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Review Article

Nursing surveillance for clinical deterioration among intensive care unit patients: A scoping review

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ABSTRACT

Objectives: To comprehensively examine and summarize the existing knowledge on nursing surveillance for clinical deterioration among intensive care unit patients by presenting study and subject, clinical deterioration, and nursing surveillance characteristics in quantitative and qualitative studies.

Methods: A systematic literature search was conducted in five electronic databases. Literature addressing nursing surveillance for detecting clinical deterioration among adult intensive care unit patients was included. Surveillance identified in quantitative studies was categorized into four nursing data types (scales, assessment records, activity records, and notes). Themes and subthemes were identified from qualitative studies. This review adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guideline.

Results: Twenty-four sources of evidence were included. Most studies were published since 2012 and conducted in developed countries. Forty-seven clinical deterioration events were identified, and prolonged length of stay was the most frequently identified events. Forty-two surveillance variables were categorized into nursing data types. Assessment records were the most frequently used nursing surveillance variables, yet notes were insufficiently employed. Qualitatively identified surveillance was categorized into six themes: vigilance and monitoring, detection and decision making, integrated documentation practice, collaborative communication, intervention and risk management, and interaction with information technology systems.

Conclusions: The integration of quantitative surveillance data with qualitative elements has the potential to enhance patient safety in intensive care environments. This scoping review offers valuable insights for nursing researchers, educators, practitioners, and stakeholders by presenting a comprehensive understanding of nursing surveillance. By synthesizing evidence that connects surveillance variables with specific nursing data types, this review highlights more effective use of surveillance data in the early detection of clinical deterioration among intensive care patients.

Implications for clinical practice: This paper provides a comprehensive understanding of nursing surveillance, including the utilization of nursing surveillance data and the implementation of nursing surveillance research into clinical practice.

Introduction

Nursing surveillance is a key intervention, activity, or process for providing safe and high-quality patient care for over several decades [1] with nurse researchers and practitioners continuously acknowledging patient safety initiatives [2]. The term surveillance has been used primarily to track infection sources to control diseases at the general population level [3], but its use has expanded to include surveillance interventions performed by nurses at specific healthcare level [4–7]. Surveillance at the population level is typically conducted over extended periods; however, surveillance carried out by nurses in hospital settings differs in that it occurs within shorter time frames, aimed at recognizing changes in patients' conditions and supporting decision-making [8]. The Nursing Intervention Classification System defined nursing surveillance

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as the purposeful and ongoing acquisition, interpretation and synthesis of patient data for clinical decision making [9]. Research on clinical surveillance performed by nurses has been conducted to explore its attributes and related factors [7,8,10,11] and examine it as influential factors on patient safety [6,12].

Intensive care unit (ICU) nurses perform more intensive surveillance than ward-based care, encompassing non-invasive and invasive monitoring, observation, and assessments [13,14]. A Delphi study has revealed the perception that critical care nurses focus primarily on monitoring clinical indicators [15]. An earlier study reported that efficient clinical surveillance in ICUs necessitates the continuous collection of real-time data to ensure timeliness and completeness of data collection [16]. Given the context of monitoring diverse clinical indicators, ICU nurses are required to possess advanced clinical decision-making capabilities to analyze and synthesize surveillance-based data grounded in situational awareness [17,18]. Earlier studies have unfolded the concept of surveillance into multi-faceted attributes and identified nursing interventions for the early detection of clinical deterioration [7,10,11,13,19]. In ICU environments, close monitoring and continuous 24-hour bedside observation are essential for the timely and accurate detection of subtle changes in patients' signs and symptoms [20,21], thereby preventing progression to adverse events [20,22]. During this process, ICU nurses continuously generate substantial volumes of nursing data reflecting nursing surveillance through advanced information technology (IT). These surveillance data can be quantitatively captured or qualitatively interpreted [21,23]. Quantitative nursing data stored in time-series formats has gained attention for its potential to detect clinical deterioration early by interpreting specific deterioration patterns as influential factors [24–27]. To date, evidence addressing nursing surveillance characteristics for detecting clinical deterioration within the ICU context remains insufficient. Furthermore, since nursing surveillance encompasses elements that cannot be quantitatively captured but only qualitatively interpreted, an integrated understanding of surveillance may help mitigate the knowledge gap between nursing surveillance research and its successful translation into practice [1].

Therefore, this scoping review aims to comprehensively examine current quantitative and qualitative research on nursing surveillance for clinical deterioration among ICU patients and summarize the findings based on (1) study and subject characteristics, (2) clinical deterioration characteristics, (3) nursing surveillance characteristics for clinical deterioration in quantitative studies and quantitative aspects in mixed-method studies, and (4) themes identified in qualitative studies and qualitative aspects in mixed-methods studies. This review will help nursing researchers, educators, practitioners, and stakeholders interested in this field to understand nursing surveillance from both quantitative and qualitative perspectives as represented in the current literature. It can also provide insight into the utilization of nursing surveillance data to detect clinical deterioration in ICU patients, based on evidence synthesizing nursing surveillance variables with types of nursing data.

Methods

Study design

Given the purpose of comprehensively reviewing the characteristics of nursing surveillance for clinical deterioration in the ICU context, this scoping review was conducted to address the research question and expand the understanding of nursing surveillance data types. This scoping review adhered to Arksey & O'Malley [28] framework and the JBI Methodology for Scoping Reviews [29–31]. Reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Review (PRISMA-ScR) guideline [32]. Based on the research questions of this scoping review, PCC (population – ICU patients; concept – nursing surveillance; context – clinical deterioration) was constructed to guide the search strategy.

Search strategy

Five electronic databases, including PubMed, CINAHL, EMBASE, Cochrane Library, and PsycINFO, were systematically searched, and Google Scholar was utilized to examine the reference lists of included literature during the full-text screening phase. The search strategy included a mix of free-text key terms and Medical Subject Headings aligned with each database, comprising the population, concept, and context. Three specific search strategies were performed. First, studies published between 2004 and 2024 were considered to identify relevant studies concerned with the research questions outlined in this review. Second, as the concept of nursing surveillance has not been sufficiently defined to be commonly used in nursing research and practice, searches were conducted using [All fields] across all electronic databases to prevent the omission of relevant studies that should be included. Third, the reference lists of all articles identified as eligible were searched for additional studies. The purpose of this scoping review and its search strategy were consulted with a librarian, and the search was implemented on February 2, 2024. The complete search strategy details are provided in Supplementary File 1.

