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BMJ Open

Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol

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Full Title:

Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol

Short Title:

Scoping review protocol on barriers to, and facilitators of, eHealth utilization in NICU

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Disclaimers

All the authors confirmed that they have reviewed and declared this manuscript entitled “Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol” is original, has not been published before, and is not currently being considered for publication elsewhere. And all of the authors approved its submission to the journal of BMJ Open

Keywords:

Scoping review protocol
eHealth technologies
Neonatal intensive care unit

Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol

Abstract

Introduction:

Parental presence in the neonatal intensive care unit (NICU) has been demonstrated to enhance infant growth and development, reduce parental anxiety and stress, and strengthen parent-infant bonding. Since eHealth technology emerged, research on its utilization in NICUs has risen substantially. There is some evidence that incorporating such technologies in the NICU can reduce parental stress and enhance parent confidence in caring for their infant.

Several countries, including China, restrict parental attendance in NICUs, citing infection control challenges, issues of privacy and confidentiality, and perceived additional workload for healthcare professionals. Due to COVID-19 pandemic-related shortages of personal protective equipment and uncertain mode of transmission, many NICUs around the world closed to parental visiting and engagement in neonatal care.

There is anecdotal evidence that, given pandemic-related restrictions, eHealth technologies, have increasingly been used in NICUs as a potential substitute for in-person parental presence.

However, the constraints and enablers of technologies in these situations have not been exhaustively examined. This scoping review aims to update the literature on eHealth technology utilization in the NICU and to explore the literature on the challenges and facilitators of eHealth technology implementation to inform future research.

Methods and analysis:

This scoping review will be guided by the five-stage Arksey and O'Malley methodology framework and the Joanna Briggs Institute methodology for scoping reviews. Relevant literature will be searched in eight electronic databases published between January 2000 and August 2022 in either English or Chinese. Grey literature will be

searched manually. Two independent reviewers will conduct eligibility screening and data extraction. Analyses will be conducted in quantitative and qualitative phases.

Ethics and dissemination:

Ethical approval will not be required, as all data and information will be obtained from the publicly available literature. The findings of this scoping review will be published as an article in a peer-reviewed journal.

Strengths and limitations of this study

- The scoping review will provide a comprehensive update on literature reporting on the use of eHealth technologies in the NICU, and particularly any advances as a result of the pandemic.
- The study will employ a systematically designed search strategy to search eight electronic databases and grey literature to ensure the comprehensiveness of the search.
- This scoping review will include studies published in English and Chinese and may overlook relevant studies in other languages.
- A critical appraisal of included studies and risk-of-bias assessment will not be undertaken, as this is a scoping review.

Introduction

Parental presence in the neonatal intensive care unit (NICU) has been found to be effective in reducing negative outcomes of NICU care for both infants and parents, such as improving early neurobehavioral outcomes in preterm infants and decreasing maternal mental health risks[1–4]. Many NICUs in the West have established protocols for family-centered care and provide parents with 24/7 access to their infants[5]. Regardless of the approach taken to support parental presence, the family's role at the bedside, even in a virtual sense, is of paramount importance to both the newborn and their parents.

Despite a considerable body of literature on interventions and approaches to enhance family engagement in care, including family-centered care and family-integrated care[6], parental involvement in providing care for their preterm newborn is still limited in many NICUs. For instance, the majority of NICUs in China have restricted visiting regulations and minimal parental involvement, making family-centered care difficult to execute[7–9]. In contrast, NICUs in Western countries in particular welcomed all parents without restrictions before Corona Virus Disease 2019 (COVID-19)[5,7].

However, with the outbreak of COVID-19, many NICUs in western countries temporarily prohibited in-person visiting in an attempt to limit the spread of COVID-19, and preserve personal protective equipment supplies[5,10]. A survey of 277 NICUs in the US reported that NICU policies preserving 24/7 parental presence decreased (83-53%, $p<0.001$), and preservation of full parental participation in rounds fell (71-32%, $p<0.001$)[5]. The European Foundation for the Care of Newborn Infants (EFCNI) COVID-19 Zero Separation Collaborative Group conducted an online survey of parents' experiences with disruption to visiting access and provision of family-centered care as a result of COVID. Of the 2100 participants who responded from 56 countries, 21% reported no parental access to their hospitalized newborn infant [11]. These abrupt restrictions on the parental presence and family involvement in NICU undoubtedly impede the capacity to deliver family-centered care. The changes may impact parental stress and neonatal

outcomes. The authors recommended the development and implementation of policies to ensure family-centered care is safeguarded during emergencies such as a pandemic, including access to their infant, adequate provision of health information, and continuous and respectful communication between health care professionals and parents.

Restrictive visiting policies may have prompted the development and implementation of eHealth technologies in NICUs[12]. eHealth is the integration of information and communications technology (ICT) and electronic processes to facilitate improved communication, delivery of health services, and management of health systems [13]. In recent years, the utilization of eHealth technologies in the NICU in western countries has been diverse and increasing[12], including supporting parents in an early discharge after childbirth using videoconferencing[14], telemedicine[15], and SMS support [16]; and facilitating parental presence and involvement in care using an interactive learning platform[17], web camera [15,18], skype/facetime and smartphone[19], in order to enhance and support their family-centered care, and improve communication and family satisfaction. A recent systematic review revealed that mobile-health technologies (mHealth) are increasingly utilized in low- and middle-income countries, although the quantity and quality remains limited[20]. eHealth technologies have increasingly been used in neonatal intensive care as a potential substitute for in-person parental presence. Additionally, the constraints and enablers of technologies in these situations have not been exhaustively examined. This scoping review seeks to update the literature on eHealth technology utilization in the NICU and to explore the literature on the barriers to, and facilitators of eHealth technology implementation in order to inform future implementation research.

Study Objectives

This scoping review will update literature in relation to the application of eHealth technology in the NICU to improve parental health outcomes and examine the facilitators of and barriers to eHealth utilization in the NICU setting.

Method and analysis

Protocol design

This scoping review will follow the methodological framework described by Arksey and O'Malley[21] in 2005 and the methodology manual published by Joanna Briggs Institute for scoping reviews[22]. The present protocol and further scoping review will be guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR)[23]. Thus, the review will follow five stages: (1) identification of the research question; (2) identification of relevant studies; (3) selection of eligible studies; (4) charting the data; and (5) collating, summarizing and reporting of the results.

Stage 1: Identifying the research question

Through consultation with the research team, the overall research questions are:

1. What eHealth technologies are used for infants and their families in the NICU?
2. What impact do eHealth technologies have on the anxiety and stress of parents of infants in the NICU?
3. What impact do eHealth technologies have on the workload of healthcare professionals in the NICU?
4. What are the facilitators of, and barriers to, implementing eHealth technologies in the NICUs?

Stage 2: Identifying relevant studies

This scoping review will use the PCC (Population, Concept, Context) framework suggested by the Joanna Briggs Institute. We will comprehensively search articles and grey literature published up to August 2022 in either English or Chinese. The databases chosen for this scoping review are PubMed, Embase, Scopus, Web of Science, ScienceDirect, CINAHL, CNKI and Wanfang. An initial exploratory search strategy based on the PCC

framework will be developed on PubMed to determine some relevant terms. Medical Subject Headings (MeSH) terms will be screened, and sorted by pertinence and frequency (Table 1). A second search strategy will be developed according to the most relevant MeSH terms. A grey literature search from websites of relevant organizations will be conducted to achieve the level of comprehensiveness required for a scoping review[24]. The organizations include the WHO, nursing associations worldwide, Google Scholar, Conference Papers Index, PapersFirst and Scopus.

