



Interventions to Mitigate EHR and Documentation Burden in Health Professions Trainees: A Scoping Review

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Abstract

Keywords

- ▶ electronic health records and systems
- ▶ documentation burden
- ▶ EHR burden
- ▶ clinician documentation
- ▶ health professions trainees
- ▶ students

Background Health professions trainees (trainees) are unique as they learn a chosen field while working within electronic health records (EHRs). Efforts to mitigate EHR burden have been described for the experienced health professional (HP), but less is understood for trainees. EHR or documentation burden (*EHR burden*) affects trainees, although not all trainees use EHRs, and use may differ for experienced HPs.

Objectives This study aimed to develop a model of how interventions to mitigate EHR burden fit within the trainee EHR workflow: the *Trainee EHR Burden Model*. (We: 1) Examined trainee experiences of interventions aimed at mitigating EHR burden (scoping review) and (2) Adapted an existing workflow model by mapping included studies (concept clarification).

Methods We conducted a four-database scoping review applying Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extensions for Scoping Review (PRISMA-ScR) guidance, examining scholarly, peer-reviewed studies that measured trainee experience of interventions to mitigate EHR burden. We conducted a concept clarification categorizing, then mapping studies to workflow model elements. We adapted the model to intervenable points for trainee EHR burden.

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Results We identified 11 studies examining interventions to mitigate EHR burden that measured trainee experience. Interventions included curriculum, training, and coaching on the existing EHR for both simulated or live tasks; evaluating scribes' impact; adding devices or technology tailored to rounds; and team communication or data presentation at end-of-shift handoffs. Interventions had varying effects on EHR burden, most commonly measured through surveys, and less commonly, direct observation. Most studies had limited sample sizes and focused on inpatient settings and physician trainees.

Conclusion Few studies measured trainee perspectives of interventions aiming to mitigate EHR burden. Many studies applied quasi-experimental designs and focused on inpatient settings. The *Trainee EHR Burden Model*, adapted from an existing workflow model, offers a starting place to situate points of intervention in trainee workflow. Further research is needed to design new interventions targeting stages of HP trainee workflow, in a range of clinical settings.

Background and Significance

Health professions trainees (henceforth *trainees*) are unique in that they are learning their field¹ and the electronic health record (EHR) simultaneously.² Trainees are reporting unprecedented levels of stress and burnout,^{3–6} to which EHR burden may contribute,⁷ with as yet unknown impacts on the future health of the trainee workforce.⁸ Rates of burnout were higher for surgical trainees than experienced surgeons in the same institution.⁹ The increased presence and usage of EHRs since 2011 has coincided with the increased discussion of the impacts of EHRs on trainees.^{10–16} In response to federal legislation, the number of hospitals with a certified EHR rose from 72% (2011) to 94% (2015).¹⁷ For experienced health professionals (HPs) over the same timeframe, EHR burden has been associated with burnout and reduced professional satisfaction.^{4,18}

We define EHR burden and documentation burden (henceforth *EHR burden*) as the expected load or workload experienced by an HP completing necessary tasks included in the documentation and EHR interaction (e.g., generation, review, analysis, and synthesis of patient data⁵; **→Supplementary Appendix 1** [available in the online version]). EHR burden can be challenging to measure.^{19,20} For HPs who have completed training, interventions to mitigate EHR burden, as well as subsequent impacts on clinical practice, satisfaction, and ultimately burnout and wellness have been explored.^{18,21} Much less is understood of trainee EHR burden and how the EHR burden experienced by trainees can be addressed.^{22–24}

Trainee EHR use, the roles and tasks trainees need to perform in their daily workflow, and time spent in the EHR contributing to health care delivery may change through different stages of training.^{22,25,26} EHR access is not universally granted during training,²² if at all.^{22,25} As a result, trainees' experience of EHRs and EHR burden may change as training progresses, and vary across different health professions.^{26,27} Trainees' interactions with data in the EHR can include data capture, data review, data entry,

synthesis or generation of impressions in notes or other documents, and interdisciplinary team communication. Models can be used as a descriptive tool in informatics and can be applied to a clinical process to understand tasks and guide improvements in the associated health informatics tools needed to complete those tasks.^{28,29} Models can therefore be used to describe *workflow*, the sequence of tasks performed by individuals in an environment.^{30,31}

Trainees have reported EHR burden has negative impacts²³ on training and time at the bedside directly caring for patients.^{14,16} Trainee perspectives of EHR burden^{16,28,32,33} have been measured through quantitative, qualitative, or a mix of methodologies. Time tradeoffs have been examined using audit log data and direct observations.¹⁴ EHR burden can detract from time spent learning and performing training tasks, such as procedures or operating room cases for surgical trainees.³³ EHR use may also interfere with the trainee and clinician educator or supervising HP and have unintended consequences on health care delivery.²

In this work, we were interested in understanding how trainee EHR workflow might fit with an existing technology workflow model^{29,31} and the targets of intervention selected by studies that aimed to mitigate or reduce trainee EHR burden. We were interested in studies that measured the trainee perspective of EHR burden.