Selection criteria

The eligibility of articles was constructed based on the following inclusion criteria: (1) population − studies that included adult patients admitted to the ICU, and described or mentioned adult ICU patients, (2) concept − studies that used data of surveillance performed by ICU nurses, and described, mentioned, or reflected nursing surveillance, and (3) context − studies that involved clinical deterioration events.

Studies were excluded according to the following criteria: (1) population – studies that included do-not-resuscitate patients, those receiving hospice care and end-of-life, and patients who had consented to the cessation of life-sustaining treatment, as well as studies not extracted findings on surveillance for ICU patients, (2) concept – studies in which nursing surveillance was conducted by non-nursing professionals or focused on infection-related screening (e.g., vaccination, biomarker) or the aspects of nurse administration (e.g., staffing, workload, or cost analysis), (3) context – studies that focused on COVID-19-related deterioration or non-ICU-specific clinical deterioration (i.e., post-ICU deterioration, pressure injuries), (4) language – studies that were not published in English, and (5) design – preprints, dissertations, case reports, editorials, commentaries, letters, retracted studies, presentations, and review articles.

Study selection

One researcher conducted a comprehensive literature search and imported the retrieved articles into EndNote 21 (Clarivate Analytics) for reference management. After removing duplicate records, the remaining articles were transferred to a Google Spreadsheet (Google LLC, Mountain View, CA, USA) to allow for screening, data extraction, and team collaboration. To identify potentially relevant studies, half of these articles were independently reviewed by one author and two researchers, and the remaining half were also independently reviewed by another author and two researchers. Full texts were reviewed to select the final set of included articles. Half of the full texts were independently assessed by two authors, and the other half by another author and two researchers. Articles with disagreements between researchers were independently re-reviewed by two authors. If consensus could not be reached, a third author joined the discussion to select the final articles.

Data extraction and analysis

Two authors independently extracted data from selected articles. One author extracted data using Elicit software, an artificial intelligence literature review research assistant tool [33,34] to extract data, while

another author independently reviewed and verified the extracted results to ensure accuracy and consistency. The extracted data were organized into (1) the study and subject characteristics, (2) clinical deterioration characteristics, (3) nursing surveillance characteristics for clinical deterioration in quantitative studies and quantitative aspects in mixed-method studies, and (4) themes identified in qualitative studies and qualitative aspects in mixed-methods studies.

Study characteristics included first author, publication year, country, study design, study aim, study settings, targeted population, data source, and subject characteristics included sample size, age, and sex.

Clinical deterioration characteristics were categorized into eight domains, including prolonged length of stay, all-cause mortality, cardiac-related, sepsis, general clinical deterioration, respiratory-related, mental-related, rapid response team calls, and unplanned transfers to ICUs.

Nursing surveillance characteristics for clinical deterioration in quantitative studies included type of surveillance provider and surveillance variables categorized according to the types of nursing data. Four types of nursing data were used: (1) nursing scales, (2) nursing assessment records, (3) nursing activity records, and (4) nursing notes. These nursing data types were operationally defined following a previously conducted review paper [35].

Regarding qualitative studies, themes and sub-themes were extracted and synthesized into common categories.

The extracted data were analyzed using descriptive statistics, with results summarized in terms of frequency, percentage, median, interquartile range, minimum, and maximum values. Findings are presented through tables and figures.

Results

The initial search yielded 30,732 studies. After removing duplicates, 23,441 studies were screened based on their titles and abstracts, and after applying the eligible criteria, 24 studies were consequently included in this review (Fig. 1).

Study and subject characteristics

Table 1shows the study and subject characteristics of included studies. Twenty-four studies ranged in publication years from 1999 to 2023, with approximately 90 % published since 2012. Two-thirds of the studies were conducted in the United States (n = 17), followed by South Korea (n = 2), the United Kingdom (n = 2), Australia, Canada, China, and Turkey (n = 1, respectively). Study designs included quantitative studies (n = 19), qualitative studies (n = 2), and mixed-methods studies (n = 3). Quantitative studies comprised one pre-post study [36], two