Table 1 List of the search strategy in terms of text words and medical subject headings

Concept	Key words	Medical subject headings
Parents	“parent*”; “mother*”; “father*”; “caregiver*”; “care giver*”; “famil*”	“parents”; “caregivers”; “family”; “mother”; “father”; “family satisfaction”; “parental satisfaction”
Neonatal	“pediatrics”; “infant*”; “newborn*”; “perinat*”; “neonate*”; “preterm*”; “premature*”; “baby”; “babies”	“pediatrics”; “infant, newborn”; “neonatal nursing”; “neonatology”; “intensive care, neonatal”
Healthcare professionals	“healthcare professional*”; “nurs*”; “neonatal nurs*”	“nurse”; “healthcare professional”; “neonatal nursing”
eHealth	“social media”; “medical apps”; “eHealth”; “telemedicine”; “internet”; “mHealth”; “mobile health”; “information technology”; “web camera”; “webcam”; “teleneonatology”; “facetime”; “skype”; “smartphone”; “videoconference*”	“telemedicine”; “medical informatics”; “internet”; “cell phone”; “mobile applications”
Barriers & Facilitator	“barrier*”; “limit*”; “difficult*”; “restrict*”; “constraint*”; “facilitator*”; “factor*”; “promot*”; “ease*”	“barrier”; “facilitator”

Parental & healthcare professional's outcomes	“anxiet*”; “stress*”; “depress*”; “pressure*”; “workload*”	“anxiety”; “healthcare workload”; “stress”; professionals,
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*truncation used to expand search

Stage 3: Study selection

In this Stage, we will specify and refine our inclusion and exclusion criteria based on the PCC framework identified for this review. Application of further eligibility criteria will ensure that selected articles are relevant to the research question. All papers derived from the search process will be imported to Covidence, which is a web-based tool to facilitate the conduct and documentation of literature reviews. Then a two-step screening will be performed. The first step is screening titles and abstracts to define the eligibility of articles. The second step is full-text screening where only those articles deemed relevant will be kept. Two reviewers will screen each article independently, and consistency checks will be performed.

Eligibility criteria

Inclusion criteria

The following criteria will guide the selection of studies that will be included in this review:

1. Articles reporting eHealth technologies to improve parental outcomes and health professionals' outcomes.
2. Articles reporting barriers to, or facilitators of, implementation of eHealth technologies in the NICU
3. Studies published in English or Chinese between 2000 and 2022
4. Studies conducted in the NICU
5. Studies that are a full report of original research.
6. Grey literature about the implementation of eHealth technologies in the NICU

Exclusion criteria

The following criteria will be considered in excluding studies from the review:

1. Studies published in other languages
2. Studies published before 2000
3. Letters to the editor, editorials, commentaries

The PRISMA flow diagram will be used in the study selection process and will be updated once the review is completed (Figure 1).

Figure 1. PRISMA Extension for Scoping reviews, 2020 flow diagram.

Stage 4: Charting the data

Using Covidence, two independent reviewers will conduct data extraction to ensure the approach is consistent with the research questions and inclusion and exclusion criteria. A standardized data-charting form will initially be developed and piloted by the reviewer team through an iterative process.

The data extraction table produced will include at least the following key elements:

1. First author's name
2. Title
3. Year of publication
4. The journal's name
5. Country of origin
6. Aim/purpose of the study
7. Study design
8. Study population
9. Sample size
10. Methodology
11. Outcomes and results of the study

12. Key findings that relate to the scoping review questions

Stage 5: Collating, summarising and reporting the results

This scoping review aims to present an overview of the research rather than evaluate the quality of the included studies.

A narrative report will be produced that synthesizes and summarizes the progress of research, the impact of eHealth technologies on outcomes of parents and healthcare professionals, and the barriers and facilitators associated with the implementation of eHealth in the NICU.

This stage will occur in two phases. First, quantitative analysis will be performed by tables about how the differences and range in variables based on the journal where the articles were published, countries and regions, field of research, approach, goal/purpose of the study, actors targeted for change, health system stakeholders involved and health system setting of focus.

Second, qualitative analysis will involve all reviewers' in-depth review of all studies. The research team will chart out the major concepts and processes used; afterward, the concepts and processes will be compared across approaches.

As appropriate, results will be presented in an aggregate and visual form (e.g., using tables and charts).

Patient and public involvement

Patients, parents, healthcare professionals, and public members will not be involved in the protocol preparation and will not be involved in drafting the scoping review.

Ethics and dissemination

Ethical approval is not required for the scoping review. All data and information will be obtained from public databases and will not involve animals and human participants.

Results of this scoping review will be shared with relevant healthcare professionals and published in referred journals. This scoping review is foundational work for a further research project that will aim to evaluate eHealth technologies to augment parent visits in the NICUs.

Authors' contributions: YZ conceived of the idea and produced the initial draft of the review protocol; LJ contributed meaningfully to the drafting, reviewing, and editing. All authors read and approved the final manuscript.

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Competing interests statement

None declared

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Number of figures and tables: 2

Reference

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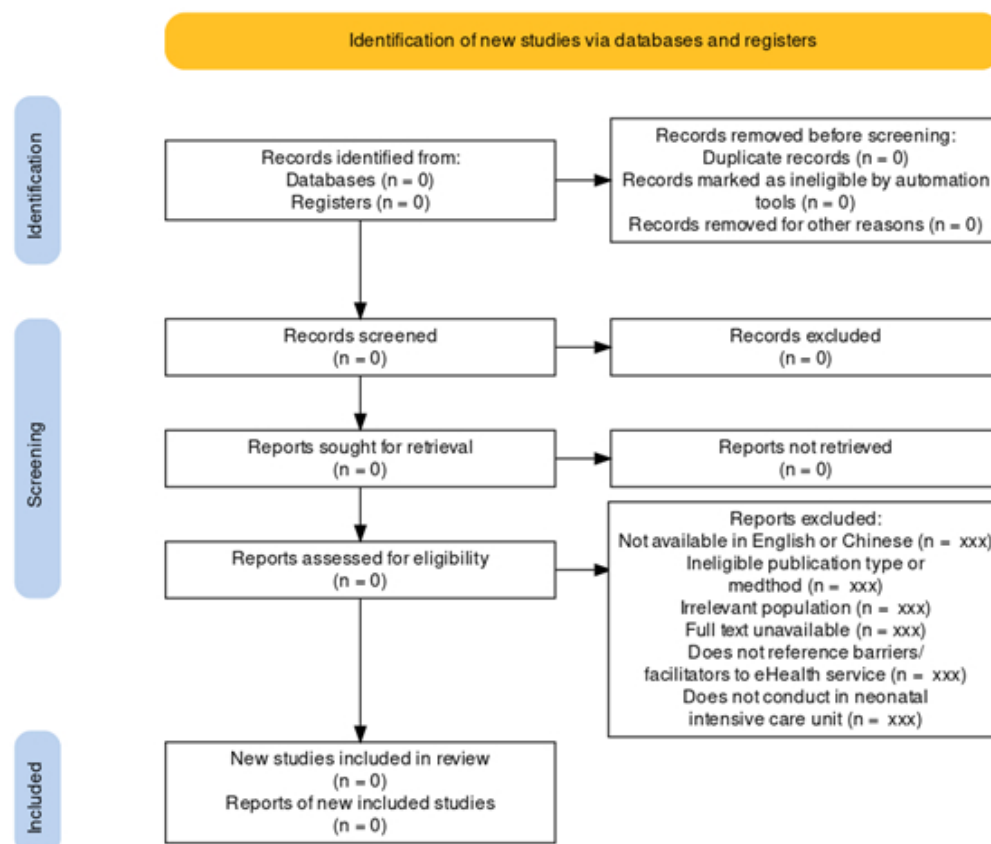


Figure 1. PRISMA Extension for Scoping reviews, 2020 flow diagram.

369x315mm (38 x 38 DPI)

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5-6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5-6
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	9
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	7-8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	8-9
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	9
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	11
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	11
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Click here to enter text.
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	11



SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7-10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	11
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Click here to enter text.
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	11-12
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	12
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Click here to enter text.
Limitations	20	Discuss the limitations of the scoping review process.	2
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Click here to enter text.
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	14

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*. 2018;169:467–473. doi: 10.7326/M18-0850.

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Disclaimers

All the authors confirmed that they have reviewed and declared this manuscript entitled “Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol” is original, has not been published before, and is not currently being considered for publication elsewhere. And all of the authors approved its submission to the journal of BMJ Open

Keywords:

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Abstract

Introduction:

Parental presence in the neonatal intensive care unit (NICU) has been demonstrated to enhance infant growth and development, reduce parental anxiety and stress, and strengthen parent-infant bonding. Since eHealth technology emerged, research on its utilization in NICUs has risen substantially. There is some evidence that incorporating such technologies in the NICU can reduce parental stress and enhance parent confidence in caring for their infant.

Several countries, including China, restrict parental attendance in NICUs, citing infection control challenges, issues of privacy and confidentiality, and perceived additional workload for healthcare professionals. Due to COVID-19 pandemic-related shortages of personal protective equipment and uncertain mode of transmission, many NICUs around the world closed to parental visiting and engagement in neonatal care.

There is anecdotal evidence that, given pandemic-related restrictions, eHealth technologies, have increasingly been used in NICUs as a potential substitute for in-person parental presence.

