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Electronic Health Records (EHR) Simulation-Based Training: A Scoping Review Protocol

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Electronic Health Records (EHR) Simulation-Based Training: A Scoping Review Protocol

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Abstract

Introduction

Effective electronic health record (EHR)-based training interventions facilitate improved EHR use for health care providers. One such training intervention is simulation-based training which emphasizes learning actual tasks through experimentation in a risk-free environment without negative patient outcomes. EHR-specific simulation-based training can be employed to improve EHR use, thereby enhancing health care providers' skills and behaviors. Despite the potential advantages of this type of training, no study has identified and mapped the available evidence. To fill that gap, this scoping review will synthesize the current state of literature on EHR simulation-based training.

Methods and analysis

The Arksey and O'Malley methodological framework refined by Levac et al will be employed. Three databases (PUBMED, Embase, and Cumulative Index to Nursing and Allied Health Literature) will be searched for published articles. ProQuest and Google Scholar will be searched to identify unpublished articles. Two reviewers will independently screen titles and abstracts against inclusion and exclusion criteria. Then, they will review full texts to determine articles for final inclusion. Citation-chaining will be conducted to manually screen references of all included studies to identify additional studies not found by the search. A data abstraction form with relevant characteristics will be developed to help address the research question. Descriptive numerical analysis will be used to describe characteristics of included studies. Based on the extracted data, research evidence of EHR simulation-based training will be synthesized.

Ethics and dissemination

Since no primary data will be collected, there will be no formal ethical review. Research findings will be disseminated through publications, presentations and meetings with relevant stakeholders.

Strengths and limitations of this study

- Identifies and maps available evidence on electronic health records simulation-based training
- Provides in-depth search strategy, elaborate eligibility criteria, and clear data extraction framework to address research question
- Provides methodologically rigorous template for future scoping review studies that seek to identify and map early evidence for interventions
- Quality of evidence will not be assessed and so robustness or generalizability of findings will not be evaluated
- Results will not answer a clinically meaningful question

Introduction

Use of electronic health records (EHRs), digital form of the traditional patient and population health information,[1] in the US health care system continues to grow.[2] Despite their benefits, there are unintended consequences, including burnout and workflow disruption, associated with EHR use.[2–4] Inadequate training and education of health care providers, among other reasons, may account for these unintended consequences.[3] Effective EHR-based training, that closely mimics

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real-world clinical conditions while replicating the cognitive load that clinicians are subjected to,[5] can improve health care quality and safety.[6]

Simulation is a methodology, not a technology, that substitutes real experiences with replicable guided experiences.[7] In health care, these guided experiences may be physical or computer-based models, live actors or virtual reality platforms.[7,8] Simulation seeks to replicate clinical scenarios without putting patients at risk.[8] Simulation-based training (SBT), now a commonplace in health care[8], emphasizes learning actual tasks through experimentation in a risk-free environment without negative patient outcomes. When applied properly, SBT creates a consistent, safe and replicable learning environment.[9] SBT has been shown to enhance health care providers' skills and behaviors,[10,11] improve patient safety outcomes,[12] and provide valuable feedback.[13] It has found utility in bridging the gap between medical students' preclinical knowledge and care of real patients,[14] enhancing surgical skills training,[15] improving performance of emergency medicine residents during central venous catheterization,[16] and improving perceptual ability of critical care fellows.[17]

SBT can take many forms, including part-task simulators, human patient simulators, simulated clinical environments, computer screen-based simulators, and virtual reality simulators.[7,10] Of particular interest in the present study is EHR-specific SBT, a type of computer-screen based simulator, aimed at maximizing the use of EHR as a clinical tool. Previous research[6,18,19] shows that EHR-specific SBT facilitates improved use of EHRs for clinicians. It is worth noting that only one recent study[20] has systematically reviewed educational interventions in the use of EHRs. The authors found that all the interventions involved data entry into a simulated EHR with none requiring extraction, aggregation or visualization of clinical data. They suggested the need to address gaps in training medical students and residents. The study population for this study was only medical students and residents. However, EHR-specific SBT is not beneficial to this population only, but also to other health care professionals like physicians and surgeons. Despite the potential advantages of EHR-specific simulation-based training,[6,10] no study has identified and mapped the available evidence. To fill that gap, this study will synthesize the current state of literature on EHR SBT. We do not wish to use the results of this study to answer a clinically meaningful question. Rather, we are interested in identifying and mapping the available evidence, hence our choice of a scoping review.[21]