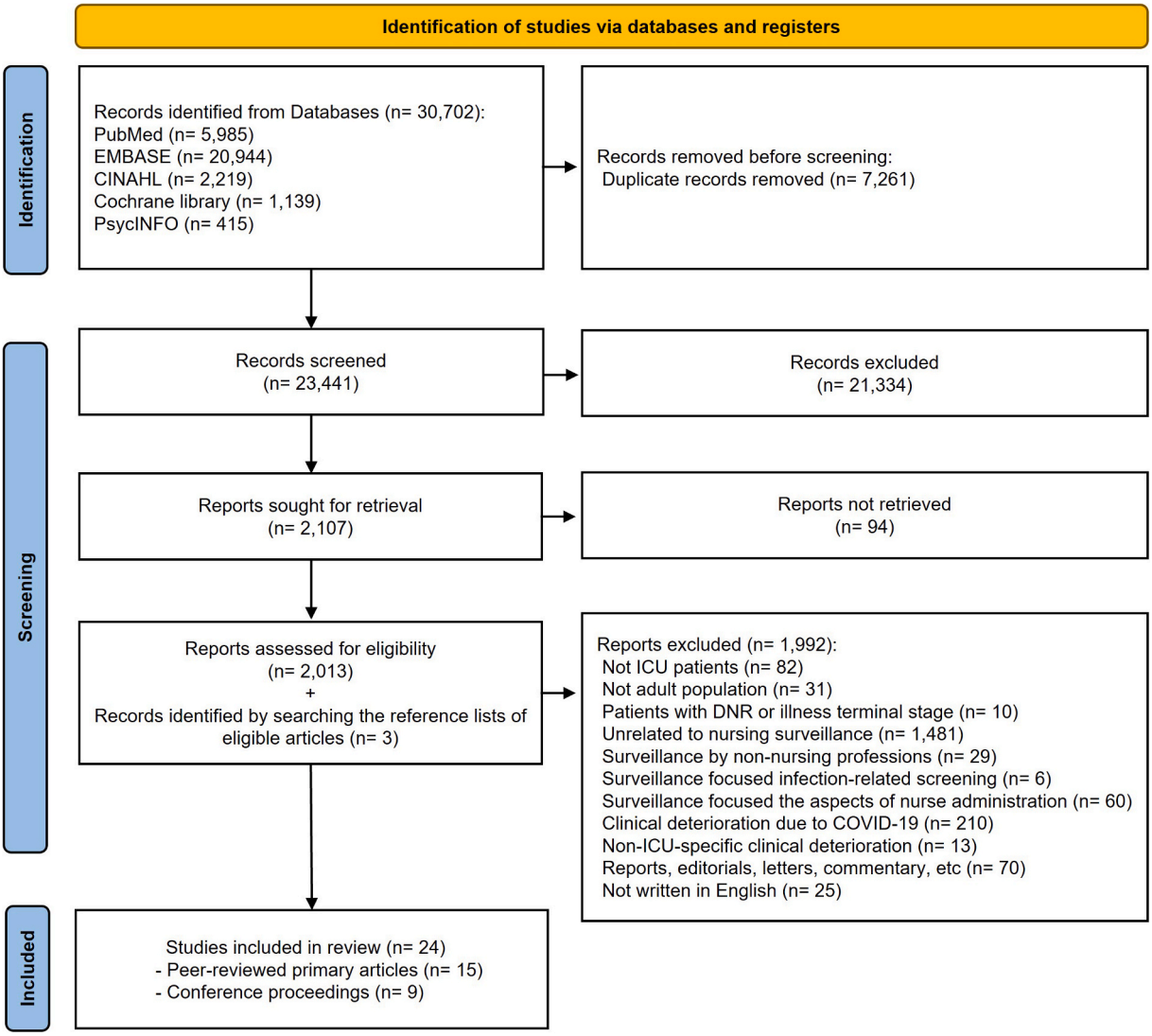

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram of the literature selection.

Table 1
Characteristics of Included Studies.

Author, year	Country	Study design	Aim	Study settings	Targeted population	Data source	Subject Sample size	Age (Mean ± standard deviation); Male: Female (n)	Key findings
Al Ashry, 2016 [48]	USA	Retrospective analysis study	To assess whether nursing compliance with an 18-item ICU checklist improves outcomes in mechanically and non-mechanically ventilated ICU patients	Single-site; MICU, SICU, TICU, NSICU	Patients	Previously collected data during the implementation of a Quality Improvement project	203 patients- Mechanically ventilated patients: 61 (Completed), 142 (Incompleted)	Completed: 57.33 ± 18.32; Incompleted: 54.88 ± 18.28; NR	− Compliance with a nurse-led ICU checklist with nursing surveillance contents was associated with an increase in the number of ICU days. − For mechanically ventilated patients, completion of the nursing checklist was associated with statistically significant increases in the number of ICU, hospital, and ventilator stay.
Alarhayem, 2019 [43]	USA	Retrospective analysis study	To assess the validity of Rothman Index scores in predicting surgical ICU readmission rates and mortality	Single- site; SICU	Patients	Electronic medical records in a hospital	1,430 patients, readmission: 79, No readmission: 1,351	SICU readmission: 52, No readmission: 49; NR	− Surgical ICU patients requiring readmission within 48 hour of transfer have a significantly higher mortality rate and longer length of stay in ICU compared to those who do not. − Patients requiring readmission have significantly lower pre-transfer and post-transfer Rothman Index scores compared to those who do not. − Rothman Index scores may be used as a clinical tool for evaluating patients before transfer from the SICU.
Blaine, 2022 [38]	USA	Prospective, observational survey study	To evaluate the impact of nurse-led rounds on attendance, nurse-to-provider communication, and key data reporting in the CTICU	NR; CTICU	Nurses	Data collected with survey	NR	NR	− Nurse-led rounds improved consistency in reporting RASS and/or CAM-ICU score and bowel movement, and enhanced perceived nurse value in multidisciplinary rounds, but did not increase nurse attendance on rounds.
Brueske, 2022 [40]	USA	Retrospective cohort study	To analyze the relationship between BSS subscores and hospital mortality and assess whether BSS subscores indirectly measure frailty	Single-site; CICU	Patients	Electronic medical records in a hospital	11,954 patients	67.6 ± 15.2; 7,430:4,524	− Lower BSS is associated with higher in-hospital mortality among CICU patients. − Friction/Shear and Sensory Perception subdomains of the BSS have the strongest association with mortality, indicating their potential role in assessing patient frailty.
Buist, 1999 [47]	Australia	Retrospective case review study	To investigate the type and duration of clinical instability prior to critical events in hospital patients	Single-site; ICUs	Patients	Medical charts in a hospital	112 patients	Unplanned ICU admissions: 62.0 ± 18.3, Planned ICU admissions: 54.1 ± 21.5; NR	− Early detection of clinical instability could improve outcomes before critical events. − Unplanned ICU admissions and cardiac arrest calls, though rare, significantly impact mortality.

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Table 1 (*continued*)

Author, year	Country	Study design	Aim	Study settings	Targeted population	Data source	Subject Sample size	Age (Mean ± standard deviation); Male: Female (n)	Key findings
Cho, 2015 [36]	South Korea	Pre-post study	To investigate the impact of the APREDEL-ICU system on nursing-sensitive outcomes and assess nurse satisfaction with this system in the MICU	Single-site; MICU	Patients, nurses	Electronic medical records in a hospital	317 patients – Pre-intervention: 145, Post-intervention: 172; 40 ICU nurses	Pre-intervention: 60.34 ± 14.89; 98:47, Pos-intervention: 60.34 ± 17.04; 101:71; NR	– Prolonged instability before events indicates missed chances for timely intervention. – The APREDEL-ICU did not result in a reduction in the occurrence of delirium episode and the number of abnormal levels of consciousness among MICU patients. – The APREDEL-ICU is an early warning system that can be adopted to alert nurses to high-risk delirious patients and support the provision of delirium prevention care. – Nurses reported increased knowledge of delirium prevention care and greater satisfaction with APREDEL-ICU, as it encouraged more careful patient monitoring.
Choi, 2013 [50]	South Korea	Retrospective observational study	To examine whether a nurse-recorded patient severity classification system predicts ICU and hospital lengths of stay and mortality	Single-site; SICUs	Patients	Clinical Data Repository, Electronic medical records in a hospital	1,432	58.8 ± 15.3; 880:552	– Critical Patient Severity Classification System recorded by ICU nurses was a highly significant predictor of length of stay and mortality in patients admitted to SICUs.
Collins, 2012 [59]	USA	Mixed-method study design with retrospective secondary data analysis and content analysis	To analyze EHR flowsheet comments and documentation patterns linked to patient outcomes	Single-site; ICUs, other units (general wards, intervention units, step-down units)	Patients	Electronic medical records in a hospital	ICU patients: 42, other unit patients: 159, at least one comment in ICU: 17	NR	– Free-text EHR flowsheet comments reflect nurses' judgment based on surveillance activities. – Frequent comment documentation events were associated with normal and abnormal measurement values. – Hourly documentation of oxygen saturation and blood pressure in the 48 hour before cardiac arrest was associated with higher survival rates among ICU patients, highlighting the value of nursing surveillance.
Daouk, 2017 [44]	USA	Retrospective cohort study	To assess the association between the Rothman Index at MICU admission and clinical outcomes	Single-site; MICU	Patients	Electronic medical records in a hospital	4,574	Mean: 57; 2,301:2,273	– Rothman Index on admission to the MICU was a strong predictor of mortality and other important MICU outcomes.
Elashwal, 2021 [53]	USA	Development and validation study	To develop and describe the WCN Consciousness Scale for consciousness assessment in critical care	NR; NICU	Patients and nurses	NR	NR	NR	– WCN Consciousness Scale provided more consistent, comprehensive assessment of arousability, alertness, attention, and response to