Objective

The objective of this work was to develop a model of how interventions to mitigate EHR burden fit within the trainee EHR workflow, henceforth referred to as the *Trainee EHR Burden Model*. To accomplish this objective, we:

1. Examined trainee experiences of interventions that aimed to mitigate EHR burden, by performing a scoping review of intervention studies that also measured trainee perspectives of EHR burden.³⁴

Table 1 Steps for developing the *Trainee EHR Burden Model* from scoping review studies

	Steps for Objective 1	Steps for Objective 2	
Study objective	Examined trainee experiences of interventions that aim to mitigate the EHR burden	Developed a model of points of intervention on EHR burden by examining trainee EHR use workflow	
		a) Map and categorize scoping review sources by elements of the existing model ²⁹	b) Develop <i>Trainee EHR Burden Model</i> (adapted model of trainee EHR workflow with overlaid categories of EHR burden interventions)
Methods	Scoping review	Concept clarification	Concept clarification
Actions	<ul style="list-style-type: none"> • Develop search strategies • Conduct search • Extract study characteristics (e.g., health profession, study type, intervention) 	Categorize scoping review studies to elements of existing workflow model ^a Conduct one round of asynchronous review of categories	Map categories of studies to existing workflow model, to develop <i>Trainee EHR Burden Model</i> (→ Fig. 3) ^a Conduct two rounds of review to refine <i>Trainee EHR Burden Model</i> (→ Fig. 3)
Results and findings	Scoping review synthesis yields a set of interventions aimed at mitigating trainee EHR burden	Categories of EHR tasks by elements of model (→ Table 4, → Fig. 2) Gaps in study interventions identified	Identify Adapted Model Gaps and opportunities for future work Final <i>Trainee EHR Burden Model</i>

Abbreviation: EHR, electronic health record.

The authors describe the steps taken to develop the *Trainee EHR Burden Model*, including aligned objectives, methods, actions, and results and findings leading up to model finalization.

^aSteps with the engagement of expert coauthors.

2. Mapped points of intervention for EHR burden from the scoping review studies to an existing workflow model.^{29,31} (a) First, we categorized included studies by applicable model²⁹ elements. (b) Then, we adapted the existing workflow model to an EHR-specific trainee workflow and overlaid the EHR burden intervention categories, to develop the *Trainee EHR Burden Model*. We used concept clarification methodology,³⁵ which can be used to adapt an existing model to a different topic area using an iterative process (→ Table 1).

Materials and Methods

We selected an existing conceptual model²⁹ to adapt based on the following criteria: (a) described technology workflow, (b) included model elements that could map to the six domains of EHR burden,^{6,31,36} and (c) included different types of intervention points (e.g., interventions that targeted training, usability, institutional culture, or technology). Further, we selected the Unertl workflow elements model²⁹ to adapt, because of its representation of health care workflow components including actors, actions, and outcomes, incorporating context and temporality.²⁹ The sociotechnical model³⁷ was considered but not selected for adaptation, as it offers some but not all of the categories of factors relevant to trainee EHR burden, and it does not present a visual of workflow. We performed a scoping review of interventions to mitigate trainee EHR burden that measured trainee perspectives regarding EHR burden and/or the intervention's impact on EHR burden. We then applied concept clarification methodology³⁵ to map the scoping review studies to the existing workflow model,²⁹

and to develop the *Trainee EHR Burden Model*. We engaged four content expert coauthors (on the EHR and HP experience of EHR use) for the concept clarification, to review, and to help refine the model.

Design and Search Strategy

We applied scoping review³⁴ and concept clarification³⁵ methods to systematically conduct this work (→ Table 1). We designed scoping review search strategies (D.R.L. and D. W.) in consultation with a health science and research librarian (A.H.) and followed guidance offered by the Johanna Briggs Institute Manual for Evidence Synthesis of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extensions for Scoping Review (PRISMA-ScR; → Supplementary Appendix 2 [available in the online version only]).³⁴ We searched four databases (Ovid MEDLINE, Embase, Web of Science, and Cochrane) over 1 week between November and December 2023 (→ Supplementary Appendix 3 [available in the online version only]). Dates did not delimit the search. We did not include Google Scholar as a database, as we prioritized reliably reproducible search strategies.

Study Selection, Eligibility Criteria, and Data Extraction

We identified studies that examined interventions to mitigate EHR burden that measured trainee experience of EHR burden. Searches included three key characteristics: (1) an inclusive mix of terms identifying trainees³¹ from a range of HP fields (e.g., nursing, medicine, pharmacy, physical and occupational therapy, speech-language pathology, and allied health professions), (2) terms regarding EHR or electronic