However, the constraints and enablers of technologies in these situations have not been exhaustively examined. This scoping review aims to update the literature on eHealth technology utilization in the NICU and to explore the literature on the challenges and facilitators of eHealth technology implementation to inform future research.

Methods and analysis:

This scoping review will be guided by the five-stage Arksey and O'Malley methodology framework and the Joanna Briggs Institute methodology for scoping reviews. Relevant literature will be searched in eight electronic databases (PubMed, Embase, Scopus, Web of Science, ScienceDirect, CINAHL, CNKI and Wanfang) published

between January 2000 and August 2022 in either English or Chinese. Grey literature will be searched manually. Two independent reviewers will conduct eligibility screening and data extraction. Analyses will be conducted in quantitative and qualitative phases.

Ethics and dissemination:

Ethical approval will not be required, as all data and information will be obtained from the publicly available literature. The findings of this scoping review will be published as an article in a peer-reviewed journal.

Registration: This scoping review protocol was registered in Open Science Framework and can be found here: <https://osf.io/AQV5P/>

Strengths and limitations of this study

- The scoping review will provide a comprehensive update on literature reporting on the use of eHealth technologies in the NICU, and particularly any advances as a result of the pandemic.
- The study will employ a systematically designed search strategy to search eight electronic databases and grey literature to ensure the comprehensiveness of the search.
- This scoping review will include studies published in English and Chinese and may overlook relevant studies in other languages.
- A critical appraisal of included studies and risk-of-bias assessment will not be undertaken, as this is a scoping review.

Introduction

Parental presence in the neonatal intensive care unit (NICU) has been found to be effective in reducing negative outcomes of NICU care for both infants and parents, such as improving early neurobehavioral outcomes in preterm infants and decreasing maternal mental health risks[1–4]. Many NICUs in the West have established protocols for family-centered care and provide parents with 24/7 access to their infants[5]. Regardless of the approach taken to support parental presence, the family's role at the bedside, even in a virtual sense, is of paramount importance to both the newborn and their parents.

Despite a considerable body of literature on interventions and approaches to enhance family engagement in care, including family-centered care and family-integrated care[6], parental involvement in providing care for their preterm newborn is still limited in many NICUs. For instance, the majority of NICUs in China have restricted visiting regulations and minimal parental involvement, making family-centered care difficult to execute[7–9]. In contrast, NICUs in Western countries in particular welcomed all parents without restrictions before Corona Virus Disease 2019 (COVID-19)[5,7].

However, with the outbreak of COVID-19, many NICUs in western countries temporarily prohibited in-person visiting in an attempt to limit the spread of COVID-19, and preserve personal protective equipment supplies[5,10]. A survey of 277 NICUs in the US reported that NICU policies preserving 24/7 parental presence decreased (83% to 53%, $p<0.001$), and preservation of full parental participation in rounds fell (71% to 32%, $p<0.001$)[5]. The European Foundation for the Care of Newborn Infants (EFCNI) COVID-19 Zero Separation Collaborative Group conducted an online survey of parents' experiences with disruption to visiting access and provision of family-centered care as a result of COVID. Of the 2100 participants who responded from 56 countries, 21% reported no parental access to their hospitalized newborn infant [11]. These abrupt restrictions on the parental presence and family involvement in NICU undoubtedly impede the capacity to deliver family-centered care. The changes may impact parental stress and neonatal

outcomes. The authors recommended the development and implementation of policies to ensure family-centered care is safeguarded during emergencies such as a pandemic, including access to their infant, adequate provision of health information, and continuous and respectful communication between health care professionals and parents.

Restrictive visiting policies may have prompted the development and implementation of eHealth technologies in NICUs[12]. eHealth is the integration of information and communications technology (ICT) and electronic processes to facilitate improved communication, delivery of health services, and management of health systems [13]. In recent years, the utilization of eHealth technologies in the NICU in western countries has been diverse and increasing[12], including supporting parents in an early discharge after childbirth using videoconferencing[14], telemedicine[15], and SMS support [16]; and facilitating parental presence and involvement in care using an interactive learning platform[17], web camera [15,18], skype/facetime and smartphone[19], in order to enhance and support their family-centered care, and improve communication and family satisfaction. A recent systematic review revealed that mobile-health technologies (mHealth) are increasingly utilized in low- and middle-income countries, although the quantity and quality remains limited[20]. eHealth technologies have increasingly been used in neonatal intensive care as a potential substitute for in-person parental presence. Additionally, the constraints and enablers of technologies in these situations have not been exhaustively examined. This scoping review seeks to update the literature on eHealth technology utilization in the NICU and to explore the literature on the barriers to, and facilitators of eHealth technology implementation in order to inform future implementation research.

Study Objectives

This scoping review will update literature in relation to the application of eHealth technology in the NICU to improve parental health outcomes and examine the facilitators of and barriers to eHealth utilization in the NICU setting.

Method and analysis

Protocol design

This scoping review will follow the methodological framework described by Arksey and O'Malley[21] in 2005 and the methodology manual published by Joanna Briggs Institute for scoping reviews[22]. The present protocol and further scoping review will be guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR)[23]. Thus, the review will follow five stages: (1) identification of the research question; (2) identification of relevant studies; (3) selection of eligible studies; (4) charting the data; and (5) collating, summarizing and reporting of the results.

Stage 1: Identifying the research question

Through consultation with the research team, the overall research questions are:

1. What eHealth technologies are used for infants and their families in the NICU?
2. What impact do eHealth technologies have on the anxiety and stress of parents of infants in the NICU?
3. What impact do eHealth technologies have on the workload of healthcare professionals in the NICU?
4. What are the facilitators of, and barriers to, implementing eHealth technologies in the NICUs?

Stage 2: Identifying relevant studies

This scoping review will use the PCC (Population, Concept, Context) framework suggested by the Joanna Briggs Institute. We will comprehensively search articles and grey literature published up to August 2022 in any language. The databases chosen for this scoping review are PubMed, Embase, Scopus, Web of Science, ScienceDirect, CINAHL, CNKI and Wanfang. An initial exploratory search strategy without any language limitation

based on the PCC framework will be developed on PubMed to determine some relevant terms. Medical Subject Headings (MeSH) terms will be screened, and sorted by pertinence and frequency (Table 1). A second search strategy will be developed according to the most relevant MeSH terms, which will be filtered by language to either English or Chinese. We also will create a subcategory of excluded articles that are not in English or Chinese, but that have English abstracts, which could help other researchers evaluate the potential for extending this work with publications in additional languages.

A grey literature search from websites of relevant organizations will be conducted to achieve the level of comprehensiveness required for a scoping review[24]. The organizations include the WHO, nursing associations worldwide, Google Scholar, Conference Papers Index, PapersFirst and Scopus.

Table 1 List of the search strategy in terms of text words and medical subject headings

Concept	Key words	Medical subject headings
Parents	“parent*”; “mother*”; “father*”; “caregiver*”; “care giver*”; “famil*”	“parents”; “caregivers”; “family”; “mother”; “father”; “family satisfaction”; “parental satisfaction”
Neonatal	“pediatrics”; “infant*”; “newborn*”; “perinat*”; “neonate*”; “preterm*”; “premature*”; “baby”; “babies”	“pediatrics”; “infant, newborn”; “neonatal nursing”; “neonatology”; “intensive care, neonatal”
Healthcare professionals	“healthcare professional*”; “nurs*”; “neonatal nurs*”	“nurse”; “healthcare professional”; “neonatal nursing”
eHealth	“social media”; “medical apps”; “eHealth”; “telemedicine”; “internet”; “mHealth”; “mobile health”; “information technology”; “web camera”; “webcam”; “teleneonatology”;	“telemedicine”; “medical informatics”; “internet”; “cell phone”; “mobile applications”

	“facetime”; “skype”; “smartphone”; “zoom”; “videoconference*”;	
Barriers & Facilitator	“barrier*”; “limit*”; “difficult*”; “restrict*”; “constraint*”; “facilitator*”; “factor*”; “promot*”; “ease*”	“barrier”; “facilitator”
Parental & healthcare professional’s outcomes	“anxiet*”; “stress*”; “depress*”; “pressure*”; “workload*”	“anxiety”; “stress”; “healthcare professionals, workload”

*truncation used to expand search

Stage 3: Study selection

In this Stage, we will specify and refine our inclusion and exclusion criteria based on the PCC framework identified for this review. Application of further eligibility criteria will ensure that selected articles are relevant to the research question. All papers derived from the search process will be imported to Covidence, which is a web-based tool to facilitate the conduct and documentation of literature reviews. Then a two-step screening will be performed. The first step is screening titles and abstracts to define the eligibility of articles. The second step is full-text screening where only those articles deemed relevant will be kept. Two reviewers will screen each article independently, and consistency checks will be performed.