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Table 1 (*continued*)

Author, year	Country	Study design	Aim	Study settings	Targeted population	Data source	Subject Sample size	Age (Mean ± standard deviation); Male: Female (n)	Key findings
									stimuli. – This scale outperformed GCS/RASS and improved communication, documentation, and earlier detection of deterioration.
Fu, 2021 [41]	USA	Retrospective cohort study design using secondary analysis	To propose an algorithm that uses only timestamps data to classify clinical deterioration events and to evaluate the impact of including time-of-day and time-to-outcome information in the model	Multi-site; ICUs	Patients	Electronic medical records in a hospital	6,720 patients	Mean: 64.8; 3,931:2,789	– Recurrent neural network models using only EHR timestamps can achieve well-performing discriminative power. – Healthcare providers' documentation recording and patterns reflect their concerns about patients' conditions, enabling the application of predictive modeling to various healthcare processes. – The feature of a 60-minute timestamp in the time-to-outcome dataset effectively captures granularity for predicting clinical deterioration in ICU patients.
Ji, 2015 [54]	China	Methodological, development and usability evaluation study	To develop and evaluate the usability of a standardized, easy-to-use mobile CAM-ICU delirium-detection app for bedside nurses	NR; ICU	Nurses	Survey entries	102 ICU nurses	NR	– Developed mobile app is a useful tool in delirium assessment and easier to use compared with regular CAM-ICU, especially in guiding nurses through assessment accurately and observing patient's condition comprehensively.
Kang, 2020 [52]	USA	Methodological study	To identify the concept of nursing concerns using the Clinical Care Classification system and to define entities and seed terms	Single-site; MICU, SICU, TICU, CICU, NICU, other units (ACUs)	Nurses	Electronic medical records in a hospital	NR	NA	– In nursing notes, the concept of a nurse's concern can be effectively captured using the CCC system. – Nurse concerns differed between clinical settings and unit types. – Nurse concerns can be used as a fundamental lexicon to facilitate automated processes, such as machine learning-based natural language processing.
Milhomme, 2018 [55]	Canada	Qualitative study using grounded theory approach	To develop a theoretical explanation of the clinical surveillance process by expert nurses in a critical care context to understand how the process unfolds	Single-site; MICU, SICU	Nurses	Individual interviews	15	NA	– Clinical surveillance in critical care is a collaborative process focused on managing patient instability and preventing complications. – Nurses' expertise enables early detection and effective responses, often guided by

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Table 1 (*continued*)

Author, year	Country	Study design	Aim	Study settings	Targeted population	Data source	Subject Sample size	Age (Mean ± standard deviation); Male: Female (n)	Key findings
									intuition and experience. − Collaboration with patients, families, and teams enhances abnormality detection and risk management. − Nurse's vigilance is key, involving attentiveness to subtle changes and proactive interventions to ensure safety. − Retaining expert nurses and fostering teamwork are essential for improving critical care outcomes.
O'Neill, 2014 [49]	UK	Retrospective observational study using longitudinal design	To evaluate NET can improve the time to assessment and management of NSTE-ACS patients	Single-site; CCU, other units (AAUs)	Patients	Previously collected secondary data in an earlier project	274 − Pre-NET: 79, NET six months: 103, NET five years: 92; CCU: 195, AAU: 79	Pre-NET: 72 ± 12; 46:44; NET six months: 67 ± 14; 58:45; NET five years: 68 ± 14; 55:37	− NET significantly reduced the time to ECG recording for patients with chest pain compared to the pre-NET. − NET significantly increased the transfer of high-risk NSTE-ACS patients to the CCU and enhanced critical care management in the CCU compared to the pre-NET. − NET can improve the process of health care delivery, which leads to optimizing the use of evidence-based guidelines and enhancing the quality of care for patients with NSTE-ACS.
Özdemir, 2019 [37]	Turkey	Observational, survey study	To evaluate nurses' attitudes, EWS awareness, and interventions for deteriorating patients.	Single-site; ICUs	Nurses	Survey entries	146 − ICUs: 64, service units: 82	NA	− The rate of EWS system use was found to be significantly higher in ICU nurses. − Symptoms such as dyspnea, altered consciousness, palpitations, and chest pain are common in life-threatening clinical deterioration, requiring nurses to promptly assess their severity and respond appropriately. − Requested tests often reflect the underlying causes of clinical deterioration, highlighting the need for careful monitoring of postoperative patients, particularly for bleeding, drain removal, and anesthesia recovery.
Perkins, 2017 [45]	USA	Retrospective observational cohort study	To compare the Rothman Index's ability to predict ICU mortality with APACHE II score	Multi-site; MICU	Patients	Electronic medical records in a hospital	5,863 encounters	Mean: 52; 2,508: 2,297	− Lower Rothman Index at ICU admission was associated with increased 24-hour ICU mortality, indicating that

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Table 1 (*continued*)