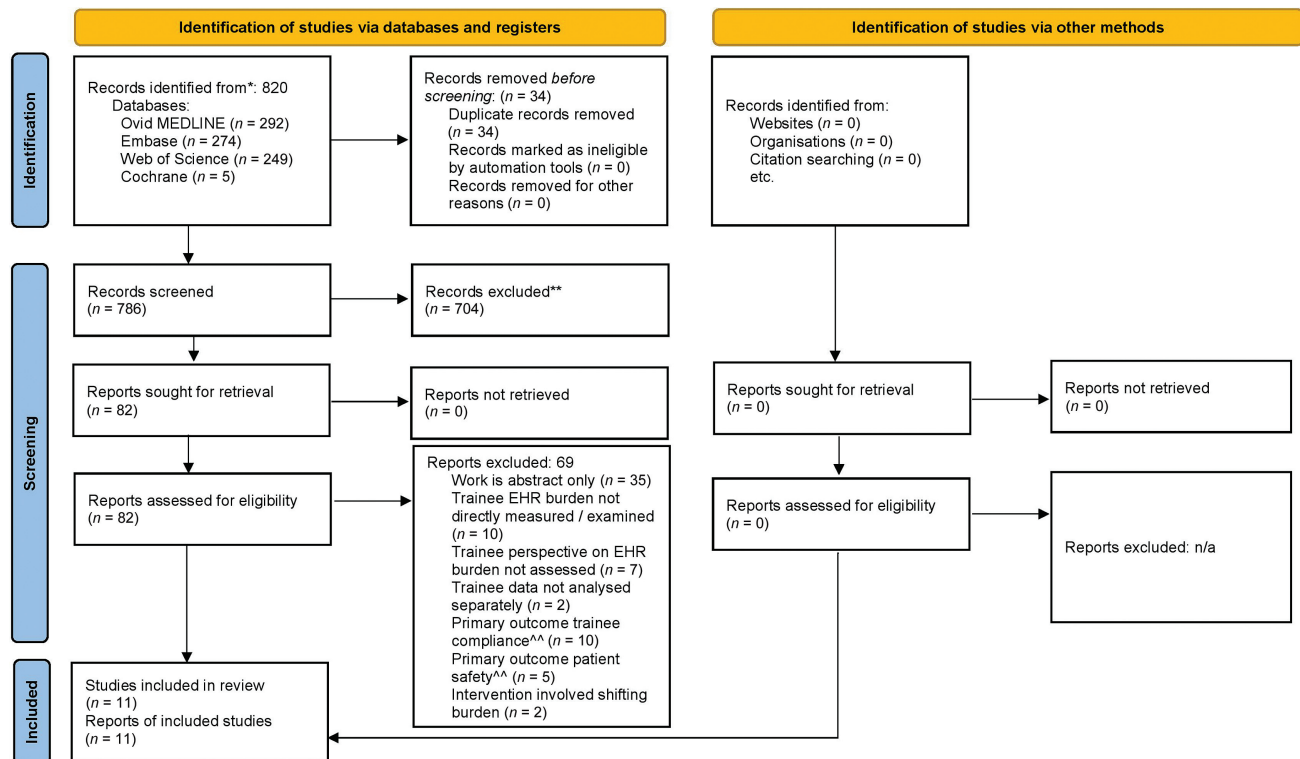


Fig. 1 PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources. *Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers). **No automation tools were used. ^^Primary outcome noted, impact on EHR burden unclear. Adapted from Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit <http://www.prisma-statement.org/>. Source: The authors present their analysis of the literature extracted during the scoping review. The sequential stages of the search are included, as well as the exclusion criteria for each key stage. EHR, electronic health record; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analysis.

medical records,³¹ and (3) terms to highlight *burden*³¹ (→Appendix 3 [available in the online version only]).

We used Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia) to collect database search results, support screening, and manage the review and results abstraction process for retrieved studies (→Fig. 1). Two authors (D.R.L. and D.W.) served as reviewers for each stage of study selection, applying a priori inclusion and exclusion criteria (→Table 2). We (D.R.L. and D.W.) extracted a range of a priori study characteristics from a final corpus of studies: (1) study objective (primary, and secondary where applicable); (2) study methods and participant numbers; (3) intervention target, (e.g., EHR task target or trainee workflow target, or both); (4) intervention design; (5) focus point of intervention in patient care delivery workflow; (6) trainee health care field; and (7) study limitations (→Table 3 and →Fig. 2). Due to the small corpus, for the data extraction stage only, studies were extracted by D.R.L. and D.W. synchronously. Results of the corpus were exported from Covidence for detailed analyses. Key observations and findings that inform the subsequent concept clarification are described below.

Inclusion Criteria

We identified studies with interventions that focused on trainees or analyzed trainees separately from experienced

HPs (→Table 2). We did not limit the type or structure of interventions, nor the timing of measurement of EHR burden relative to the intervention. Trainee EHR burden measurement could be a primary or secondary aim of the study (e.g., one study had a primary patient safety outcome, with a secondary outcome of measurement of trainee perspectives of EHR burden). Quantitative measures of EHR use such as metrics³⁸ (e.g., time-based metrics, analyses of document characteristics or note length, EHR use, or patient-focused outcomes) were not excluded; but if captured alone, these were not considered measures of trainee experience of EHR use for inclusion. We excluded studies with an abstract only, as reporting of methods was not sufficient to ensure the methods met the inclusion criteria. We present a detailed evaluation of limitations of the included studies in the “Limitations of Scoping Review Studies” section.

Exclusion Criteria

We excluded studies that did not examine trainee perspectives of EHR burden (→Table 2). We also excluded studies if they (1) conducted observational or descriptive studies of EHR burden or use, or quantified trainee perspectives without evaluating an intervention; or (2) did not report or include study design. We based this criterion on the inability to assume an intervention would positively or negatively

Table 2 Title and abstract review criteria, screening inclusion and exclusion criteria

Title and abstract review criteria	
Inclusion	Exclusion
Population <ul style="list-style-type: none"> • Study involves trainees as a focus (any discipline)^a ^aException to trainee only focus: Trainees are analyzed separately but studied in combination with experienced HP • Trainee perspective and experience of EHR burden is the focus (i.e., not administrative, regulatory, task completion, etc.) 	Population <ul style="list-style-type: none"> • Trainees not analyzed separately from other health professionals • “Resident” term in work applied to an <i>inhabitant</i> of a facility or geographic location, not applied to HP trainee • Different topics relating to the EHR • Different topics unrelated to informatics • Documentation not related to health care
Intervention <ul style="list-style-type: none"> • Examines an intervention or some effort to mitigate EHR burden as part of a study 	Intervention <ul style="list-style-type: none"> • No intervention to mitigate EHR burden • Only <i>describes</i> or quantifies the issue of EHR burden on trainees (without effort to mitigate) • Does not measure trainee perspective of EHR burden as part of a study
Study characteristics <ul style="list-style-type: none"> • Trainee-related outcomes including their perspective are measured and reported 	Study characteristics <ul style="list-style-type: none"> • Not a study (i.e., editorial, perspective, white paper, letter to the editor)
Full-text review criteria	
Inclusion	Exclusion
Context is related to health professional trainees AND the criteria below are met: <ul style="list-style-type: none"> • Trainee perspective on EHR burden evaluated using any form of measurement • Measurement includes EHR perspective assessed from the trainee, not indirectly through EHR metrics, EHR usage, observation, or other data (although other measures can also be captured in study outcomes) 	<ul style="list-style-type: none"> • Work is an abstract only • Primary outcome of trainee compliance, unclear impact on trainee EHR burden • Primary outcome clinical (patient-related), unclear impact on trainee EHR burden • Primary outcome patient safety, unclear impact on EHR burden • Intervention involved shifting EHR tasks to another clinical team member (i.e., shifting of burden) • Trainee data not analyzed separately from experienced HP • Trainee EHR burden not directly measured or examined • Trainee perspective regarding EHR burden was not fully assessed or reported • Manuscript not published in English

Abbreviations: EHR, electronic health record; HP, health professional.

