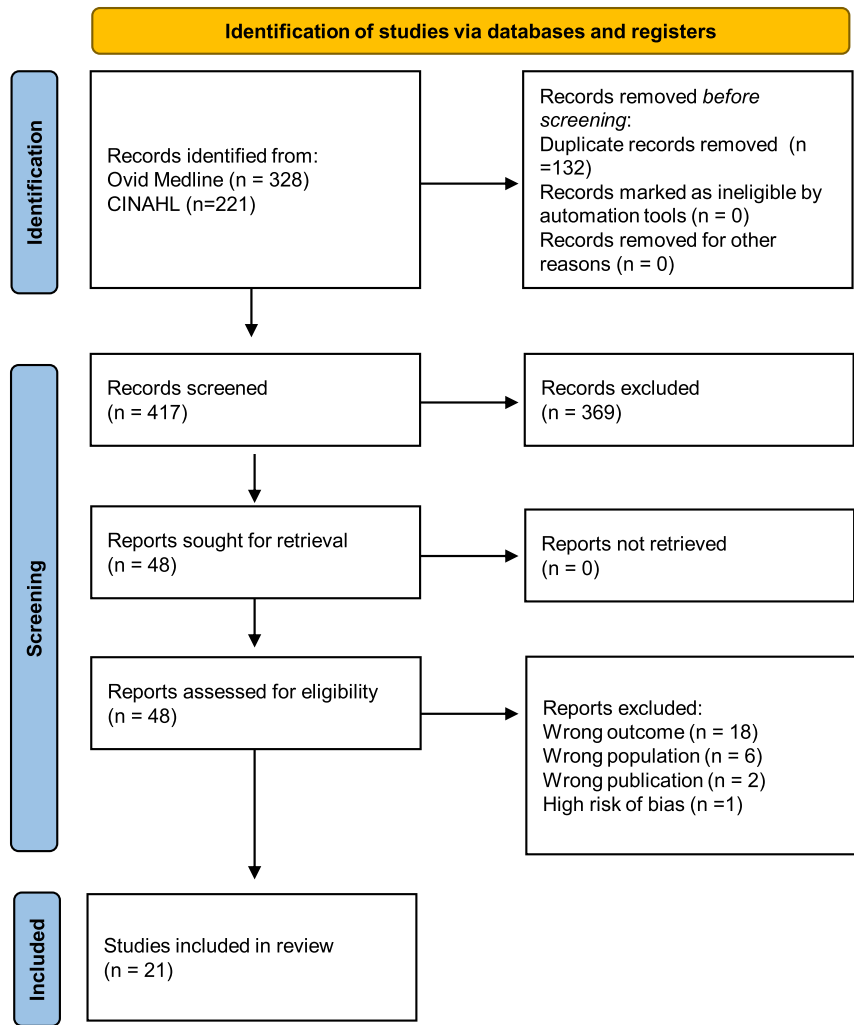


FIGURE 1. Flow diagram of study screening.

(n = 20). Studies were the most conducted in the United States (n = 9). The sample sizes in the studies ranged from 18 to 12 377 (Table 2).

Usability Measures

Psychometric measures were most frequently used to examine nurses' perceived EHR usability. Instruments used in the quantitative and mixed-methods studies included the Technology Acceptance Model (n = 2), the System Usability Scale (n = 1), the National Usability-Focused Health Information System Scale (n = 1), the Questionnaire for User Interface Satisfaction (QUIS) (n = 1), Nurses' Perceptions of Electronic Documentation (n = 1), and the Unified Theory of Acceptance and Use of Technology (n = 1). Eight studies used self-developed questionnaires or adapted questionnaires from previous studies. Interviews (n = 3), focus groups (n = 2), open-ended questions (n = 1), and observations

(n = 2) were used alone or in combination in the mixed-methods and qualitative studies (Supplementary Digital Content 1, <http://links.lww.com/CIN/A307>).

Nurses' Perceived EHR Usability

Nurses provided diverse perspectives on EHR usability, encompassing both positive and negative viewpoints across work settings. The duration of EHR usage was found to be associated with nurses' perceived EHR usability. In a study conducted by Carayon et al,<sup>13</sup> the perceived usability of EHRs was assessed at 3 and 12 months after implementation by ICU nurses, revealing that the average usability score improved slightly over time. Similarly, nurses tended to perceive EHR positively over time in other studies.<sup>27,30</sup> There were also negative perceptions of EHRs and their impact on nurses. Melnick et al<sup>7</sup> conducted a cross-sectional survey on a sample of US nurses (n = 1285) from varied