Methods and analysis

This protocol conforms to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist.[22] We will employ the Arksey and O'Malley[23] methodological framework refined by Levac et al[24]: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) collating, summarizing and reporting the results, and (6) consultation.

Stage 1: Identifying the research question

According to Arksey and O'Malley[23], the scoping review research question should be broad enough to summarize the breadth of evidence. In the present study, we seek to synthesize the available evidence by asking the question:

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What is known from the existing literature about EHR SBT?

Given the exploratory nature of the scoping review, we may refine this research question as we review the literature. We define an EHR as a digitized version of a patient's health information generated as a result of encounters in a health care delivery setting and maintained by authorized health care providers for planning and for delivering safe and proper treatment[25]. Also, we define SBT as computer screen-based simulations intended for learners to acquire knowledge or assess learners' competency of knowledge attainment and/or provide learners feedback related to clinical knowledge and critical-thinking skills.[7]

Stage 2: Identifying relevant studies

To be as comprehensive as possible, we will search electronic databases and reference lists of included articles. We will search three databases from inception to present: PUBMED, Embase, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Since this is an exploratory study, we will also search ProQuest and Google Scholar to identify unpublished articles. A preliminary search on PUBMED, with the help of a health sciences librarian, yielded 128 articles. We present the sample search strategy in Table 1. We will use a similar search strategy to retrieve articles from the other databases. We will download citations and remove duplications using the Zotero reference management software.

Table 1

Search strategy for PUBMED

Search	Query	Items found
#1	((Simulation[tw] OR simulate[tw] OR simulated[tw] OR simulating[tw]) AND (train[tw] OR training[tw] OR trained[tw]))	25,799
#2	Electronic Health Records[mesh] OR Electronic Health Records[tiab] OR Electronic Health Record[tiab] OR Medical Order Entry Systems[mesh] OR Medical Order Entry Systems[tiab] OR Medical Order Entry System[tiab] OR Computerized Provider Order Entry[tiab] OR Computerized Physician Order Entry[tiab] OR Medical Records Systems, Computerized[mesh] OR Electronic Medical Records[tiab] OR Electronic Medical Record[tiab] OR Electronic Health Record[tiab] OR Computerized Medical Record[tiab] OR Computerized Medical Records[tiab] OR electronic documentation[tiab] OR electronic charting[tiab]	56,201
#3	#1 AND #2	128

Stage 3: Study selection

We will carry out article selection in two stages. First, two reviewers (J.N and K.A) will independently screen titles and abstracts against inclusion and exclusion criteria (see Table 2) with the aid of Covidence,[26] a web-based screening and data extraction tool.

Table 2

Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion

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Technology used for simulation-based training	Computer screen-based	Part-task, human patient, simulated clinical environment, virtual reality
Language	English	Non-English
Text availability	Full text	Abstract only
Study design	Randomized control trial, cohort study, cross-sectional study, case-control study	Animal research study, systematic review, meta-analysis

A third reviewer (L.M) will assist in resolving disagreements regarding article eligibility. In the second stage, two reviewers will independently review the selected full-text articles to determine eligibility. Also, we will conduct citation-chaining to manually screen references of all included studies to identify additional studies not found by the search. Figure 1 displays the flow of studies from stages 1-2.