The authors developed and conducted this screening strategy applying the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extensions for Scoping Review (PRISMA-Scr) guidance, with the results of four databases, to identify studies with interventions to mitigate EHR burden for health professions trainees. See [►Appendix 3](#) (available in the online version only) for the Search Strategies.

impact trainee EHR burden experience without assessment of the trainee perspective.

Concept Clarification

A concept clarification can be used to analyze and adapt an existing model or framework.³⁵ The first step in our concept clarification of the workflow model was grouping the scoping review corpus by workflow model categories ([►Table 4](#)). Intervention studies were categorized using the elements of the existing model, and mapped to develop a trainee workflow ([►Fig. 2](#)). Next, we mapped categories of EHR tasks, workflow steps, and interventions to the Unertl model of workflow²⁹ ([►Fig. 2](#)). The categories of studies were mapped to develop the adapted workflow model, *Trainee EHR Burden Model*, representing trainee EHR use with points of intervention for trainee EHR burden ([►Fig. 3](#)). Because of the inclusive nature of trainee categories, and differing ways trainees in different health professions fields work within the EHR, we anticipated not all stages in the adapted model would be

represented by the scoping review corpus nor would they apply to all types of trainees. Finally, we adapted the existing workflow model. We selected five domain expert coauthors with expertise in research, trainees, EHRs, HP training and experience of EHR use, and EHR burden (C.A.B., E.R.M., S.C.R., and S.T.R.) to provide expert review of the analysis of the corpus in the concept clarification phase. Expert input was obtained and incorporated through two rounds of iterative, asynchronous review. The full coauthors team achieved consensus on the categories of trainee workflow and the *Trainee EHR Burden Model*.

Results

Our four-database search yielded 820 records ([►Fig. 1](#)), which we reviewed and iteratively screened to achieve the scoping review corpus of 11 eligible studies for extraction. Thirty-five of 69 studies at the full-text stage were excluded as only an abstract was available. We manually identified

Table 3 Characteristics of included studies with interventions aimed at mitigating trainee EHR burden

Study (year published)	Work conducted (years)	Country	Participant reported in source	Participants per study arm	Health professional	Objective category ^a	Methods
Ash et al (1999) ³²	Before 2000	The United States	Yes, but only for some study aims	Observation Unclear, more than nine across sites, number of sites not specified Focus groups two focus groups across sites, number of participants and sites not specified	Physician	(1) Examine trainee perspective or experience of EHR burden	Direct observation; qualitative (including open-ended survey or interview)
Balch et al (2022) ⁴³	Since 2020	The United States	Yes	Total participants 34 interns, 20 senior residents. Trainees are considered individuals and in teams Intervention <ul style="list-style-type: none"> • Intervention group: One team, 13 interns, 7 senior residents rotated in/out of team over study • Control groups: Two teams, total of 21 interns and 13 senior residents rotated in/out of team over study Time-motion study of rounding 14 intern days (160.5 hours) <ul style="list-style-type: none"> • Intervention group: 7 intern days • Control groups: 7 intern days Number of participants observed per rounding not specified Audit log study Then survey and audit log data collected Postintervention survey Participants not specified	Physician	(2) Patient safety or regulatory compliance	Quant survey; quant audit logs; direct observation
Bernstein et al (2010) ⁴⁴	2001–2010	The United States	Yes, but only for some study aims	Survey 31 of (52%) pre/post survey Log data Participants not specified	Physician	(1) Examine trainee perspective or experience of EHR burden	Quant audit logs; qualitative (including open-ended survey or interview)
Crotty et al (2018) ⁴⁹	2011–2015	The United States	Yes	Questionnaire <ul style="list-style-type: none"> • 133 of 159 (84%) precurriculum questionnaire • 122 of 159 (77%) postcurriculum and implementation questionnaire • 108 of 159 (68%) linked pre- and post-responses <ul style="list-style-type: none"> • 89 of 94 (95%) precourse survey • 66 of 94 (70%) postcourse survey 	Physician	(1) Examine trainee perspective or experience of EHR burden	Quant survey
Frenzel (2010) ⁴⁵	2001–2010	The United States	Yes		Pharmacist	(1) Examine trainee perspective or experience of EHR burden	Quant survey; direct observation

Table 3 (Continued)

Study (year published)	Work conducted (years)	Country	Participant reported in source	Participants per study arm	Health professional	Objective category ^a	Methods
Johnson and Roth (2021) ⁴⁰	2016–2020	The United States	Yes, but only for some study aims	Training Number of participants not specified, of 26 invited Survey • Iterative Pretraining Surveys: Not specified • Iterative Posttraining Surveys: Not specified	Physician	(3) Trainee EHR use/usability	Quant survey
Lanier et al (2017) ⁴⁶	2011–2015	Switzerland	Yes, but only for some study aims	Survey • 17 of 27 (63%) preintervention survey • 17 of 27 (63%) postintervention survey Video-recorded encounters • 142, number of distinct persons participating in recorded sessions not specified • 73 preintervention recordings • 69 postintervention recordings	Physician	(1) Examine trainee perspective or experience of EHR burden	Quant survey; direct observation
Lapointe et al (2018) ⁴⁷	2016–2020	The United States	Yes, but only for some study aims	Survey 25 of the unspecified invited participants	Physician	(1) Examine trainee perspective or experience of EHR burden	Quant survey
Nokes et al (2012) ⁴¹	2011–2015	The United States	Yes	200, mandatory completion after course-related education module	Nurse	(1) Examine trainee perspective or experience of EHR burden	Quant survey
Walsh and Stetson (2012) ⁴⁸	2011–2015	The United States	Yes, but only for some study aims	Survey 62 of 130 (48%) postimplementation survey	Physician	(3) Trainee EHR use/usability	Quant survey
Zoghbi et al (2018) ⁴²	2016–2020	The United States	Yes	Study 11 of 15 (73%)	Physician	(1) Examine trainee perspective or experience of EHR burden	Quant survey; quant audit logs; direct observation

Abbreviation: EHR, electronic health record.