**Table 2. Study Characteristics**

First Author	Study Design	Country	Sample Size ; Setting	Study Aim	EHR Functionality
Abu Raddaha (2017) <sup>18</sup>	Analytical cross-sectional	Oman	169; a public teaching hospital	Explore opinions, perceptions and attitudes of nurses regarding the use of the EHR system	Overall EHR
Alboliteeh (2022) <sup>19</sup>	Analytical cross-sectional	Saudi Arabia	327; three government hospitals	Determine the perception of nurses on the utilization and barriers to the use of EHRs	Overall EHR
Ay (2014) <sup>20</sup>	Analytical cross-sectional	Turkey	601; a university hospital	Determine the usage of the electronic patient record system, the reasons and limitations behind the system not being used, the opinions and beliefs of the nurses about the system	EPR
Carayon (2011) <sup>13</sup>	Two analytical cross-sectional	USA	121 at 3 mo and 161 at 12 mo post-EHR implementation; four ICUs at a hospital	Assess ICU nurses' acceptance of EHR technology and examine the relationship between EHR design, implementation factors, and nurse acceptance	Overall EHR, CPOE, eMAR, nursing flowsheet
Dowding (2015) <sup>21</sup>	Multisite case qualitative study	USA	28; two hospitals	Explore how nurses use an integrated EHR in practice	Overall EHR
Heidarizadeh (2017) <sup>22</sup>	Qualitative	Iran	18; one hospital	Explore perceptions of the challenges of using an electronic documentation system	EDS
Ibrahim (2019) <sup>23</sup>	Qualitative	Canada	13; home care sector	Explore registered RNs' experience with EDS usage in home care	EDS
Jedwab (2022) <sup>24</sup>	Qualitative	Australia	158; six hospitals	Explore Australian nurses' postimplementation experiences of an organization-wide EMR system	EMR
Kaihlanen (2020) <sup>25</sup>	Analytical cross-sectional	Finland	3383; mixed	Examine the associations of EHR usability and user age with stress related to information systems and cognitive failures	Overall EHR
Kutney-Lee (2021) <sup>6</sup>	Analytical cross-sectional	USA	12 004 nurses and 1 281 848 surgical patients; 343 hospitals	Examine associations between EHR usability and nurse job (burnout, job dissatisfaction, and intention to leave) and surgical patient (inpatient mortality and 30-d readmission) outcomes	Overall EHR
Kutney-Lee (2019) <sup>14</sup>	Analytical cross-sectional	USA	12 377; 353 hospitals across four states	Examine the independent and joint effects of comprehensive EHR system adoption and the work environment on system usability, including satisfaction and effectiveness, and nurse-reported quality of care and safety	Overall EHR
Maillet (2015) <sup>26</sup>	Analytical cross-sectional	Canada	616; four hospitals	Investigate explanatory factors for acceptance and actual use of an electronic patient record in acute care settings as well as for their satisfaction	EPR
Melnick (2021) <sup>7</sup>	Analytical cross-sectional	USA	1285; mixed	Measure perceived EHR usability and its association with burnout	Overall EHR
Moreland (2012) <sup>27</sup>	Analytical cross-sectional	USA	389 at baseline, 213 at 3 mo, and 117 at 6 mo; one tertiary hospital	Determine if nurse perceptions of satisfaction with eMAR related to workload, teamwork, ease of documentation, drug information accuracy, patient safety, and overall satisfaction changed across time	eMAR

(continues)

Table 2. Study Characteristics, Continued

First Author	Study Design	Country	Sample Size ; Setting	Study Aim	EHR Functionality
Murphy (2023) <sup>28</sup>	Analytical cross-sectional	USA	50; one rural hospital	Explore ease of use of the EMR in supporting the nursing care of heart failure patients while in the hospital	EMR
Ramoo (2023) <sup>29</sup>	Analytical cross-sectional	Malaysia	350; one hospital	Assess the perception and satisfaction of nurses toward the EMR system in a teaching hospital	EMR
Schenk (2021) <sup>30</sup>	Mixed-methods	USA	153 at survey and 10 at interviews; one regional hospital	Examine changes in RN perceptions of electronic documentation	Overall EHR
Top (2012) <sup>31</sup>	Analytical cross-sectional	Turkey	200: three hospitals	Investigate the views of EMRs used by nurses working at hospital clinics (inpatient care units)	EMR
Tubaishat (2018) <sup>32</sup>	Analytical cross-sectional	Jordan	1539; 15 hospitals	Explore perceptions of usefulness and ease-of-use of EHRs	Overall EHR
Wisner (2021) <sup>33</sup>	Qualitative	USA	21; two community hospitals (labor and delivery units)	Explore labor and delivery nurses' perceptions of how interaction with and use of the EHR affects their cognitive work	Overall EHR
Wynter (2021) <sup>34</sup>	Qualitative	Australia	39; three hospitals	Describe nurses' and midwives' experiences following the first phase of the implementation of an EMR system	EMR