Eligibility criteria

Inclusion criteria

The following criteria will guide the selection of studies that will be included in this review:

1. Articles reporting eHealth technologies to improve parental outcomes and health professionals’ outcomes.
2. Articles reporting barriers to, or facilitators of, implementation of eHealth technologies

in the NICU

3. Studies published in English or Chinese between 2000 and 2022

4. Studies conducted in the NICU

5. Studies that are a full report of original research.

6. Grey literature about the implementation of eHealth technologies in the NICU

Exclusion criteria

The following criteria will be considered in excluding studies from the review:

1. Studies published in other languages

2. Studies published before 2000

3. Letters to the editor, editorials, commentaries

The PRISMA flow diagram will be used in the study selection process and will be updated once the review is completed (Figure 1).

Figure 1. PRISMA Extension for Scoping reviews, 2020 flow diagram.

Stage 4: Charting the data

Using Covidence, two independent reviewers will conduct data extraction to ensure the approach is consistent with the research questions and inclusion and exclusion criteria. A standardized data-charting form will initially be developed and piloted by the reviewer team through an iterative process.

The data extraction table produced will include at least the following key elements:

1. First author's name
2. Title
3. Year of publication
4. The journal's name
5. Country of origin
6. Aim/purpose of the study

7. Study design
8. Study population
9. Sample size
10. Methodology
11. Outcomes and results of the study
12. Key findings that relate to the scoping review questions

Stage 5: Collating, summarising and reporting the results

This scoping review aims to present an overview of the research rather than evaluate the quality of the included studies.

A narrative report will be produced that synthesizes and summarizes the progress of research, the impact of eHealth technologies on outcomes of parents and healthcare professionals, and the barriers and facilitators associated with the implementation of eHealth in the NICU.

This stage will occur in two phases. First, quantitative analysis will be performed by tables about how the differences and range in variables based on the journal where the articles were published, countries and regions, field of research, approach, goal/purpose of the study, actors targeted for change, health system stakeholders involved and health system setting of focus.

Second, qualitative analysis will involve two reviewers' in-depth review of all studies in both English and Chinese. A qualitative data management software system (NVIVO-11) will be used to facilitate data analysis. The research team will chart out the key concepts and processes used; Firstly, we will analyse the data using a descriptive summary to describe the characteristics of included studies and apply a content analysis approach to identify barriers to and facilitators of eHealth technologies in NICU. Two reviewers will undergo training on coding the extracted data using a broad-based coding scheme to achieve 80% coding agreement. Next, we will report the analysed results using themes and

produce the outcomes with reference to our study purpose. Then, we will perform an overall interpretation of the relationships among the synthesized themes and subthemes and of the meaning of our findings as well as identifying the knowledge gaps. Implications for future research and clinical practice will also be discussed. Consistent with the framework proposed by Arksey and O'Malley, an assessment of the quality of individual studies and a risk-of-bias assessment will not be conducted. As appropriate, results will be presented in an aggregate and visual form (e.g., using tables and charts).

Patient and public involvement

Patients, parents, healthcare professionals, and public members will not be involved in the protocol preparation and will not be involved in drafting the scoping review.

Ethics and dissemination

Ethical approval is not required for the scoping review. All data and information will be obtained from public databases and will not involve animals and human participants. Results of this scoping review will be shared with relevant healthcare professionals and published in refereed journals. This scoping review is foundational work for a further research project that will aim to evaluate eHealth technologies to augment parent visits in the NICUs.

Authors' contributions: YZ conceived of the idea and produced the initial draft of the review protocol; LJ contributed meaningfully to the drafting, reviewing, and editing. All authors read and approved the final manuscript.

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Competing interests statement

None declared

World Count: 2828

Number of figures and tables: 2

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For peer review only

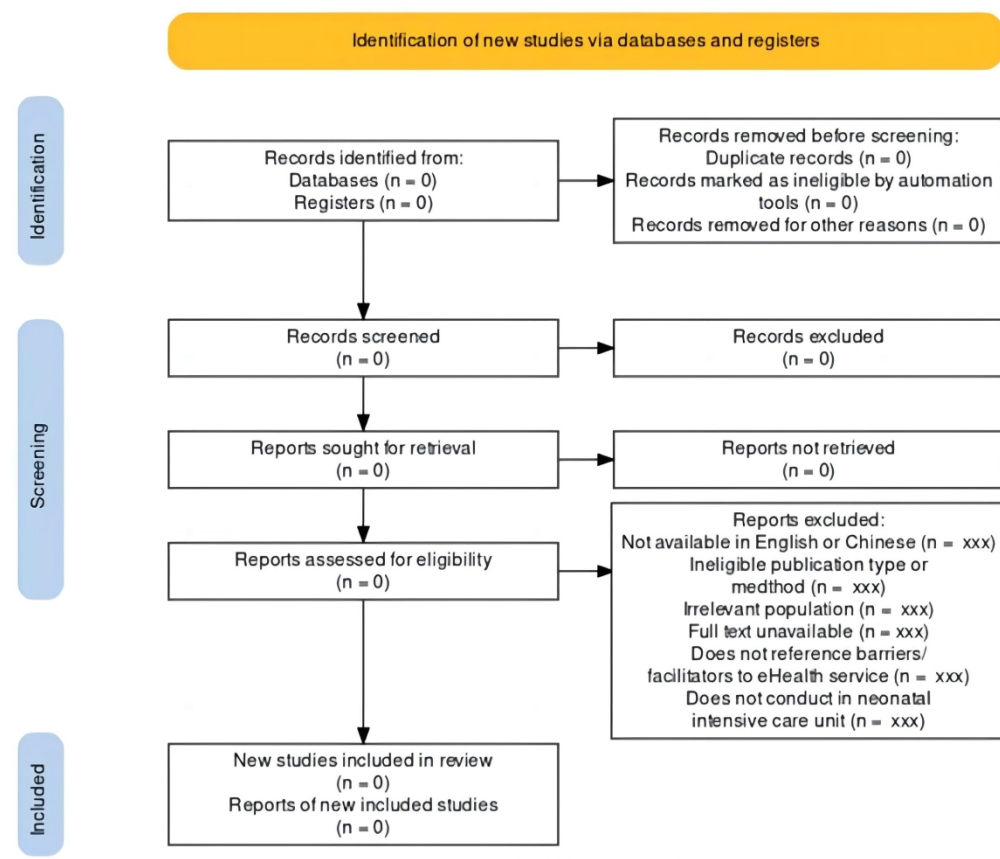


Figure 1. PRISMA Extension for Scoping reviews, 2020 flow diagram.

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5-6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5-6
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	9
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	7-8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	8-9
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	9
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	11
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	11
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Click here to enter text.
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	11

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SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7-10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	11
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Click here to enter text.
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	11-12
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	12
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Click here to enter text.
Limitations	20	Discuss the limitations of the scoping review process.	2
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Click here to enter text.
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	14

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.



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Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol

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Short Title:

Scoping review protocol on barriers to, and facilitators of, eHealth utilization in NICU

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Disclaimers

All the authors confirmed that they have reviewed and declared this manuscript entitled “Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol” is original, has not been published before, and is not currently being considered for publication elsewhere. And all of the authors approved its submission to the journal of BMJ Open

Keywords:

Scoping review protocol
eHealth technologies
Neonatal intensive care unit

Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol

Abstract

Introduction:

Parental presence in the neonatal intensive care unit (NICU) has been demonstrated to enhance infant growth and development, reduce parental anxiety and stress, and strengthen parent-infant bonding. Since eHealth technology emerged, research on its utilization in NICUs has risen substantially. There is some evidence that incorporating such technologies in the NICU can reduce parental stress and enhance parent confidence in caring for their infant.

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There is anecdotal evidence that, given pandemic-related restrictions, eHealth technologies, have increasingly been used in NICUs as a potential substitute for in-person parental presence.

However, the constraints and enablers of technologies in these situations have not been exhaustively examined. This scoping review aims to update the literature on eHealth technology utilization in the NICU and to explore the literature on the challenges and facilitators of eHealth technology implementation to inform future research.