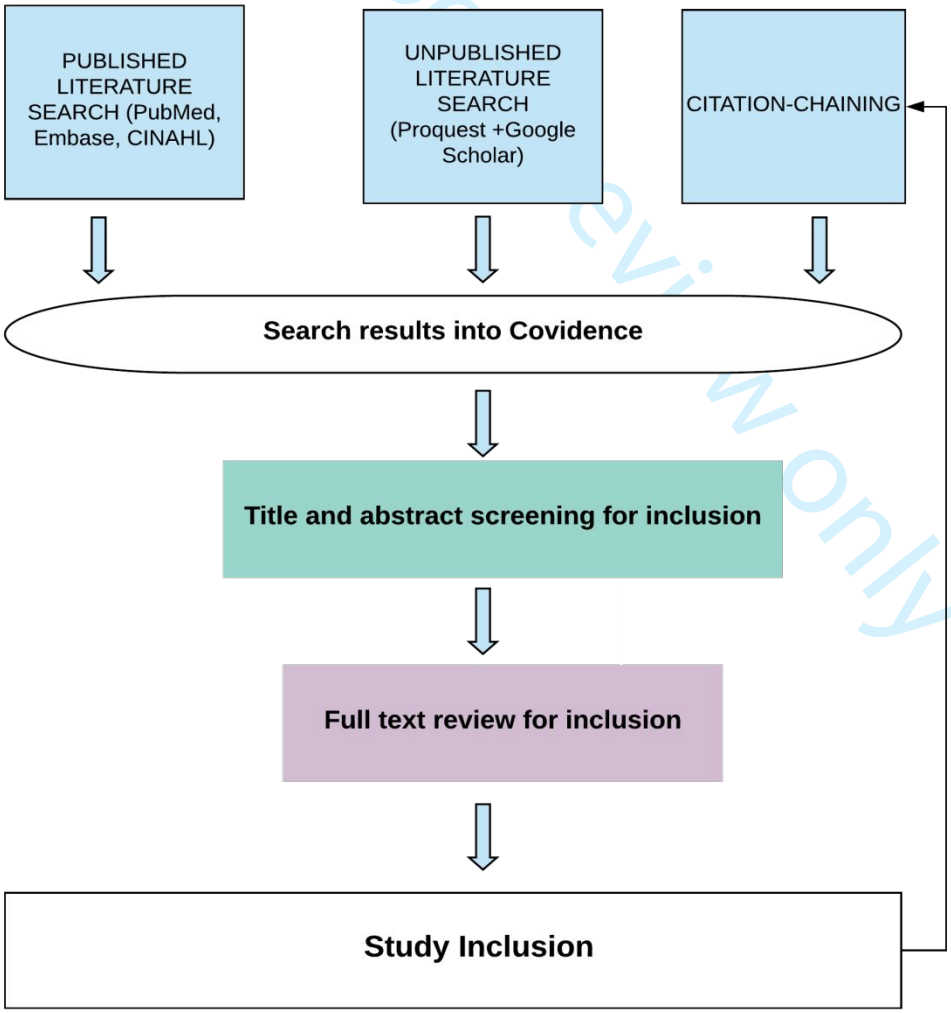

Figure 1

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Flow of studies within Stages 1-2

Stage 4: Charting the data

Through an iterative process, we will develop a data abstraction form with relevant characteristics to help address the research question. Each researcher will independently pilot the data abstraction form about 7-10 studies to determine its consistency with the research question. For each study, variables will be extracted for each category – research, simulation study and EHR (see Table 3). Together, these data will form the basis of our analysis.

Table 3

Overview of variables and related classification method

Category	Variable	Classification method
Research	Year of publication	Metadata
	Geolocation	
	Number of participants	
	Participants' age group	
	Specialty	
Simulation study	Aim of simulation	Gaba[7]
	Unit of participation in simulation	
	Experience level of simulation participants	
	Knowledge, skill, attitudes addressed	
	Site of simulation participation	
	Extent of direct participation in simulation	
	Feedback accompanying simulation	
EHR	Health information and data	Institute of Medicine[27]
	Results management	
	Order entry/management	
	Decision support management	
	Electronic communication and connectivity	
	Patient support	
	Administrative processes	
	Reporting and population health management	

Stage 5: Collating, summarizing and reporting the results

We will not evaluate the robustness or generalizability of our findings since we do not seek to assess the quality of evidence.[23] Rather, we will collate, summarize and report our findings using descriptive numerical analysis. Two reviewers (J.N and K.A) will conduct this analysis to present a summary of the nature and distribution of the studies included in the review. We will produce tables and charts mapping the distribution of studies. Based on the data extracted, we will synthesize research evidence of EHR simulation-based training.