practice settings. Nurses rated their current EHR usability as low, with an average usability score grade of “F,” and the nurse-reported EHR usability was correlated with professional burnout.<sup>7</sup> Kailanen et al<sup>25</sup> reported that if nurses perceive EHRs as poor, it increased their levels of stress related to information systems and higher incidences of cognitive failures.<sup>25</sup> Kutney-Lee et al<sup>6</sup> supported these findings by adding that nurses working in hospitals with lower EHR usability experienced significantly higher odds of burnout, job dissatisfaction, and intention to leave, in comparison to those working in hospitals with better usability.<sup>6</sup> Kutney-Lee et al<sup>14</sup> reported that the work environment was a significant factor influencing EHR usability, as nurses in more favorable work environments were less likely to report negative experiences with EHRs. Electronic health record training from the workplace played a significant positive role in nurses' perception of the EHR's usefulness and their intention to use it.<sup>19</sup> The sections below examine more carefully how these findings provide insight into the three human factor outcomes of nurses' satisfaction, system performance, and system safety, based on the questions in survey instruments, and qualitative questions and responses.

Nurses' Perceived EHR Satisfaction

Seven studies reported findings related to nurses' satisfaction with their EHR. Electronic health record satisfaction was focused on nurses' subjective perceptions and largely influenced by EHR performance and implementation environment within hospitals. Many nurses found their current EHR systems

to be satisfactory and felt the system improved their workflows.<sup>26,27,29,31</sup> They also felt comfortable using the system.<sup>29</sup> A type of EHR was an important factor that influenced nurses' satisfaction.<sup>6</sup> When hospitals adopted a comprehensive EHR, nurses were less likely to report dissatisfaction compared with the hospitals that adopted a basic EHR.<sup>6</sup> The satisfaction levels tended to increase the longer nurses used the EHR.<sup>27</sup>

Nurses expressed dissatisfaction with EHRs due to the low speed of system performance and the frequent duration of system outages.<sup>29</sup> Qualitative findings from Wynter et al<sup>34</sup> reported that EHRs had negative effects on nurses' well-being, including their levels of frustration, stress, and exhaustion because the EHR interfered with their workflows. Nurses were dissatisfied with using the EHR because they did not consider it to be user-friendly.<sup>34</sup> Nurses were also dissatisfied with the complexity and lack of intuitiveness of the system, as well as the need to remember how to navigate it and access information.<sup>24</sup>

Nurses' Perceived EHR Performance

Seventeen studies reported findings related to EHR performance. In the reviewed studies, EHR performance was assessed based on criteria such as usefulness, ease of use, compatibility with work, efficiency, and effectiveness. Nurses reported that EHRs were easy to use<sup>18,19,26–30,32</sup> and useful<sup>13,19,26,29,32</sup> when the EHR facilitated access to the patients' comprehensive health data<sup>18,20,21,34</sup> by making the



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records more organized.<sup>20</sup> Nurses reported that they were able to view all clinical information in one location, improving legibility and reducing duplication of documentation.<sup>24</sup> Nurses reported that EHRs improved efficiency by reducing time spent on transcribing nursing reports, allowing nurses to allocate more time to patient care.<sup>22</sup> Nurses perceive that EHRs enabled easier and more immediate communication of patient information, thus supporting them in staying up to date with changes in patient care and facilitating clinical decision-making.<sup>21,23,34</sup>

However, some nurses reported that the EMR system negatively impacted communication by reducing interactions among clinicians and between clinicians and patients.<sup>24</sup> In addition, nurses expressed the system was not well integrated into their workflows.<sup>31</sup> An observational study by Dowding et al<sup>21</sup> reported an exemplar where poor EHR design led to a workaround, namely, that nurses printed off the summary handover sheet and then annotated it with their own notes to use throughout the shift as the EHR information was insufficient.<sup>21</sup> Ibrahim et al<sup>23</sup> conducted interviews with nurses and highlighted design issues related to EHR performance, including a lack of user-friendliness, poor fit with nurses' workflow and needs, and inadequate interface compatibility.<sup>23</sup> Nurses experienced disruptions in information management, patient care coordination, and communication due to the use of EHRs, as they struggled to synthesize information.<sup>29,33,34</sup>