Author, year	Country	Study design	Aim	Study settings	Targeted population	Data source	Subject Sample size	Age (Mean ± standard deviation); Male: Female (n)	Key findings
									Rothman Index had good predictive value for in-ICU mortality, comparable to APACHE II.
Rincon, 2017 [56]	USA	User-centered evaluation study with qualitative study design	To evaluate the usability and effectiveness of a telehealth ICU sepsis alert system in enhancing nurse surveillance and decision-making	NR; ICUs	Nurses	Focus group discussions	NR	NA	– The sepsis prompt was found to be visible, distinct, and easily detectable by nurses, improving the efficiency of sepsis screening. – The prompt provided a clear response mechanism and balanced false alerts with misses, enhancing its usability and effectiveness. – Nurses reported overall satisfaction with the sepsis prompt, noting it was easy to learn and improved screening efficiency compared to manual methods.
Rossetti, 2020 [46]	USA	Retrospective observational cohort study	To assess whether adding nursing documentation HPM-Signals to MEWS improves early identification of adverse events	Multi-site; ICU, SDU and ACU	Patients	Flowsheet data from electronic medical records	28,394 patients (38,885 encounters)	Median: 62 (18-115); 13,479:14,915	– Incorporating nursing documentation pattern on HPM-Signals to MEWS increased lead time for detecting clinical deterioration with similar overall discrimination, showing clinician behavior signals can enhance early-warning systems.
Rossetti, 2021 [57]	USA	Mixed-method study design with an iterative framework development approach, including the combination of data-driven modeling and simulation testing	To describe HPM-ExpertSignals development	Multi-site; ICUs, other units (intermediate care units, general wards, acute care units)	Patients, nurses, physicians	Electronic medical records in two hospitals, simulation feedbacks	Site A: 123,981 patients, site B: 188,512 patients; 17 nurses, 6 physicians	NR	– The HPM-ExpertSignals framework effectively models nurse and clinician behaviors to enhance predictive modeling of patient outcomes. – The development model improves patient risk prediction with higher hazard ratios and longer lead times than MEWS and NEWS. – Three key themes emerged from the development model: (1) predictive signals can be derived from clinical behavior, (2) clinical domain expertise is essential for interpretation, and (3) temporal focus enhances clinical utility. – Four key themes were identified through the development model simulation testing: (1) clinical decision-making, (2) paradigm shift, (3) believability, and (4) interactions with clinical information systems.

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Table 1 (*continued*)

Author, year	Country	Study design	Aim	Study settings	Targeted population	Data source	Subject Sample size	Age (Mean ± standard deviation); Male: Female (n)	Key findings
Schnock, 2021 [58]	USA	Mixed-method study design, including focus groups, semi-structured interviews, and data mining of EHR data	To investigate nursing documentation patterns to identify indicators of patient deterioration and recovery, quantify variations in the ICU and ACU, and validate their clinical relevance with nurses and physicians	Single-site; ICUs, other units (ACUs)	Patients, nurses, physicians	Focus group interviews, electronic medical records in a hospital	8,552 patients – ICUs: 1,162, ACUs: 7,390; 29 health professionals – ICUs: 5 (nurses), 2 (physicians), ACUs: 20 (nurses), 2 (physicians)	NR	– Challenges were identified in measuring clinical expertise and analyzing interactions with clinical information systems. – In the ICU, increases in heart rate and temperature documentation in the nursing flowsheet and withheld medications were significantly associated with inpatient mortality. – PRN medication administration was associated with an increased likelihood of survival in the ICU; however, due to clinician disagreement, the final analysis was excluded. – The main theme of the focus group interviews revealed documentation, monitoring, taking vital signs, and communication.
Smischney, 2012 [51]	USA	Retrospective observational study	To evaluate whether a structured ICU transfer communication template reduces ICU readmissions	NR; SICU	Patients	Hospital medical records and survey data	141	NR	– Template improved communication quality and was associated with zero ICU readmissions for 5 weeks post-implementation though compliance is relatively low.
Thomason, 2005 [39]	USA	Prospective observational cohort study	To determine the incidence of delirium among non-ventilated ICU patients and its association with ICU length of stay, hospital length of stay, and in-hospital mortality	Single-site; MICU	Patients	Information collected prospectively at the time of enrollment	260 – Delirium: 125, Non-delirium: 135	Delirium: 56 ± 18; 62:63; Never Non-delirium: 49 ± 17; 67:68	– Delirium occurred in nearly half of non-ventilated ICU patients, independently predicting longer hospital stays but showing no significant relationship with mortality after adjustment. – The study supports routine delirium monitoring in MICU patients using validated tools such as RASS and CAM-ICU.
Tran, 2023 [42]	USA	Retrospective cohort study using secondary analysis	To develop a sepsis prediction model using continuous vital signs and machine learning and compare its performance with previous scoring systems.	Single-site; ICUs	Patients	The Medical Information Mart for Intensive Care IV database	48,886 – Sepsis: 8,149, Non-sepsis: 40,737	NR	– A machine-learning model incorporating surveillance variables measured by nurses demonstrated superior performance in predicting sepsis onset compared to traditional scoring systems.

Abbreviations: AAU: Acute Admissions Units; ACU: Acute Care Unit; APACHE: Acute Physiology and Chronic Health Evaluation; APREDEL-ICU: Automatic Prediction of Delirium in Intensive Care Units; BSS: Braden Skin Score; CAM-ICU: The Confusion Assessment Method for the Intensive Care Unit; CCC: Clinical Care Classification; CCU: Coronary Care Unit; CICU: Cardiac Intensive Care Unit; CTICU: Cardiothoracic Intensive Care Unit; ECG: Electrocardiogram; EHR: Electronic Health Record; EWS: Early Warning Score; GCS: Glasgow Coma Scale; HPM-Signals: Healthcare Process Modeling Framework to Phenotype Clinician Behaviors for Exploiting the Signal Gain of Clinical Expertise; ICU: Intensive Care Unit; MEWS: Modified Early Warning Score; MICU: Medical Intensive Care Unit; NA: Not Applicable; NET: Nurse-led Early Triage; NEWS: National Early Warning Score; NICU: Neurological Intensive Care Unit; NSICU: Neurosurgical Intensive Care Unit; NSTE-ACS: Non-ST-elevation acute coronary syndrome; NR: Not Reported; PRN: pro re nata; QI: Quality Improvement; RASS: Richmond Agitation Sedation Scale; SD: Standard Deviation; SDU: Step-Down Unit; SICU: Surgical Intensive Care Unit; STEMI: ST-segment elevation myocardial infarction; TICU: Trauma Intensive Care Unit; WCN: World Congress of Neurology.

observational survey study [37,38], one prospective cohort study [39], seven retrospective cohort studies [40–46], one retrospective case review study [47], four retrospective observational studies [48–51], and three methodological study [52–54]. Two qualitative studies included a grounded theory approach [55] and a user-centered evaluation study using focus group interview (FGI) [56]. Three mixed-method studies contained two explanatory sequential designs [57,58] and a convergent parallel design [59]. Most study settings (n = 15) were single-site, followed by multi-site (n = 4) and not reported (n = 5). Most studies (n = 17) were conducted in ICU settings only, while seven studies included both ICU and other clinical units. Of the studies conducted solely in ICU settings, three studies [36,39,48] reported ICU nurses working in two shifts. One study [36] included nurse-to-patient ratios of 1:2.2 and 1:2.5, while the remaining studies (n = 14) did not report information regarding the nursing work environment.