Methods and analysis:

This scoping review will be guided by the five-stage Arksey and O'Malley methodology framework and the Joanna Briggs Institute methodology for scoping reviews. Relevant literature will be searched in eight electronic databases published between January 2000 and August 2022 in either English or Chinese. Grey literature will be

searched manually. Two independent reviewers will conduct eligibility screening and data extraction. Analyses will be conducted in quantitative and qualitative phases.

Ethics and dissemination:

Ethical approval will not be required, as all data and information will be obtained from the publicly available literature. The findings of this scoping review will be published as an article in a peer-reviewed journal.

Registration: This scoping review protocol was registered in Open Science Framework and can be found here: <https://osf.io/AQV5P/>

Strengths and limitations of this study

- The scoping review will provide a comprehensive update on literature reporting on the use of eHealth technologies in the NICU, and particularly any advances as a result of the pandemic.
- The study will employ a systematically designed search strategy to search eight electronic databases and grey literature to ensure the comprehensiveness of the search.
- This scoping review will include studies published in English and Chinese and may overlook relevant studies in other languages.
- A critical appraisal of included studies and risk-of-bias assessment will not be undertaken, as this is a scoping review.

Introduction

Parental presence in the neonatal intensive care unit (NICU) has been found to be effective in reducing negative outcomes of NICU care for both infants and parents, such as improving early neurobehavioral outcomes in preterm infants and decreasing maternal mental health risks[1–4]. Many NICUs in the West have established protocols for family-centered care and provide parents with 24/7 access to their infants[5]. Regardless of the approach taken to support parental presence, the family's role at the bedside, even in a virtual sense, is of paramount importance to both the newborn and their parents.

Despite a considerable body of literature on interventions and approaches to enhance family engagement in care, including family-centered care and family-integrated care[6], parental involvement in providing care for their preterm newborn is still limited in many NICUs. For instance, the majority of NICUs in China have restricted visiting regulations and minimal parental involvement, making family-centered care difficult to execute[7–9]. In contrast, NICUs in Western countries in particular welcomed all parents without restrictions before Corona Virus Disease 2019 (COVID-19)[5,7].

However, with the outbreak of COVID-19, many NICUs in western countries temporarily prohibited in-person visiting in an attempt to limit the spread of COVID-19, and preserve personal protective equipment supplies[5,10]. A survey of 277 NICUs in the US reported that NICU policies preserving 24/7 parental presence decreased (83% to 53%, $p<0.001$), and preservation of full parental participation in rounds fell (71% to 32%, $p<0.001$)[5]. The European Foundation for the Care of Newborn Infants (EFCNI) COVID-19 Zero Separation Collaborative Group conducted an online survey of parents' experiences with disruption to visiting access and provision of family-centered care as a result of COVID. Of the 2100 participants who responded from 56 countries, 21% reported no parental access to their hospitalized newborn infant [11]. These abrupt restrictions on the parental presence and family involvement in NICU undoubtedly impede the capacity to deliver family-centered care. The changes may impact parental stress and neonatal

outcomes. The authors recommended the development and implementation of policies to ensure family-centered care is safeguarded during emergencies such as a pandemic, including access to their infant, adequate provision of health information, and continuous and respectful communication between health care professionals and parents.

Restrictive visiting policies may have prompted the development and implementation of eHealth technologies in NICUs[12]. eHealth is the integration of information and communications technology (ICT) and electronic processes to facilitate improved communication, delivery of health services, and management of health systems [13]. In recent years, the utilization of eHealth technologies in the NICU in western countries has been diverse and increasing[12], including supporting parents in an early discharge after childbirth using videoconferencing[13], telemedicine[14] and SMS support [15]; and facilitating parental presence and involvement in care using an interactive learning platform[16], web camera [14,17], skype/facetime and smartphone[18], in order to enhance and support their family-centered care, and improve communication and family satisfaction. Also, eHealth technologies such as wechat and smartphone are widely used in the NICU in China[19,20]. A recent systematic review revealed that mobile-health technologies (mHealth) are increasingly utilized in low- and middle-income countries, although the quantity and quality remains limited[21]. eHealth technologies have increasingly been used in neonatal intensive care as a potential substitute for in-person parental presence. Additionally, the constraints and enablers of technologies in these situations have not been exhaustively examined. This scoping review seeks to update the literature on eHealth technology utilization in the NICU and to explore the literature on the barriers to, and facilitators of eHealth technology implementation in order to inform future implementation research.

Study Objectives

This scoping review will update literature in relation to the application of eHealth

technology in the NICU to improve parental health outcomes and examine the facilitators of and barriers to eHealth utilization in the NICU setting.

Method and analysis

Protocol design

This scoping review will follow the methodological framework described by Arksey and O'Malley[22] in 2005 and the methodology manual published by Joanna Briggs Institute for scoping reviews[23]. The present protocol and further scoping review will be guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews(PRISMA-ScR)[24]. Thus, the review will follow five stages: (1) identification of the research question; (2) identification of relevant studies; (3) selection of eligible studies; (4) charting the data; and (5) collating, summarizing and reporting of the results.

Stage 1: Identifying the research question

Through consultation with the research team, the overall research questions are:

1. What eHealth technologies are used for infants and their families in the NICU?
2. What impact do eHealth technologies have on the anxiety and stress of parents of infants in the NICU?
3. What impact do eHealth technologies have on the workload of healthcare professionals in the NICU?
4. What are the facilitators of, and barriers to, implementing eHealth technologies in the NICUs?

Stage 2: Identifying relevant studies

This scoping review will use the PCC (Population, Concept, Context) framework suggested by the Joanna Briggs Institute. We will comprehensively search articles and grey literature published up to August 2022 in any language. The databases chosen for this

scoping review are PubMed, Embase, Scopus, Web of Science, ScienceDirect, CINAHL, CNKI and Wanfang. An initial exploratory search strategy without any language limitation based on the PCC framework will be developed on PubMed to determine some relevant terms. Medical Subject Headings (MeSH) terms will be screened, and sorted by pertinence and frequency (Table 1). A second search strategy will be developed according to the most relevant MeSH terms, which will be filtered by language to either English or Chinese. We also will create a subcategory of excluded articles that are not in English or Chinese, but that have English abstracts, which could help other researchers evaluate the potential for extending this work with publications in additional languages.

A grey literature search from websites of relevant organizations will be conducted to achieve the level of comprehensiveness required for a scoping review[25]. The organizations include the WHO, nursing associations worldwide, Google Scholar, Conference Papers Index, PapersFirst and Scopus.

Table 1 List of the search strategy in terms of text words and medical subject headings

Concept	Key words	Medical subject headings
Parents	“parent*”; “mother*”; “father*”; “caregiver*”; “care giver*”; “famil*”	“parents”; “caregivers”; “family”; “mother”; “father”; “family satisfaction”; “parental satisfaction”
Neonatal	“pediatrics”; “infant*”; “newborn*”; “perinat*”; “neonate*”; “preterm*”; “premature*”; “baby”; “babies”	“pediatrics”; “infant, newborn”; “neonatal nursing”; “neonatology”; “intensive care, neonatal”
Healthcare professionals	“healthcare professional*”; “nurs*”; “neonatal nurs*”	“nurse”; “healthcare professional”; “neonatal nursing”
eHealth	“social media”; “medical apps”; “eHealth”; “telemedicine”; “internet”; “mHealth”; “mobile health”; “mobile health”	“telemedicine”; “medical informatics”; “internet”; “cell phone”; “mobile

	“information technology”; “web camera”; “webcam”; “teleneonatology”; “facetime”; “skype”; “smartphone”; “zoom”; “videoconference*”;	applications”
Barriers & Facilitator	“barrier*”; “limit*”; “difficult*”; “restrict*”; “constraint*”; “facilitator*”; “factor*”; “promot*”; “ease*”	“barrier”; “facilitator”
Parental & healthcare professional’s outcomes	“anxiet*”; “stress*”; “depress*”; “pressure*”; “workload*”	“anxiety”; “stress”; “healthcare professionals, workload”

*truncation used to expand search

Stage 3: Study selection

In this Stage, we will specify and refine our inclusion and exclusion criteria based on the PCC framework identified for this review. Application of further eligibility criteria will ensure that selected articles are relevant to the research question. All papers derived from the search process will be imported to Covidence, which is a web-based tool to facilitate the conduct and documentation of literature reviews. Then a two-step screening will be performed. The first step is screening titles and abstracts to define the eligibility of articles. The second step is full-text screening where only those articles deemed relevant will be kept. Two reviewers will screen each article independently, and consistency checks will be performed.