Stage 6: Consultation

Stakeholder consultation is an essential component of scoping review methodology.[28] This stage focuses on the development of a plan to consult with stakeholders to help identify potential studies to include in the review, interpretation of research findings and the dissemination of these findings. We propose to consult with two stakeholders – one with expertise in simulation training

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and another who has participated in SBT on one or more research projects. The aim is to integrate the experiences of SBT experts and participants to ensure that the design, conduct, and knowledge translation of this scoping review is relevant to the population it involves – researchers and healthcare professionals.

Ethics and dissemination

Since no primary data will be collected, there will be no need for a formal ethical review. To our knowledge, this is the first scoping review to identify and map the evidence for EHR-specific SBT for healthcare professionals.

The strength of this scoping review protocol lies in its in-depth search strategy, elaborate eligibility criteria, and clear data extraction plan. This protocol provides a methodologically rigorous template for future scoping review studies for identifying and mapping early evidence for interventions. Findings from the review will be submitted to relevant journals such as the British Medical Journal, and BMC Medical Informatics and Decision Making. Further, we aim to share our results with relevant key stakeholders including clinicians, health information managers, EHR vendors, policy makers, and healthcare organizations to provide a direction for future researchers seeking to develop and implement EHR-specific SBT.

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account for these unintended consequences.[3] Effective EHR-based training, that closely mimics real-world clinical conditions while replicating the cognitive load that clinicians are subjected to,[5] can improve health care quality and safety.[6]

Simulation is a methodology, not a technology, that substitutes real experiences with replicable guided experiences.[7] In health care, these guided experiences may be physical or computer-based models, live actors or virtual reality platforms.[7,8] Simulation seeks to replicate clinical scenarios without putting patients at risk.[8] Simulation-based training (SBT), now a commonplace in health care[8], emphasizes learning actual tasks through experimentation in a risk-free environment without negative patient outcomes. When applied properly, SBT creates a consistent, safe and replicable learning environment.[9] SBT has been shown to enhance health care providers' skills and behaviors,[10,11] improve patient safety outcomes,[12] and provide valuable feedback.[13] It has found utility in bridging the gap between medical students' preclinical knowledge and care of real patients,[14] enhancing surgical skills training,[15] improving performance of emergency medicine residents during central venous catheterization,[16] and improving perceptual ability of critical care fellows.[17]

SBT can take many forms, including part-task simulators, human patient simulators, simulated clinical environments, computer screen-based simulators, and virtual reality simulators.[7,10] Of particular interest in the present study is EHR-specific SBT, a type of computer-screen based simulator, aimed at maximizing the use of EHR as a clinical tool. Previous research[6,18,19] shows that EHR-specific SBT facilitates improved use of EHRs for clinicians. It is worth noting that only one recent study[20] has systematically reviewed educational interventions in the use of EHRs. The authors found that all the interventions involved data entry into a simulated EHR with none requiring extraction, aggregation or visualization of clinical data. They suggested the need to address gaps in training medical students and residents. The study population for this study was only medical students and residents. However, EHR-specific SBT is not beneficial to this population only, but also to other health care professionals like physicians and surgeons. Despite the potential advantages of EHR-specific simulation-based training,[6,10] no study has identified and mapped the available evidence. To fill that gap, this study will synthesize the current state of literature on EHR SBT. We do not wish to use the results of this study to answer a clinically meaningful question. Rather, we are interested in identifying and mapping the available evidence, hence our choice of a scoping review.[21]

Methods and analysis

This protocol conforms to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) checklist[22]. We have included a copy of the PRISMA-P checklist as a supplementary file, completed with page numbers indicating where each item can be found in our manuscript. The final publication of this work will adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist.[23] We will employ the Arksey and O'Malley[24] methodological framework: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) collating, summarizing and reporting the results, and (6) consultation.