**Nurses' Perceived EHR Safety**

Four studies reported findings related to EHR safety. In the reviewed studies, EHR safety was assessed through medication administration safety and potential poor patient outcomes. Nurses acknowledged that in some cases the EHR had improved the safety of medication administration.<sup>21,27</sup> Dowding et al<sup>21</sup> reported that the EHR alerted when nurses accidentally opened the wrong patient chart, extracted an incorrect dosage from automated dispensing cabinets, or attempted to administer a drug that had already been given.<sup>21</sup> However, concerns about medication safety were also reported, because of the loss of nurses' narratives in the EHR and the lack of clarity in medication orders within the EHR.<sup>24</sup> Furthermore, the level of EHR usability may be associated with patient safety, with surgical patients treated in hospitals with lower EHR usability experiencing significantly higher odds of inpatient mortality and 30-day readmission compared with patients in hospitals with better usability.<sup>6</sup>

**DISCUSSION**

Although EHR usability has garnered significant attention, a relatively small number of studies have explicitly evaluated nurses' role-specific perspectives on EHR usability. In this review, we synthesize the types of participants included in the

studies and the study locations, the study methods, EHR usability-related findings, and their alignment of findings with the human factor goals of satisfaction, performance, and safety. The majority of the studies included in this review utilized reliable and validated questionnaires to capture the viewpoints of hospital-based nurses in the United States. Whereas some questionnaires focused solely on usability, others incorporated usability-related questions as part of a broader questionnaire. For instance, in some studies, EHR usability was not clearly defined but was assessed through measures such as EHR perception or EHR use. Similarly, in qualitative studies, usability-related themes were sometimes derived from nurses' perceptions and utilization of the system. This variation in measurement approach, although potentially appropriate for individual studies, made it challenging to synthesize findings across studies.

The perceived usability of EHRs among nurses across different studies is challenging to categorize as simply "good" or "bad" because of the varying contexts in which the studies were conducted. The outcomes resulting from EHR implementation are dynamic and influenced by contextual forces and conditions.<sup>33</sup> EHR have undeniably brought unprecedented benefits to healthcare, particularly for nurses and nursing care delivery. However, there are still areas that require improvement.

To gain a better understanding of EHR usability from nurses' perspectives, we examined the usability-related findings in relation to three human factor goals: satisfaction, performance, and safety. Nurses' satisfaction with EHRs is considered a critical factor for successful system implementation.<sup>26</sup> Several internal and external factors influence nurses' satisfaction, with compatibility with their work being the most significant determinant.<sup>26</sup> However, nurses often perceive a lack of nursing input in the design of EHR systems, leading to frustration.<sup>35</sup> The need for nurses' involvement in the development of EHRs and the importance of incorporating their input have been consistently emphasized.<sup>18,24,29</sup>

Nurses' perceptions of EHR performance were reported most frequently across studies, potentially because of the ease of measuring performance-related factors such as "ease of use" and "usefulness" using established psychometric instruments. Nurses acknowledged that EHRs have improved data integrity, communication, and time efficiency. However, the implementation of EHRs also introduced new types of workloads because of nurses' unmet needs with the system. The full acceptance of a new EHR or modifications to an existing one depends on end users' expectations and perceptions of the potential benefits and impacts of the EHR on care quality.<sup>36</sup> EHR vendors should consider the voices of nurses more extensively in order to improve EHR performance.

Only four studies reported findings related to nurses' perceptions of EHR safety. This is likely because safety issues

associated with EHRs are often harder to measure. However, the implementation of EHRs into nurses' nonlinear workflow has created several hazards to patient safety.<sup>35</sup> The mismatches between EHRs and nursing work have resulted in unintended consequences that can negatively impact patient safety.<sup>37–39</sup> Customizing templates to align with unit specialties can help alleviate risks to patient safety.<sup>4</sup>

The findings of this review suggest that researchers may be prioritizing improvements in perceived performance and satisfaction over safety, possibly because satisfaction and performance are easier to measure than safety. Careful consideration is needed regarding which outcomes (satisfaction, performance, safety) should be prioritized in terms of nurses' perceived use of EHRs. Because improvement can only be achieved through measurement, the impact of not measuring safety-related usability outcomes should be taken into account.

This study has some limitations. Not all usability-related findings may have been included in this review, as usability is a multidimensional concept that can be studied under different names, not explicitly specified as “usability.” In addition, there was limited evidence on the usability of specific functionalities in EHRs. Nurses may have different perspectives on usability for specific functionalities (eg, sufficient usability in eMARs, whereas insufficient usability in nursing flowsheets). Therefore, future research should explore the usability of specific functionalities in EHRs.

## CONCLUSION

Although the adoption of EHRs has significantly impacted nursing care, studies addressing nurses' role-specific perceptions of EHR usability are limited. When aligning data collected with the concepts of satisfaction, performance, and safety, we see that perceptions of performance and satisfaction are being measured more often than safety. The results of this review highlight both the need for more studies in this area and also the need to identify what concepts we want to measure and how to measure those concepts.

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