Eligibility criteria

Inclusion criteria

The following criteria will guide the selection of studies that will be included in this review:

1. Articles reporting eHealth technologies to improve parental outcomes and health professionals’ outcomes.

2. Articles reporting barriers to, or facilitators of, implementation of eHealth technologies in the NICU
 3. Studies published in English or Chinese between 2000 and 2022
 4. Studies conducted in the NICU
 5. Studies that are a full report of original research.
 6. Grey literature about the implementation of eHealth technologies in the NICU
- In the inclusion criteria, No.1~No.2 are linked by “OR”, No.3~No.5 are linked by “AND”.

Exclusion criteria

The following criteria will be considered in excluding studies from the review:

1. Studies published in other languages
2. Studies published before 2000
3. Letters to the editor, editorials, commentaries

The PRISMA flow diagram will be used in the study selection process and will be updated once the review is completed (Figure 1).

Figure 1. PRISMA Extension for Scoping reviews, 2020 flow diagram.

Stage 4: Charting the data

Using Covidence, two independent reviewers will conduct data extraction to ensure the approach is consistent with the research questions and inclusion and exclusion criteria. A standardized data-charting form will initially be developed and piloted by the reviewer team through an iterative process.

The data extraction table produced will include at least the following key elements:

1. First author’s name
2. Title
3. Year of publication
4. The journal’s name
5. Country of origin

6. Aim/purpose of the study
7. Study design
8. Study population
9. Sample size
10. Methodology
11. Outcomes and results of the study
12. Key findings that relate to the scoping review questions

Stage 5: Collating, summarising and reporting the results

This scoping review aims to present an overview of the research rather than evaluate the quality of the included studies.

A narrative report will be produced that synthesizes and summarizes the progress of research, the impact of eHealth technologies on outcomes of parents and healthcare professionals, and the barriers and facilitators associated with the implementation of eHealth in the NICU.

This stage will occur in two phases. First, quantitative analysis will be performed by tables about how the differences and range in variables based on the journal where the articles were published, countries and regions, field of research, approach, goal/purpose of the study, actors targeted for change, health system stakeholders involved and health system setting of focus.

Second, qualitative analysis will involve two reviewers' in-depth review of all studies in both English and Chinese. A qualitative data management software system (NVIVO-11) will be used to facilitate data analysis. The research team will chart out the key concepts and processes used; Firstly, we will analyse the data using a descriptive summary to describe the characteristics of included studies and apply a content analysis approach to identify barriers to and facilitators of eHealth technologies in NICU. Two reviewers will undergo training on coding the extracted data using a broad-based coding scheme to

achieve 80% coding agreement. Next, we will report the analysed results using themes and produce the outcomes with reference to our study purpose. Then, we will perform an overall interpretation of the relationships among the synthesized themes and subthemes and of the meaning of our findings as well as identifying the knowledge gaps. Implications for future research and clinical practice will also be discussed. Consistent with the framework proposed by Arksey and O'Malley, an assessment of the quality of individual studies and a risk-of-bias assessment will not be conducted. As appropriate, results will be presented in an aggregate and visual form (e.g., using tables and charts).

Patient and public involvement

Patients, parents, healthcare professionals, and public members will not be involved in the protocol preparation and will not be involved in drafting the scoping review.

Ethics and dissemination

Ethical approval is not required for the scoping review. All data and information will be obtained from public databases and will not involve animals and human participants. Results of this scoping review will be shared with relevant healthcare professionals and published in refereed journals. This scoping review is foundational work for a further research project that will aim to evaluate eHealth technologies to augment parent visits in the NICUs.

Authors' contributions: YZ conceived of the idea and produced the initial draft of the review protocol; LJ contributed meaningfully to the drafting, reviewing, and editing. All authors read and approved the final manuscript.

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Competing interests statement

None declared

World Count: 3354

Number of figures and tables: 2

Reference

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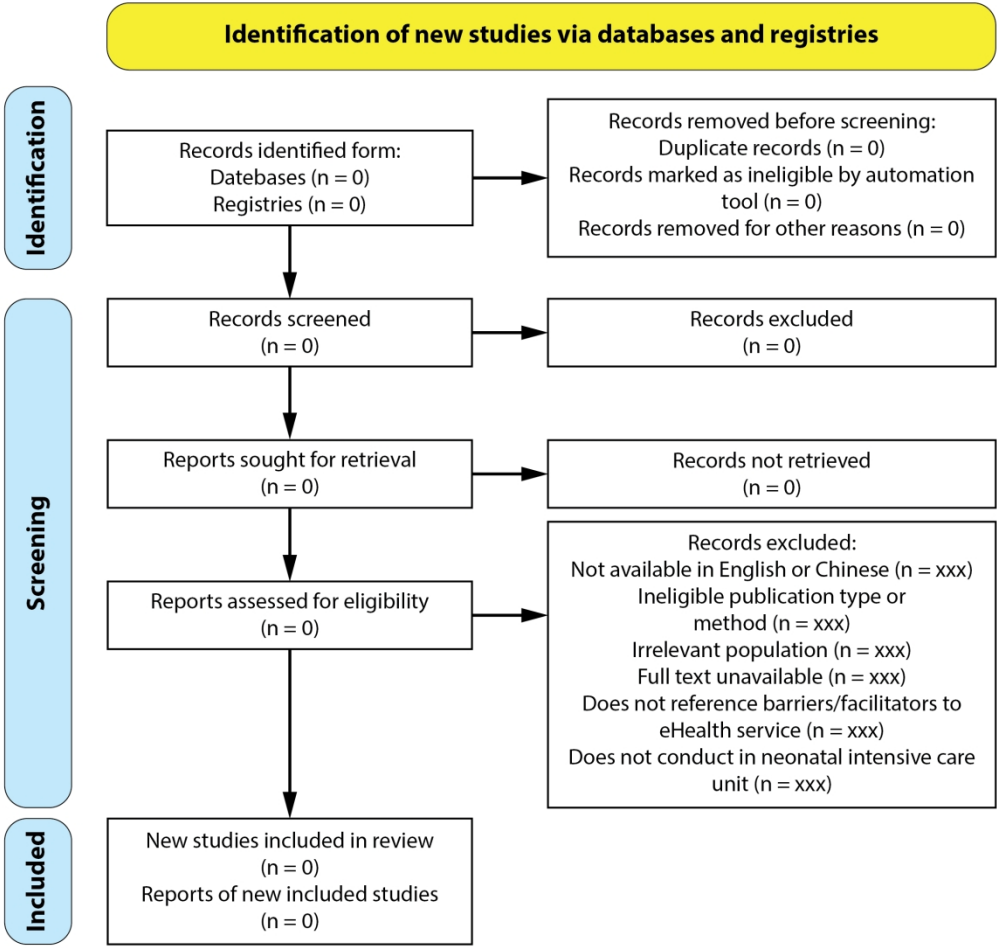


Figure 1. PRISMA Extension for Scoping reviews, 2020 flow diagram.

482x465mm (118 x 118 DPI)

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5-6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5-6
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	9
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	7-8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	8-9
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	9
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	11
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	11
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Click here to enter text.
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	11

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SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7-10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	11
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Click here to enter text.
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	11-12
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	12
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Click here to enter text.
Limitations	20	Discuss the limitations of the scoping review process.	2
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Click here to enter text.
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	14

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*. 2018;169:467–473. doi: 10.7326/M18-0850.



BMJ Open

Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol

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Keywords:	Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, Information technology < BIOTECHNOLOGY & BIOINFORMATICS, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Protocols & guidelines < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Neonatal intensive & critical care < INTENSIVE & CRITICAL CARE

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Full Title:

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Short Title:

Scoping review protocol on barriers to, and facilitators of, eHealth utilization in NICU

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Disclaimers

All the authors confirmed that they have reviewed and declared this manuscript entitled “Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol” is original, has not been published before, and is not currently being considered for publication elsewhere. And all of the authors approved its submission to the journal of BMJ Open

Keywords:

Scoping review protocol
eHealth technologies
Neonatal intensive care unit

Barriers to, and facilitators of, eHealth utilization by parents of high-risk newborn infants in the NICU: a Scoping Review Protocol

Abstract

Introduction:

Parental presence in the neonatal intensive care unit (NICU) has been demonstrated to enhance infant growth and development, reduce parental anxiety and stress, and strengthen parent-infant bonding. Since eHealth technology emerged, research on its utilization in NICUs has risen substantially. There is some evidence that incorporating such technologies in the NICU can reduce parental stress and enhance parent confidence in caring for their infant.