The authors extracted study characteristics, including location of study by country, study participants, and field of health professions trainees, as well as methods applied to study the intervention.

^aRefers to measured primary objective in the study, that is, (1) examine trainee perspective or experience of EHR burden, (2) patient safety or regulatory compliance, or (3) trainee EHR use/usability.

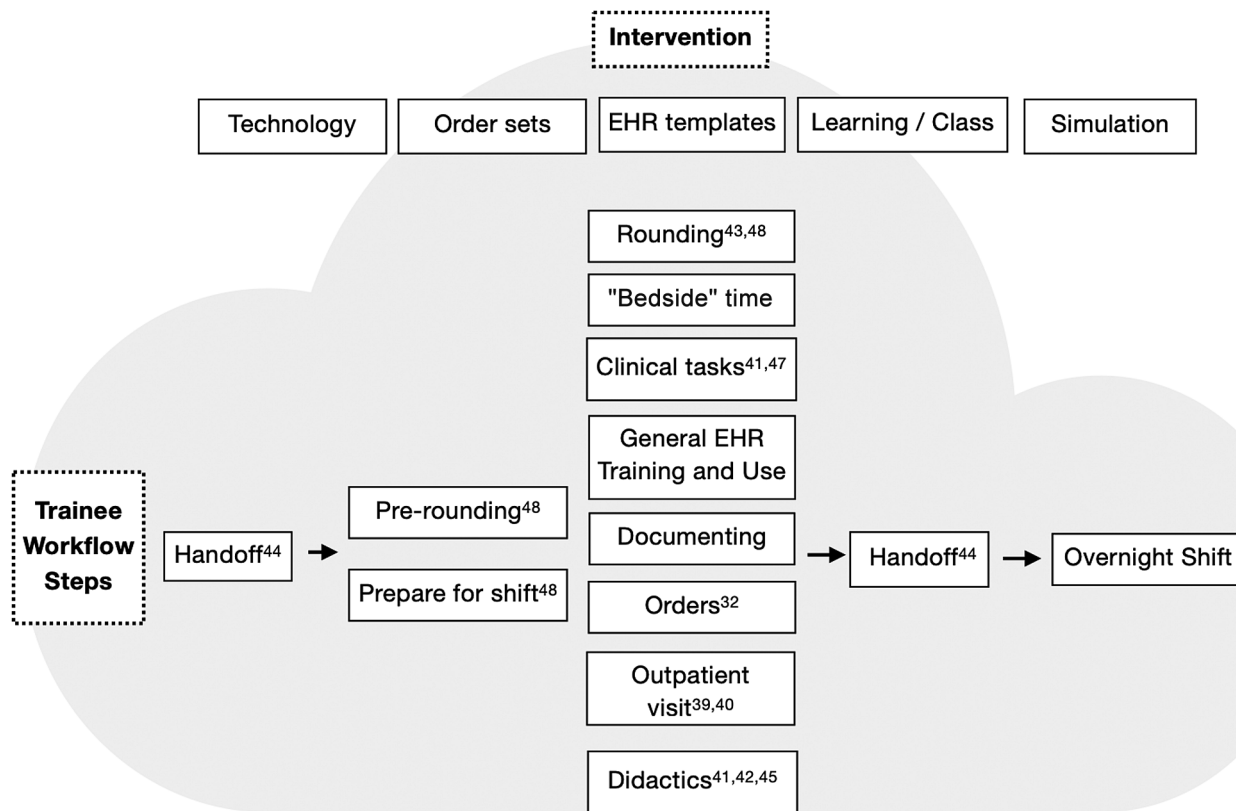


Fig. 2 The scoping review corpus workflow map. Source: The authors' analysis of the scoping review corpus, categorizing EHR-related tasks that can contribute to EHR burden for health professional trainees. Interventions in the included studies were also examined and categorized. EHR, electronic health record.

each available data point in 11 studies selected for extraction (→Table 3). Individual EHR tasks were often the focus of the intervention (e.g., computerized order entry, entering orders or documentation),^{32,39–42} while other studies focused on shared tasks (e.g., team interdisciplinary rounds, handoff at shift change, general workflow during the day across team members, and interdisciplinary team communication via text paging).^{43–48} Five of the 11 studies were conducted prior to 2012,^{32,39,41,44–46} although they still had relevance to the development of the workflow model. These earlier studies examined interventions ranging from handoffs at shift change,⁴⁴ and implementation and training on EHR use,^{32,39,41} to the addition of tablets to morning rounds.⁴⁵

All corpus studies included trainees exclusively in their intervention and analyses. Nine studies focused on physician trainees, ranging in training stage from medical student through residency and post-residency. One study focused on nursing students, and one study examined pharmacy student experiences (→Table 4). Quantitative survey methods were most commonly applied ($n=10$), either alone ($n=5$) or in combination with other quantitative or qualitative methods ($n=5$). Four studies employed direct observation as one arm of the study design, while two studies employed qualitative methods to capture trainee experiences of EHR burden. Most studies reported their work was evaluated and either granted exemption or considered to be a quality improvement study by institutional review boards (IRBs). Several studies did not report IRB status.

Concept Clarification: Study Categories and Trainee EHR Burden Model

We then used a concept clarification³⁵ to develop the *Trainee EHR Burden Model*, which identifies points of the trainee EHR workflow to consider for interventions to alleviate EHR burden. Most studies from the scoping review mapped to model elements and points of interventions in the inpatient setting (→Fig. 2), resulting in an adapted model that best applies to the inpatient trainee workflow (→Fig. 3). Several logical points in trainee workflow not present in the included studies were added to the model (in →Fig. 2, see boxes without superscript citations). Intervention categories presented in →Figs. 2 and 3 were limited to those identified in the studies.