Most quantitative studies (77.3 %, including the quantitative components of mixed-methods studies) targeted patients [36,39–51,57–59], while the remaining publications (n = 5) focused on nurses [37,38,52–54]. These quantitative designs employed targeted population data that was prospectively collected by researchers [37–39,53,54], retrospectively collected by researchers [48,49,51], and obtained from medical records [36,40–47,50,52,57–59]. Of the 14 studies that utilized electronic medical records (EMRs), 13 studies (92.9 %) used electronically documented nursing records, while only one study used manually documented nursing charts [47]. Among the studies using EMRs, the most recently published study [42] utilized a publicly available database, Medical Information Mart for Intensive Care IV.

Qualitative designs, including the qualitative components of mixed-method studies, included patients admitted to ICUs [59], ICU nurses [55,56], and both ICU nurses and physicians [57,58]. Qualitative data were collected from EMRs [59], individual interviews [55], FGI [56,58], and simulation testing feedback [57].

Quantitative studies, including those from mixed-methods designs, had a median sample size of 1,413 (interquartile range: 260–8,552), while qualitative studies, including qualitative components of mixed-methods designs, involved a median of 27 healthcare professionals (interquartile range: 20–35).

In studies reporting age, the mean patient age ranged from 49 to 72 years. The median number of male subjects was 493 (interquartile range: 60–2456). Patient severity was reported in five studies using total comorbidities [36], Acute Physiology And Chronic Health Evaluation score (APACHI)-II [39,47,48], APACHE-III [40], and the Charlson comorbidity index [39,40]. Three studies reported on mechanical ventilation, either by days ventilated [48] or ventilator use [36,40].

Clinical deterioration characteristics

All reviewed literature included clinical deterioration events, about which ICU nurses are concerned. Clinical deterioration events were categorized to present the characteristics of clinical deterioration, as shown in Fig. 2. Detailed clinical deterioration events of each study are presented in Table 1.

A total of 47 clinical deterioration events were identified across the 24 included studies. Prolonged length of stay was the most frequently reported (13/47, 27.7 %; ICU: n = 6, hospital: n = 7) [39,43–45,47,48,50]. This was followed by all-cause mortality (10/47, 21.3 %; ICU: n = 3, hospital: n = 7) [39–41,43,44,47,50,57,59]. Other common outcomes were cardiac-related events (n = 6), such as cardiac arrest, cardiac arrest calls, non-ST-elevation acute coronary syndrome [47,49,57–59]; sepsis (n = 4) [42,56–58]; and general clinical deterioration (n = 4), including complications and instability [37,41,55]. Less frequently reported outcomes were respiratory-related deterioration (n = 3; e.g., prolonged ventilator stay, respiratory arrest, duration of mechanical ventilation) [44,48,58]), unplanned transfer to ICUs (n = 3) [43,57,58], mental-related deterioration (n = 2; e.g., delirium, changes in consciousness) [36], and rapid response team calls (n = 2) [41,57].

Nursing surveillance characteristics for clinical deterioration in quantitative research

The subjects performing surveillance for patients' clinical deterioration were nurses (n = 16) and nurses working in conjunction with other healthcare personnel (n = 8). Types of nurses included clinical nurses working in ICUs [36–40,43,45,46,48,50,54,55,57–59], tele-ICU nurses [56], acute coronary syndrome specialist nurses and trained triage nurses working in cardiac ICUs [49], neuroscience specialist nurses [53], and not reported [41,42,44,47,51]. Three of the included studies [55,57,58] mentioned nurses' clinical experience, primarily

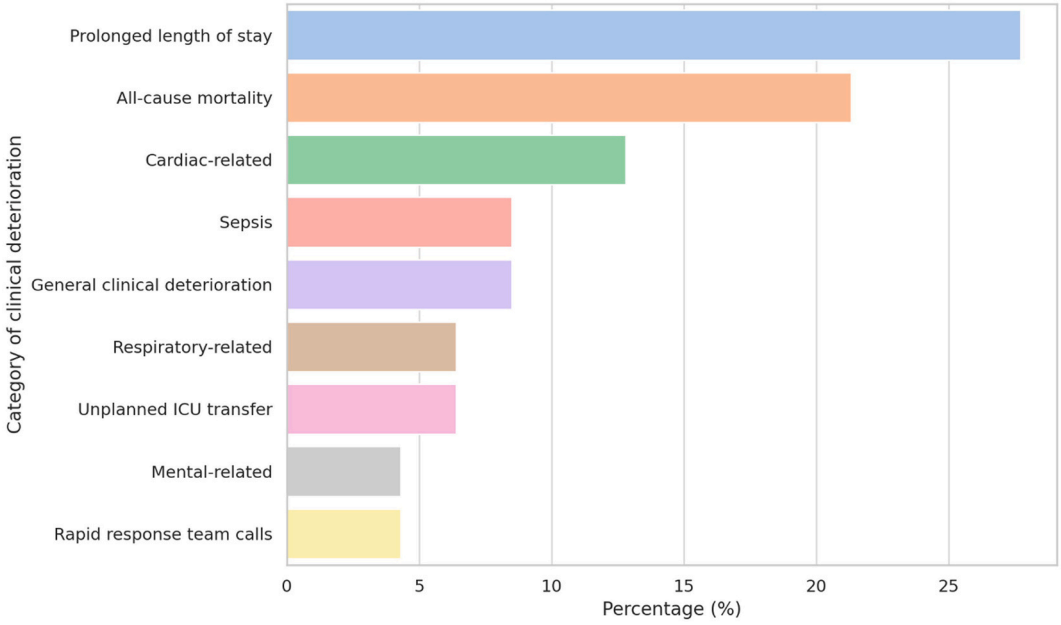

Fig. 2. Proportion of clinical deterioration categories. (n = 47). Clinical deterioration events were counted across the 24 included studies, with a total of 47 clinical deterioration events identified within these studies.