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Stage 1: Identifying the research question

According to Arksey and O'Malley[24], the scoping review research question should be broad enough to summarize the breadth of evidence. In the present study, we seek to synthesize the available evidence by asking the question:

What is known from the existing literature about EHR SBT?

We did not use a mnemonic to guide the construct of our research question. Rather, we consulted a group of health care educators to determine attributes of EHR SBT. Given the exploratory nature of the scoping review, we may refine this research question as we review the literature. We define an EHR as a digitized version of a patient's health information generated as a result of encounters in a health care delivery setting and maintained by authorized health care providers for planning and for delivering safe and proper treatment[25]. Also, we define SBT as computer screen-based simulations intended for learners to acquire knowledge or assess learners' competency of knowledge attainment and/or provide learners feedback related to clinical knowledge and critical-thinking skills.[7] These definitions are needed to establish a clear scope to the study and guide the search strategy. We do not have a target population. Consequently, the target population may include students, residents, clerks, technicians, nurses, physicians, managers, and regulators.

Stage 2: Identifying relevant studies

To be as comprehensive as possible, we will search electronic databases and reference lists of included articles. We will search three databases from inception to January 29, 2020: PUBMED, Embase, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Since this is an exploratory study, we will also search ProQuest and Google Scholar to identify unpublished articles. A preliminary search on PUBMED, with the help of a health sciences librarian, yielded 235 articles. We present the sample search strategy in Table 1. We will use a similar search strategy to retrieve articles from the other databases. Only literature written in English, randomized control trials, cohort studies, cross-sectional studies, and case-control studies will be considered for inclusion. We will download citations and remove duplications using the Zotero reference management software.

Table 1

Sample search strategy for PUBMED

Search	Query	Items found
#1	((simulat*[tw] OR simulate[tw] OR simulated[tw] OR simulating[tw]) AND (train[tw] OR training[tw] OR trained[tw] OR educat*[tw]))	40,682
#2	Electronic Health Records[mesh] OR Electronic Health Records[tiab] OR Electronic Health Record[tiab] OR Medical Order Entry Systems[mesh] OR Medical Order Entry Systems[tiab] OR Medical Order Entry System[tiab] OR Computerized Provider Order Entry[tiab] OR Computerized Physician Order Entry[tiab] OR Medical Records Systems, Computerized[mesh] OR Electronic Medical Records[tiab] OR Electronic Medical Record[tiab] OR Electronic Health Record[tiab] OR Computerized Medical Record[tiab] OR Computerized Medical Records[tiab] OR electronic documentation[tiab] OR electronic charting[tiab]	59,024

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#3	#1 AND #2	235

Stage 3: Study selection

We will carry out article selection in two stages. First, two reviewers (J.N and K.A) will independently screen titles and abstracts against inclusion and exclusion criteria (see Table 2) with the aid of Covidence,[26] a web-based screening and data extraction tool.

Table 2

Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Technology used for simulation-based training	Computer screen-based	Part-task, human patient, simulated clinical environment, virtual reality
Language	English	Non-English
Text availability	Full text	Abstract only
Study design	Randomized control trial, cohort study, cross-sectional study, case-control study	Animal research study, systematic review, meta-analysis, literature review, scoping review

A third reviewer (L.M) will assist in resolving disagreements regarding article eligibility. In the second stage, two reviewers will independently review the selected full-text articles to determine eligibility. Also, we will conduct citation-chaining to manually screen references of all included studies to identify additional studies not found by the search. Figure 1 displays the flow of studies from stages 1-2.