Included Sources Examined by Category of Intervention in Trainee Electronic Health Record Workflow

Studies of Interventions on Training and Evaluating Electronic Health Record Use

Six studies, published between 1999 and 2018, examined the impact of training interventions or assessing trainees while using EHRs, in a variety of settings and clinical scenarios (e.g., inpatient, ambulatory, operative/surgical setting, pharmacy).^{32,40,42,45,46,48} Five of six studies had a physician trainee focus, with one study of pharmacy trainees.⁴⁵ Publications reported interventions ranging from supporting order entry,³² observing and training on ambulatory EHR use with patients present,⁴³ and expanding EHR exposure and

Table 4 Categories of interventions and characteristics of studies aiming to mitigate Trainee EHR Burden

Study (year published)	Methods	Objective category	Objective (Prose)	Extracted point of intervention or activity [categorizing model element step]
Ash ^P (1999)	Direct observation; qualitative (including open-ended survey or interview)	(1) Examine trainee perspective or experience of EHR burden	From Abstract: "Objective: Describe the perceptions of house staff physicians about their experience using computerized physician order entry (POE) in hospitals. From Methods: Qualitative study using data from participant observation, focus groups, and both formal and informal interviews."	Computerized order entry (CPOE) [Orders]
Balch ^P (2022)	Quant survey; quant audit logs; direct observation	(2) Patient safety or regulatory compliance	From Abstract: "Objective: To improve resident efficiency through a novel workflow using mobile laptops and modified rounding-in-flow."	Morning interdisciplinary inpatient rounds [Prerounding, Rounding]
Bernstein ^P (2010)	Quant audit logs; qualitative (including open-ended survey or interview)	(1) Examine trainee perspective or experience of EHR burden	From Introduction: "We therefore predicted that the creation and introduction of an EMR-generated physician sign-out tool would be well received, given its automated data transfer features and remote accessibility. This article describes the impact of implementing such a tool at our hospital on physician perception of workflow and satisfaction with the sign-out process." From Methods: "To determine the effect of sign-out document functionality within the EMR, we conducted a cohort study using historical controls at the main campus of LPCH. LPCH is a 272-bed tertiary care women's and children's hospital affiliated with Stanford University and is located in Palo Alto, California."	Handoff or sign-out at shift change [Handoff]
Crotty ^P (2018)	Quant survey	(1) Examine trainee perspective or experience of EHR burden	From Abstract: "We assessed anticipatory attitudes about open notes and explored factors influencing residents' propensity toward note transparency." From Introduction: "As open notes spread nationally, we sought to understand residents' perceptions of anticipated risks and benefits to their patients and to themselves, in terms of workload and education. We anticipated that a better understanding of these issues could help inform residency programs in the transparency era."	Patient portal communication [Outpatient visit]
Frenzel ^P (2010)	Quant survey; direct observation	(1) Examine trainee perspective or experience of EHR burden	From Abstract: "Objective. To develop, implement, and evaluate the use of electronic medical records (EMRs) in disease state management activities to teach pharmacy students patient-centered care skills."	EHR training and EHR use, during disease-based learning [Didactics]
Johnson ^P (2021)	Quant survey	(3) Trainee EHR use/usability	From Introduction: "Our hypothesis was that increased peer-led EHR training could result in increased efficiency, thereby decreasing burnout and improving resident wellness." From methods: "Within our Family Medicine residency over November 2019 to February 2020, we implemented two major interventions designed to educate our 26 residents on our outpatient EHR (Athena) and thereby increase efficiency and improve wellness."	EHR training and EHR use in outpatient setting [Outpatient visit]

(Continued)

Table 4 (Continued)

Study (year published)	Methods	Objective category	Objective (Prose)	Extracted point of intervention or activity [categorizing model element step]
Lanier ^P (2017)	Quant survey; direct observation	(1) Examine trainee perspective or experience of EHR burden	From Introduction: "The aim of our study was to assess the impact of training on EHR-related communication skills of residents with real patients during the first 10 min of the clinical encounter. We chose to focus on the first 10 min because we have observed that our residents tend to use the EHR mainly at the beginning of the encounter. In particular, we wanted to explore how EHR use changed when patients introduced psychosocial issues." From Abstract: "We developed and implemented a HIPAA-compliant, EHR-integrated text paging at a busy 591-bed urban hospital. Access was granted to unit clerks, nursing staff, case managers, and physicians. Senders could either send a traditional telephone number page or a text page through our EHR. The recipient could then either acknowledge receipt of the page or take appropriate actions. Afterward, Internal medicine residents were polled on overall satisfaction difference between basic phone based numeric paging and the enhanced EHR text paging system." From Methods: "In an attempt to foster improved communication channels, we developed and implemented a new text-paging system to supplement the current traditional system. Residents and IT staff worked together to create text paging through our existing EHR to send a HIPAA-compliant and secure text page."	EHR training and EHR use during outpatient encounter, including interaction with patient [Outpatient visit]
Lapointe ^P (2018)	Quant survey	(1) Examine trainee perspective or experience of EHR burden	From Abstract: "Modules were developed to teach EHR skills using a case study of a homebound person requiring wound care and the Medicare-required OASIS documentation system. This article describes the development and implementation of the module for an upper-level baccalaureate nursing program located in New York City." From body of manuscript: "Improved documentation of home health care through nursing student educational intervention." "External funding supported the development of an educational innovation through a partnership between a home care agency staff and nursing faculty. Modules were developed to teach EHR skills using a case study of a homebound person requiring wound care and the Medicare-required OASIS documentation system. This article describes the development and implementation of the module for an upper-level baccalaureate nursing program located in New York City."	Interdisciplinary team communication, inpatient, [Clinical tasks]
Nokes ^{RN} (2012)	Quant survey	(1) Examine trainee perspective or experience of EHR burden	From Abstract: "Modules were developed to teach EHR skills using a case study of a homebound person requiring wound care and the Medicare-required OASIS documentation system. This article describes the development and implementation of the module for an upper-level baccalaureate nursing program located in New York City." From body of manuscript: "Improved documentation of home health care through nursing student educational intervention." "External funding supported the development of an educational innovation through a partnership between a home care agency staff and nursing faculty. Modules were developed to teach EHR skills using a case study of a homebound person requiring wound care and the Medicare-required OASIS documentation system. This article describes the development and implementation of the module for an upper-level baccalaureate nursing program located in New York City."	Education around required documentation in home health care setting, [Clinical tasks]