Table 2
Nursing surveillance variables matched with nursing data types.

Type of nursing data	Nursing surveillance variables	Included studies ($n = 22$)	References
Nursing scale	Confusion Assessment Method for the ICU	4	[38,39,48,54]
	Glasgow Coma Scale	3	[37,40,47]
	Rothman Index	3	[43–45]
	Braden Score	2	[40,48]
	Richmond Agitation-Sedation Scale	2	[38,39]
	Critical Patient Severity Classification System	1	[50]
	Early warning score for detecting delirium risk	1	[36]
	Thrombolysis in Myocardial Infarction Score	1	[49]
	Modified Aldrete Score	1	[37]
	World Congress of Neurology Consciousness Scale	1	[53]
Nursing assessment records	Vital sign measurements	7	[37,41,46,47,57–59]
	Level of consciousness	4	[37,46,48,56]
	Chest pain levels	2	[37,49]
	Sepsis screening	2	[42,48]
	Appearance	1	[37]
	Bowel movement	1	[38]
	Central venous pressure	1	[59]
	Electrocardiogram changes (indicative of ST-elevation myocardial infarction)	1	[49]
	Endotracheal tube size and position	1	[48]
	Foley catheter patency	1	[48]
	Grimace	1	[37]
	Intravenous catheter access	1	[48]
	Level of head elevation	1	[48]
	Mechanical ventilator mode and setting	1	[48]
	Mobility	1	[48]
	Nutrition state	1	[48]
	Palpitation	1	[37]
	Presence of convulsion	1	[47]
	Respiratory distress	1	[37]
	Skin integrity	1	[48]
	Urine output	1	[47]
Nursing activity records	Medication administration	5	[37,41,48,57,58]
	Application of the oxygen supply device	1	[37]
	Chart review of therapy or consults	1	[48]
	Hygiene-related activity (bathing and oral care)	1	[48]
	Notification to doctors, other nurses, and blue code teams	1	[37]
	Rounding with multidisciplinary teams	1	[38]
	Pressure reduction activity (including the application of specialty bed, gel pad, and cushioned boots)	1	[48]
	Restraint application	1	[48]
	Specimen collection	1	[37]
Nursing notes	Nursing comments in the flowsheet	6	[41,46,51,57–59]
	Narrative nursing notes	3	[41,52,57]

involving nurses with more than 3–5 years of ICU experience.

Table 2 describes nursing surveillance variables used in 22 quantitative designs (including the components of quantitative studies in mixed-method research) and classifies them into nursing data types. Nursing assessment records (n = 21) contained the most diverse types of nursing surveillance variables, followed by nursing activity records (n = 9), nursing scales (n = 10), and nursing notes (n = 2). Nursing assessment records predominantly utilized vital sign measurements [37,41,46,47,57–59], followed by level of consciousness [37,46,48,56], chest pain levels [37,49], and sepsis screening [42,48]. Seven studies using vital sign measurements employed real values [37,40,47,59], and timestamps and entry frequencies of vital sign measurements [41,57,58]. Regarding nursing activity records, medication administration [37,41,48,57,58] was the most frequently utilized nursing surveillance variable. Among them, medication administration withheld [41,57,58], pro re nata medication [57,58], and one-time medication [41,57] frequencies were commonly employed. Among nursing scales, the Confusion Assessment Method for the ICU (CAM-ICU) [38,39,48,54] was the most used nursing surveillance variable, followed by the Glasgow Coma Scale (GCS) [37,40,47] and Rothman Index [43–45]. Nursing notes encompassed nursing comments in flowsheets [41,46,51,57–59] and narrative nursing notes [41,52,57].

Nursing surveillance characteristics for clinical deterioration in qualitative research

Five qualitative designs (including the components of qualitative studies in mixed-method research) encompassed 24 themes and 16 subthemes [55,57–59], with one study presenting no themes [56]. The six nursing surveillance elements identified distinct yet interconnected components of clinical practice. First, 'Vigilance and Monitoring' emerged, including assessment [59], remaining vigilant in unstable contexts and collecting data [55], monitoring specific signs and taking vital signs [58], and recognizing clinical behaviors as predictive signals [57]. Second, 'Detection and Decision Making' incorporated detecting problems and making decisions [55] and applying clinical domain expertise for interpretation [57]. Third, 'Integrated Documentation Practices' encompassed references to other documentation specifically noted by ICU nurses to direct attention to critical clinical information elsewhere in the patient's chart, such as 'a-fib, see note' [59], documenting care team communication and medication administration [58], and validating nurses' documentation efforts through the surveillance system's use of nursing documentation [57]. Fourth, 'Collaborative Communication' involved awareness among healthcare professionals [59], working in synergy [55], team communication [58], and team-based care [57]. Fifth, 'Intervention and Risk Management' included interventions [59], managing complication risks [55], and patient prioritization with improved critical thinking [57]. Finally, 'Interaction with IT systems' addressed clinical information systems interactions [57] and highlighted data in electronic health records (EHRs) [58].

Discussion

This scoping review identified 24 studies addressing nursing surveillance for clinical deterioration among ICUs. The review comprehensively summarized nursing surveillance by synthesizing quantitatively identified nursing surveillance into nursing data types, and by categorizing qualitatively identified themes and sub-themes into common elements.

Most included studies were published from 2012 onwards, which suggests a growing interest in surveillance among researchers in acute care settings [6–12]. These publication trends align with those reported in a bibliographic study [1]. Most studies included in this review were conducted in the United States, and almost all were conducted in developed countries. To overcome the limitations of geographical diversity, it is recommended that future research expand to underrepresented regions and populations, thereby promoting equity and generalizability in nursing surveillance research.

Approximately two-thirds of the included studies incorporated retrospective analysis using EHRs. This is consistent with the introduction and application of EHR systems in ICU clinical practice in developed countries [60], which has enabled efficient execution of surveillance.

The most recent study has employed publicly available databases, which aligns with the trend in nursing data utilization [23,35].

Research designs integrating this evidence into ICU clinical practice included simulation studies [42,56,57] and longitudinal pre-post studies [36] targeting ICU nurses. To date, no studies have reported ICU-specific nursing surveillance into clinical practice. These findings align with results from a bibliographic study [1] indicating challenges in transitioning nursing surveillance research into clinical practices. Nevertheless, a recent randomized controlled trial (RCT) revealed the effects of nursing surveillance systems in acute care units and ICUs [61]. Although this study did not specifically report ICU-specific clinical deterioration effects, it suggests that as the concept of nursing surveillance evolves, efforts are being made to bridge the gap between nursing research and clinical practice.