Several countries, including China, restrict parental attendance in NICUs, citing infection control challenges, issues of privacy and confidentiality, and perceived additional workload for healthcare professionals. Due to COVID-19 pandemic-related shortages of personal protective equipment and uncertain mode of transmission, many NICUs around the world closed to parental visiting and engagement in neonatal care.

There is anecdotal evidence that, given pandemic-related restrictions, eHealth technologies, have increasingly been used in NICUs as a potential substitute for in-person parental presence.

However, the constraints and enablers of technologies in these situations have not been exhaustively examined. This scoping review aims to update the literature on eHealth technology utilization in the NICU and to explore the literature on the challenges and facilitators of eHealth technology implementation to inform future research.

Methods and analysis:

The five-stage Arksey and O'Malley methodological framework and the Joanna Briggs Institute scoping review methodology will serve as the foundation for this scoping review. Eight databases will be searched for relevant literature published between January 2000 and August 2022 in either English or Chinese. Grey literature will be

manually searched. Data extraction and eligibility screening will be carried out by two impartial reviewers. There will be periods of both quantitative and qualitative analysis.

Ethics and dissemination:

Since all data and information will be taken from publicly accessible literature, ethical approval won't be necessary. A peer-reviewed publication will be published with the results of this scoping review.

Registration: This scoping review protocol was registered in Open Science Framework and can be found here: <https://osf.io/AQV5P/>

Strengths and limitations of this study

- The scoping review will provide a comprehensive update on literature reporting on the use of eHealth technologies in the NICU, and particularly any advances as a result of the pandemic.
- The research will conduct a structured search through eight electronic databases and grey literature in order to guarantee the comprehensiveness of the search.
- This scoping review will focus on publications written in English and Chinese.
- As this is a scoping review, no critical evaluation of the included studies or risk of bias assessment will be done.

Introduction

Parental presence in the neonatal intensive care unit (NICU) has been found to be effective in reducing negative outcomes of NICU care for both infants and parents, such as improving early neurobehavioral outcomes in preterm infants and decreasing maternal mental health risks[1–4]. Many NICUs in the West have established protocols for family-centered care and provide parents with 24/7 access to their infants[5]. Regardless of the approach taken to support parental presence, the family's role at the bedside, even in a virtual sense, is of paramount importance to both the newborn and their parents.

Despite a considerable body of literature on interventions and approaches to enhance family engagement in care, including family-centered care and family-integrated care[6], parental involvement in providing care for their preterm newborn is still limited in many NICUs. For instance, the majority of NICUs in China have restricted visiting regulations and minimal parental involvement, making family-centered care difficult to execute[7–9]. In contrast, NICUs in Global North in particular welcomed all parents without restrictions before Corona Virus Disease 2019 (COVID-19)[5,7].

However, with the outbreak of COVID-19, many NICUs in Global North temporarily prohibited in-person visiting in an attempt to limit the spread of COVID-19, and preserve personal protective equipment supplies[5,10]. A survey of 277 NICUs in the US reported that NICU policies preserving 24/7 parental presence decreased (83% to 53%, $p<0.001$), and preservation of full parental participation in rounds fell (71% to 32%, $p<0.001$)[5]. The European Foundation for the Care of Newborn Infants (EFCNI) COVID-19 Zero Separation Collaborative Group conducted an online survey of parents' experiences with disruption to visiting access and provision of family-centered care as a result of COVID. Of the 2100 participants who responded from 56 countries, 21% reported no parental access to their hospitalized newborn infant [11]. These abrupt restrictions on the parental presence and family involvement in NICU undoubtedly

impede the capacity to deliver family-centered care. The changes may impact parental stress and neonatal outcomes. The authors recommended the development and implementation of policies to ensure family-centered care is safeguarded during emergencies such as a pandemic, including access to their infant, adequate provision of health information, and continuous and respectful communication between health care professionals and parents.

Restrictive visiting policies may have prompted the development and implementation of eHealth technologies in NICUs[12]. eHealth is the integration of information and communications technology (ICT) and electronic processes to facilitate improved communication, delivery of health services, and management of health systems [13]. In recent years, the utilization of eHealth technologies in the NICU in Global North has been diverse and increasing[12], including supporting parents in an early discharge after childbirth using videoconferencing[13], telemedicine[14] and SMS support [15]; and facilitating parental presence and involvement in care using an interactive learning platform[16], web camera [14,17], skype/facetime and smartphone[18], in order to enhance and support their family-centered care, and improve communication and family satisfaction. Also, eHealth technologies such as wechat and smartphone are widely used in the NICU in China[19,20]. A recent systematic review revealed that mobile-health technologies (mHealth) are increasingly utilized in low- and middle-income countries, although the quantity and quality remains limited[21]. eHealth technologies have increasingly been used in neonatal intensive care as a potential substitute for in-person parental presence. Additionally, the constraints and enablers of technologies in these situations have not been exhaustively examined. This scoping review seeks to update the literature on eHealth technology utilization in the NICU and to explore the literature on the barriers to, and facilitators of eHealth technology implementation in order to inform future implementation research.

Study Objectives

This scoping review will update literature in relation to the application of eHealth technology in the NICU to improve parental health outcomes and examine the facilitators of and barriers to eHealth utilization in the NICU setting.

Method and analysis

Protocol design

The scoping review will adhere to the methodological framework outlined by Arksey and O'Malley[22] in 2005, as well as the methodology manual published by the Joanna Briggs Institute for scoping reviews[23]. The PRISMA-ScR will serve as the guiding framework for both the current protocol and any subsequent scoping review[24]. Thus, the review will proceed through five stages: (1) identifying the research question; (2) identifying relevant studies; (3) selection of relevant articles; (4) charting the data; and (5) collating, summarising and reporting of results.

Stage 1: Identifying the research question

Through consultation with the research team, the overall research questions are:

1. What eHealth technologies are used for infants and their families in the NICU?
2. What impact do eHealth technologies have on the anxiety and stress of parents of infants in the NICU?
3. What impact do eHealth technologies have on the workload of healthcare professionals in the NICU?
4. What are the facilitators of, and barriers to, implementing eHealth technologies in the NICUs?

Stage 2: Identifying relevant studies

The scoping review will utilise the PCC (Population, Concept, Context) framework as recommended by the Joanna Briggs Institute. We will comprehensively

search articles and grey literature published up to August 2022 in any language. The databases chosen for this scoping review are PubMed, Embase, Scopus, Web of Science, ScienceDirect, CINAHL, CNKI and Wanfang. A preliminary exploratory search strategy based on the PCC framework will be created on PubMed To find some pertinent terms, with no language restrictions. The Medical Subject Headings (MeSH) terms will be evaluated and ranked according to their relevance and frequency (Table 1). A second search strategy will be created based on the most pertinent MeSH terms, which will be filtered to either English or Chinese. We also will create a subcategory of excluded articles that are not in English or Chinese, but that have English abstracts, which could help other researchers evaluate the potential for extending this work with publications in additional languages.

A search of grey literature from the websites of pertinent organisations will be done to get the level of comprehensiveness necessary for a scoping review[25]. The organizations include the WHO, nursing associations worldwide, Google Scholar, Conference Papers Index, PapersFirst and Scopus.