Table 4 (Continued)

Study (year published)	Methods	Objective category	Objective (Prose)	Extracted point of intervention or activity [categorizing model element step]
Walsh ^P (2012)	Quant survey	(3) Trainee EHR use/usability	From Introduction: "The Department of Medicine at Columbia University Medical Center provided tablet computers (Apple iPads) to medicine house staff to provide mobile access to the necessary tools of the EHR. The integration of tablet computers into the clinical workflow as well as obstacles to the use of these devices will be discussed." From Methods: "The iPads provided a new interface to browse, search, and download these articles. This application was also deployed on devices at launch. A subjective survey was administered six months after provision of the Apple iPads on the house staff service."	Evaluation of workflow and general EHR use with addition of new technology (tablet) [Rounding, Clinical tasks]
Zoghbi ^P (2018)	Quant survey; quant audit logs; direct observation	(1) Examine trainee perspective or experience of EHR burden	From Abstract: "We hypothesized that exposure to these videos would lead to increased resident efficiency and confidence in performing essential perioperative tasks, ultimately leading to improved clinical performance." From Introduction: "We hypothesized that exposing our interns to these novel 'how to' videos would enhance interns' clinical performance on the simulated emergencies and improve their efficiency, confidence, and task completion rate on performing these key perioperative EMR tasks. To evaluate our approach, we assessed the time it took our interns to perform key EMR tasks before and after having viewed the 'how to' videos through our web application platform. We also assessed their use of these skills during a simulated perioperative emergency. Finally, we surveyed their level of confidence in executing these tasks both before and after exposure to the videos. Our aim was to demonstrate that these videos, deployed through an easily accessible mobile platform, could serve as an efficient adjunctive learning tool that simultaneously provides learners with flexibility while also minimizing the need for instructional personnel and resources."	EHR training and EHR use, simulated EHR tasks including instructional videos [Clinical tasks]

Abbreviation: EHR, electronic health record.

In terms of the domain of study subjects for column "Study," P, physician; Pharm, pharmacist, and RN, nurse.

The authors extracted both the study objectives in categories to align with the existing workflow model. Study objectives and narrative text in prose format were extracted from each study in the authors' wording. The scoping review included studies ($n = 11$) that were each categorized in terms of the point of intervention or EHR activity that would map to the existing workflow model.

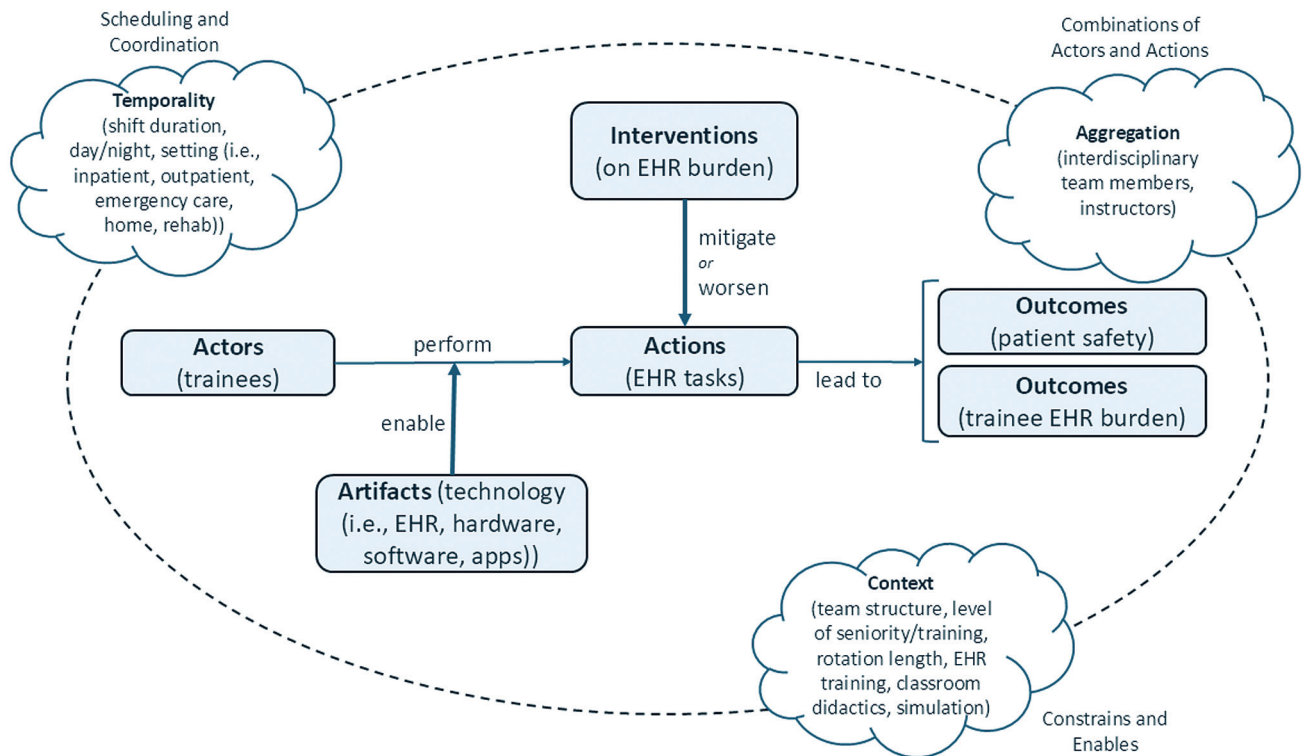


Fig. 3 Trainee EHR Burden Model—concept clarification of Unertl workflow model for trainee EHR burden interventions.²⁷ Source: The authors' analysis of the scoping review corpus, categorized included studies and then mapped those categories to the Unertl workflow model to adapt the model to the health professional trainee workflow (*Trainee EHR Burden Model*), with recognition of potential points of intervention on the HP trainee workflow to mitigate the EHR burden. EHR, electronic health record; HP, health professional.