The studies' settings were primarily single-center ICU environments, with relatively few multi-site studies. The most recent published RCT of nursing surveillance [61] was conducted in two-site hospital clusters with the same EHR system to easily capture the homogeneity of nursing surveillance. In order to consistently identify surveillance data and enhance external validity, utilizing accessible multi-institutional ICU data [62,63] or considering mapping to standardized nursing terminology across different hospital ICU environments could be beneficial [64–67], though related research remains scarce.

Healthcare institutions can prevent adverse health outcomes by rapidly recognizing and appropriately responding to clinical deterioration [68]. Prolonged length of stay [39,43–45,47,48,50] emerged as the most frequently reported adverse event. This was followed by all-cause mortality [39–41,43,44,47,50,57,59] and cardiac-related deterioration events [47,49,57–59]. A RCT study demonstrated that an early warning system utilizing nursing surveillance characteristics significantly reduced mortality, length of stay, sepsis, and unplanned ICU transfers [61]. This study included both ICUs and general wards, suggesting that the cut-off threshold for surveillance warning score alert alarms might have been calibrated for general hospital settings. Bedside monitoring of organ-support devices and hemodynamic indicators enables more rapid and timely response to patient needs [16,20,21]. Future work should operationalize ICU-specific patterns derived from nursing surveillance data collected during ICU practice as key features within emerging artificial intelligence–based information technologies, and on linking these to real-time clinical decision support systems for ICU health professionals.

The potential utility of nursing surveillance data extends further, as such data may constitute valuable variables for clinical deterioration prediction. Indeed, a systematic review reported superior performance of models incorporating nursing data compared to those relying exclusively on physiological measures [23]. This scoping review showed that nursing assessment records included the most diverse surveillance variables. Among those, vital sign measurements were the most frequently utilized [37,41,46,47,57–59], followed by level of consciousness, sepsis screening, and chest pain levels. The frequency of vital sign measurements could be used as proxies for surveillance, as nurses measure vital signs when concerned about patient deterioration [41,46,57,58]. A systematic review identified vital sign measurements as key predictive factors [24]. while a RCT study constructed surveillance initiatives using manual assessments (e.g., palpation, auscultation, physical examination) by synthesizing monitoring-based data [4]. These findings might suggest that the integration of manually assessed data and monitoring-based data may be crucial for accurately capturing ICU patients' clinical deterioration.

Regarding nursing activity records, medication administration activities were primarily identified as surveillance variables, with prominent variables appearing to be medication administration withhold [41,57,58], pro re nata medication [57,58], and one-time medication [41,57]. These variables are reported as nursing surveillance variables identified through patterns of nurses sensitively recognizing and responding to changes in patient condition [46].

Among nursing scales, the CAM-ICU and GCS, both of which are associated with nursing-sensitive outcomes such as delirium [69], was most frequently nursing surveillance variable. In addition, the Rothman Index, which is composed of real-time objective measures integrating nursing assessment records, has the potential to predict clinical deterioration in ICU settings when combined with EMR implementation [70]. However, further validation is needed across a wider range of deterioration events.

Nursing notes written when nurses consider it necessary to communicate with other healthcare professionals, were identified as a valuable data source for nursing surveillance. Nursing notes were examined through content analysis [59], natural language processing [57], or mapping to standardized nursing terminology [52]. Narrative nursing notes are difficult to capture quantitatively; however, they offer valuable insight into the intrinsic elements of nursing surveillance. Large language models, which have recently received significant attention, have considerable potential for analyzing unstructured data such as nursing notes [67,71,72]. However, research integrating these advanced technologies with surveillance variables remains in its early stage.

Nursing surveillance is inherently dynamic and multifaceted, evolving over time in response to clinical complexity. Although its conceptual boundaries are challenging to define [8], five attributes identified as vigilance, decision-making, documentation, communication, and system interaction. These synthesized results showed the highest consistency with previous studies [1,7,16]. Surveillance in contemporary ICU environments is increasingly shaped by health information systems [61,73], integrating nurses' clinical judgment with real-time data to detect clinical deterioration. As timeliness is highly emphasized in ICUs [61], fostering an infrastructure that supports seamless interaction between nurses and technology is essential. This includes cultivating a supportive organizational culture and enhancing nursing education to strengthen system literacy and clinical responsiveness.

Limitations

Our scoping review has several limitations. First, although this scoping review focused on ICU patients, six studies included non-ICU settings, introducing some uncertainty in isolating ICU-specific contexts. However, consistent with the purpose of a scoping review, we included and analyzed studies that involved ICU patients in the final literature. Second, this review was limited to adult populations; therefore, the findings cannot be generalizable to pediatric or neonatal populations. Third, while we constructed search keywords to include the conceptual scope of nursing surveillance, studies that did not include relevant keywords in the full text may have been unintentionally excluded. To address this, we applied the "All fields" option during the database search to retrieve a comprehensive set of records.

Conclusion

Nursing surveillance in ICUs serves as an essential practice for identifying and preventing avoidable clinical deterioration. This review synthesized current evidence by mapping quantitative nursing surveillance data to nursing data types and categorizing qualitative findings into common thematic elements. While such data can support timely and effective decision-making for patients in high-acuity settings, the range of surveillance data currently utilized in ICU practice remains limited. Qualitative insights suggest that nursing surveillance is transitioning from individual vigilance and patient monitoring to technologically supported systems that actively interact with nurses in ICU environments. Enhancing patient safety in these settings will require the integration of robust quantitative monitoring data with the contextual and experiential dimensions of nursing surveillance.

Clinical trial registration

This scoping review protocol was registered on the Open Science Framework Registries (https://doi.org/10.17605/OSF.IO/GPFDV, registered 19/03/2024).

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CRediT authorship contribution statement

Yeonju Kim: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yesol Kim:** Writing – review & editing, Validation, Methodology, Formal analysis, Conceptualization. **Jiin Kim:** Writing – review & editing, Visualization, Validation, Methodology, Formal analysis, Data curation. **Mona Choi:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethics statement

This research was conducted in accordance with research ethics and legislation and corresponding policies.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.iccn.2025.104218.

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