Stage 4: Charting the data

Through an iterative process, we will develop a data abstraction form with relevant characteristics to help address the research question. Each researcher will independently pilot the data abstraction form about 7-10 studies to determine its consistency with the research question. For each study, variables will be extracted for each category – research, simulation study and EHR (see Table 3). Together, these data will form the basis of our analysis.

Table 3

Overview of variables and related classification method

Category	Variable	Classification method
Research	Year of publication	Metadata
	Geolocation	
	Number of participants	
	Participants' age group	
	Specialty	
Simulation study	Aim of simulation	Gaba[7]
	Unit of participation in simulation	
	Experience level of simulation participants	

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	Knowledge, skill, attitudes addressed	
	Site of simulation participation	
	Extent of direct participation in simulation	
	Feedback accompanying simulation	
EHR	Health information and data	Institute of Medicine[27]
	Results management	
	Order entry/management	
	Decision support management	
	Electronic communication and connectivity	
	Patient support	
	Administrative processes	
	Reporting and population health management	

Stage 5: Collating, summarizing and reporting the results

We will not evaluate the robustness or generalizability of our findings since we do not seek to assess the quality of evidence.[24] Rather, we will collate, summarize and report our findings using descriptive numerical analysis. Two reviewers (J.N and K.A) will conduct this analysis to present a summary of the nature and distribution of the studies included in the review. We will produce tables and charts mapping the distribution of studies. Based on the data extracted, we will synthesize research evidence of EHR simulation-based training.

Stage 6: Consultation

Stakeholder consultation is an essential component of scoping review methodology.[28] This stage focuses on the development of a plan to consult with stakeholders to help identify potential studies to include in the review, interpretation of research findings and the dissemination of these findings. We propose to consult with two stakeholders – one with expertise in simulation training and another who has participated in SBT on one or more research projects. The aim is to integrate the experiences of SBT experts and participants to ensure that the design, conduct, and knowledge translation of this scoping review is relevant to the population it involves – researchers and healthcare professionals.

Patient and public involvement

There was no patient or public involvement in the design of this protocol.

Anticipated outcome

The scoping review will synthesize the current state of the literature on EHR-specific SBT based on Gaba's dimensions and the Institute of Medicine's EHR functionalities. Anticipated outcomes include (1) mapping of the literature on the use of simulation-based EHR training in health care, (2) comparison of EHR functionalities across prior simulation-based EHR training studies, and (3) outline areas where further research is needed.

Ethics and dissemination

Since no primary data will be collected, there will be no need for a formal ethical review. To our knowledge, this is the first scoping review to identify and map the evidence for EHR-specific SBT for healthcare professionals.

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The strength of this scoping review protocol lies in its in-depth search strategy, elaborate eligibility criteria, and clear data extraction plan. This protocol provides a methodologically rigorous template for future scoping review studies for identifying and mapping early evidence for interventions. Findings from the review will be submitted to relevant journals such as the British Medical Journal, and BMC Medical Informatics and Decision Making. Further, we aim to share our results with relevant key stakeholders including clinicians, health information managers, EHR vendors, policy makers, and healthcare organizations to provide a direction for future researchers seeking to develop and implement EHR-specific SBT.

Contributorship statement: JN contributed to the conceptualization of the study, wrote and edited the manuscript. KA and LM contributed to the conceptualization of the study and edited the manuscript.

Competing interests: None declared.

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Data sharing statement: There are no data in this work.