Table 1 List of the key words and medical subject headings used in the search strategy

Concept	Key words	Medical subject headings
Parents	“parent*”; “mother*”; “father*”; “caregiver*”; “care giver*”; “famil*”	“parents”; “caregivers”; “family”; “mother”; “father”; “family satisfaction”; “parental satisfaction”
Neonatal	“pediatrics”; “infant*”; “newborn*”; “perinat*”; “neonate*”; “preterm*”; “premature*”; “baby”; “babies”	“pediatrics”; “infant, newborn”; “neonatal nursing”; “neonatology”; “intensive care, neonatal”

Healthcare professionals	“healthcare professional*”; “nurs*”; “neonatal nurs*”	“nurse”; “healthcare professional”; “neonatal nursing”
eHealth	“social media”; “medical apps”; “eHealth”; “telemedicine”; “internet”; “mHealth”; “mobile health”; “information technology”; “web camera”; “webcam”; “teleneonatology”; “facetime”; “skype”; “smartphone”; “zoom”; “videoconference*”;	“telemedicine”; “medical informatics”; “internet”; “cell phone”; “mobile applications”
Barriers & Facilitator	“barrier*”; “limit*”; “difficult*”; “restrict*”; “constraint*”; “facilitator*”; “factor*”; “promot*”; “ease*”	“barrier”; “facilitator”
Parental & healthcare professional’s outcomes	“anxiet*”; “stress*”; “depress*”; “pressure*”; “workload*”	“anxiety”; “stress”; “healthcare professionals, workload”

*truncation used to expand search

Stage 3: Selection of relevant articles

In this Stage, we will specify and refine our inclusion and exclusion criteria based on the PCC framework identified for this review. The application of additional eligibility criteria guarantees that the selected articles are pertinent to the research question. All papers derived from the search process will be imported to Covidence, which is a web-based tool to facilitate the conduct and documentation of literature reviews. Then, a two-step screening procedure will be conducted. The first step involves screening article titles and abstracts to determine their eligibility. The second step is

full-text screening where only those articles deemed relevant will be kept. Each article will be evaluated independently by two reviewers, and consistency checks will be conducted.

Eligibility criteria

Inclusion criteria

The selection of studies for this review will be based on the following criteria:

1. Articles reporting eHealth technologies to improve parental outcomes and health professionals’ outcomes.
2. Articles reporting barriers to, or facilitators of, implementation of eHealth technologies in the NICU
3. Studies published in English or Chinese between 2000 and 2022
4. Studies conducted in the NICU
5. Studies that are a full report of original research.
6. Grey literature about the implementation of eHealth technologies in the NICU

In the inclusion criteria, No.1~No.2 are linked by “OR”, No.3~No.5 are linked by “AND”.

Exclusion criteria

The review will exclude studies based on specific criteria as follow:

1. Studies published in other languages
2. Studies published before 2000
3. Letters to the editor, editorials, commentaries

The PRISMA flowchart will be utilised in the study selection procedure and updated once the evaluation is complete (Figure 1).

Figure 1. PRISMA Extension for Scoping reviews, 2020 flow diagram.

Stage 4: Charting the data

Using Covidence, two independent reviewers will conduct data extraction to ensure the approach is consistent with the research questions and inclusion and exclusion criteria.

The reviewer team plans to create and test a standardised data-charting form through an iterative process.

The data extraction table produced will include at least the following key elements:

1. First author's name
2. Title
3. Year of publication
4. The journal's name
5. Country of origin
6. Aim/purpose of the study
7. Study design
8. Study population
9. Sample size
10. Methodology
11. Outcomes and results of the study
12. Key findings that relate to the scoping review questions

Stage 5: Collating, summarising and reporting the results

This scoping review aims to present an overview of the research rather than evaluate the quality of the included studies.

A narrative report will be produced that synthesizes and summarizes the progress of research, the impact of eHealth technologies on outcomes of parents and healthcare professionals, and the barriers and facilitators associated with the implementation of eHealth in the NICU.

This stage will occur in two phases. First, a quantitative analysis will be

conducted using tables to determine the differences and range of variables based on the journal where the articles were published, countries and regions, field of research, methodology, objective/purpose of the study, actors targeted for change, health system stakeholders involved, and health system setting.

Second, two reviewers will thoroughly examine all papers in both English and Chinese as part of the qualitative analysis. To make data analysis easier, a qualitative data management software system (NVIVO-11) will be employed. The study team will list the important ideas and procedures that were employed. In order to describe the characteristics of the studies that were included, we will first evaluate the data using a descriptive summary. Then, we'll employ a content analysis strategy to pinpoint the eHealth technology in NICU's facilitators and inhibitors. Two reviewers will be trained on how to code the retrieved data using a broad-based coding system in order to get 80% coding agreement. The results of our analysis will then be reported utilising themes, and they will be produced in accordance with the goal of our study. We will then conduct a comprehensive analysis of the linkages between the synthesised themes and subthemes, of the significance of our findings, and of the knowledge gaps, as well as determine the meaning of our findings. The implications for current clinical practise and upcoming research will also be covered. According to Arksey and O'Malley's suggested methodology, neither an evaluation of the quality of individual studies nor a risk-of-bias assessment will be conducted. As required, results will be presented in an aggregated and visual format (e.g., using tables and charts).

Patient and public involvement

Patients, parents, healthcare professionals, and members of the public will not be involved in the writing of the protocol or the drafting of the scoping review.

Ethics and dissemination

This scoping review doesn't need ethical approval. There will be no participation by humans or animals, and all data and information will be gathered from open databases. The findings of this scoping review will be disseminated to pertinent healthcare specialists and published in peer journals. This scoping review is foundational work for a further research project that will aim to evaluate eHealth technologies to augment parent visits in the NICUs.

Authors' contributions: YZ conceived of the idea and produced the initial draft of the review protocol; LJ contributed meaningfully to the drafting, reviewing, and editing. All authors read and approved the final manuscript.

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Competing interests statement

None declared

World Count: 2396

Number of figures and tables: 2

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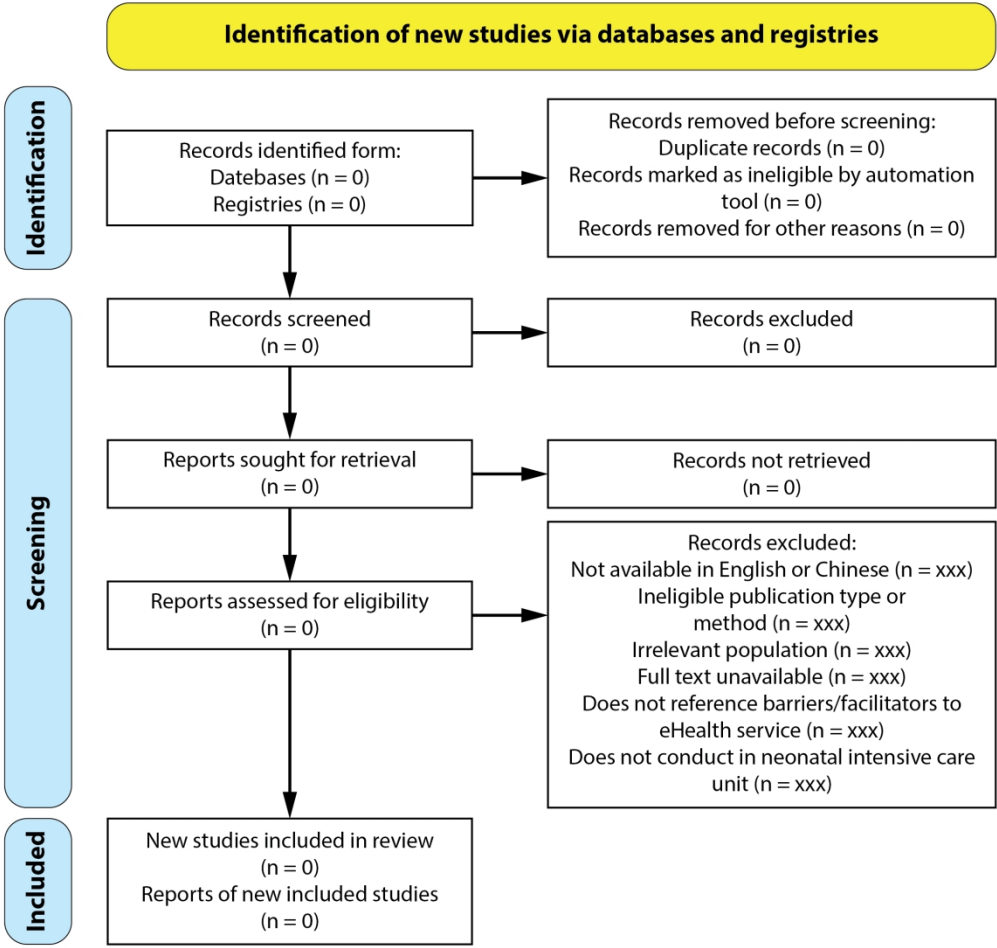


Figure 1. PRISMA Extension for Scoping reviews, 2020 flow diagram.

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5-6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5-6
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	9
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	7-8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	8-9
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	9
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	11
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	11
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Click here to enter text.
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	11

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SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7-10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	11
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Click here to enter text.
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	11-12
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	12
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Click here to enter text.
Limitations	20	Discuss the limitations of the scoping review process.	2
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Click here to enter text.
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	14

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