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Figure 1

Flow of studies within Stages 1-2

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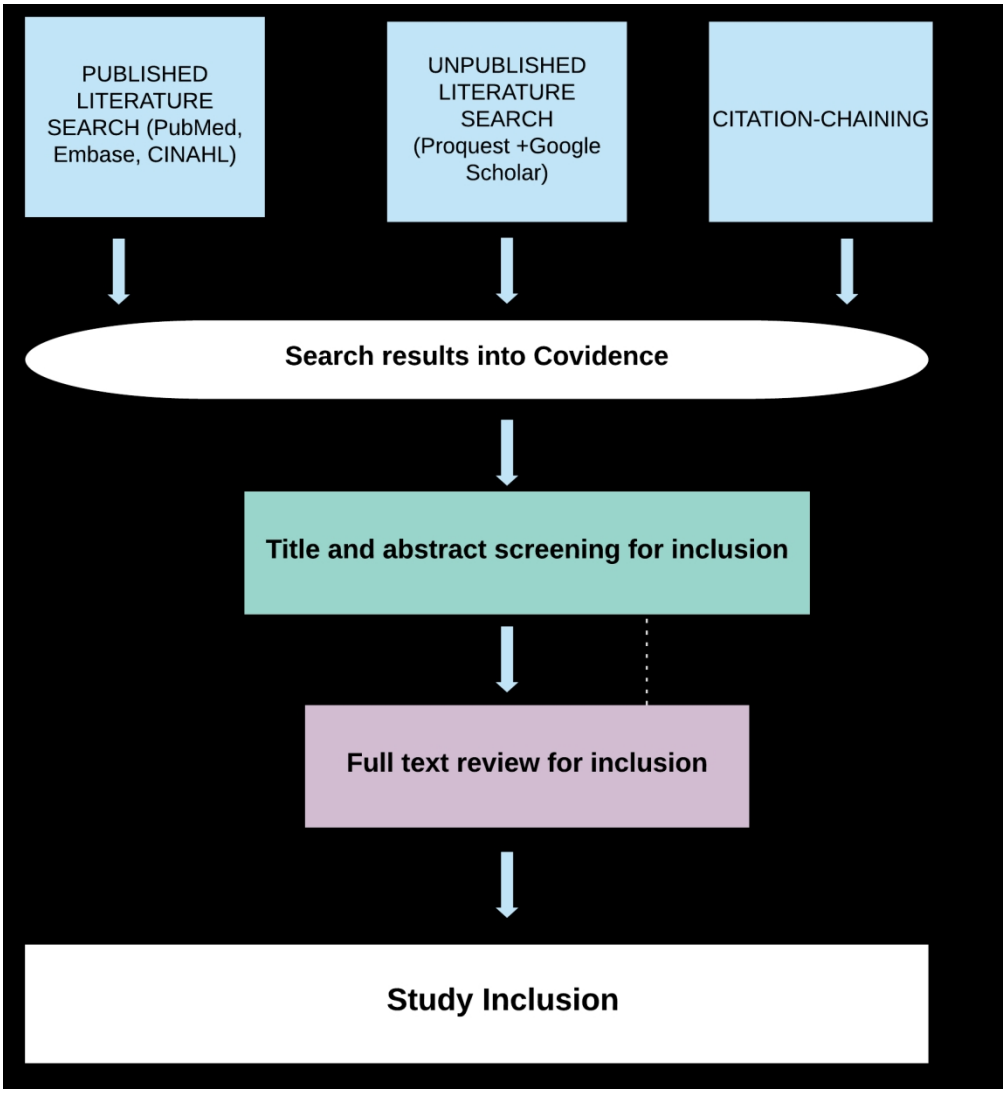

Figure 1
Flow of studies within Stages 1-2

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PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol

Section and topic	Item No	Checklist item	Page
ADMINISTRATIVE INFORMATION			
Title:			
Identification	1a	Identify the report as a protocol of a systematic review	1
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	NA
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number	NA
Authors:			
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	7
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	NA
Support:			
Sources	5a	Indicate sources of financial or other support for the review	7
Sponsor	5b	Provide name for the review funder and/or sponsor	7
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	7
INTRODUCTION			
Rationale	6	Describe the rationale for the review in the context of what is already known	3
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	3
METHODS			
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	4
Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	4
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	4

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Study records:			
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	4
Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	5
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	5
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	NA
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	6
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	NA
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised	6
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2, Kendall's τ)	NA
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	NA
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	NA
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	NA
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	NA

From: Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart L, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015 Jan 2;349(jan02 1):g7647.

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