training for pharmacy trainees.⁴⁵ One study⁴² applied a simulated EHR environment (e.g., educational video interventions), with the goal of improving surgical resident trainee efficiency and confidence in core EHR tasks; surveys measured the trainee experience of EHR task completion and confidence levels after simulated procedures. One study⁴¹ applied small incremental training modules related to EHR use and iteratively evaluated trainee experience, which was unique compared with other interventions.

Study of Real-Time Electronic Health Record Use during Rounds

One controlled mixed methods study⁴³ (time-motion study with a postintervention survey) included the introduction of a novel mobile laptop and associated workflow design to shift emphasis to order-entry and team EHR use during rounds, with the goal of reducing documentation time and improving trainee EHR use experience during the remainder of the day. While the stated primary focus was impacting patient safety, both trainee perspectives of EHR use and quantitative EHR use data were analyzed. One participant team was exposed to the intervention workflow and tablet, and two teams served as comparison or control arms, using their usual institutional workflow.⁴³

Studies Involving Trainee/Patient and Trainee/Interdisciplinary Team Communication

Two studies examined trainee/patient communication,^{39,46} although we reported results of Lanier et al (2017)⁴⁶ under

the “Concept clarification: Study categories and Trainee EHR Burden Model” section because their focus was also on improving EHR use through training. One source applied pre-post-measurements of trainee perspectives and experience of a previously designed curriculum³⁹ to prepare trainees for patient portal communication prior to functionality implementation.⁴⁹ Trainee attitudes of workload and general message burden were assessed both in anticipation and after the use of the portal elicited.⁴⁹ A quantitative survey⁴⁷ was combined with EHR use data, to evaluate a Health Insurance Portability and Accountability Act (HIPAA)-compliant “EHR-integrated text paging” system intervention in an urban hospital emergency department, designed to improve the quality of information shared with the trainee.⁴⁷ Postimplementation, trainees reported the ability to focus on learning activities without interruption.

Studies of Handoff Interventions

One qualitative cohort study with historical controls⁴⁴ introduced an “EMR-generated physician sign-out tool,” conducting open-ended surveys and select interviews 6 months after implementation of the handoff tool intervention to pediatric resident trainees. Trainee perceptions of the impact on workflow included increased satisfaction with the sign-out process and reduced time devoted to what the authors reported as “redundant data entry.” The authors noted their primary motivation was enhancing the safety of patient handoffs, but measured the potential benefits for trainee workflow.

Studies with Home Care Documentation Focus

One survey study ($n = 200$ nursing students) assessed an educational curriculum intervention designed to improve home care nursing student documentation.⁴⁷ Following case-based modules, developed to teach nursing students specific documentation skills, postcompletion surveys were administered.

Limitations of Scoping Review Studies

Most studies included in this scoping review reported a variety of logistical and methodological limitations, utilizing heterogeneous terms to describe study limitations. Several studies reported characteristics of physician trainees rotating between units and across teams as a challenge in study design. The trainee rotations and time on a given service were reported by several studies, including the impact of interdisciplinary or group EHR utilization when designing a control or comparison group. Sample sizes were reported as a limitation in several studies, due to a small number of trainees in a program, and/or because trainees had limited time and availability to participate in intervention research. While participant numbers were reported by most studies, the difference between those invited and those who participated was not reported in several studies.

Discussion

We identified 11 intervention studies that aimed to mitigate trainee EHR burden, and assessed and reported the trainee perspective of the intervention (→Table 3). Study methods included qualitative, quantitative, and mixed methods assessments of interventions at various points in the trainee workflow. We developed *The Trainee EHR Burden Model* which can help visualize points in trainee workflow that EHR burden interventions might address. Many *Trainee EHR Burden Model* elements did not have study interventions that mapped to the element, and as previously noted, many studies were over a decade old. The model offers an opportunity to take a broader view of how interventions in future work could be targeted to fit within the trainee workflow while identifying which elements are currently understudied. Gaps in the literature were visualized more clearly by mapping existing interventions to this new model.

Few studies considered how the intervention fit within the trainee EHR workflow, spanned multiple workflow steps, or studied broad changes to the format or usability of how trainees interact with the EHR. This may be related to complex ways that interdisciplinary teams use EHRs⁴³ as well as institutional environments determining many facets of EHR use that studies acknowledged as limitations.

We identified many studies that presented excellent descriptions of EHR burden or quantifications of its impact, which did not present potential interventions. While a systematic analysis of the excluded studies was not performed, we observed that a large number of *excluded* studies described the EHR burden or quantified its impact, but did not offer an intervention to improve trainees' EHR burden.^{12,26,50–52} This anecdotal observation aligns with prior

work on experienced HPs that demonstrated more description in the literature of the impact of EHR burden, than solutions to address it.^{6,53}

This scoping review highlights the challenges studies involving trainees often face, including (1) rotation of trainees between units or service lines affecting exposure to interventions; (2) learning the EHR while learning clinical fields⁴²; and (3) opportunities and challenges related to frequent handoffs between trainees, colleagues, and teams.⁴⁴ Teaching trainees how to interact with the patient and computer simultaneously was a novel approach applied by Lanier et al (2017),⁴⁶ with a goal of affecting both trainee EHR interactions and patient experience. One study required the participation of all students who rotated through a class,⁴¹ with the potential to introduce bias in survey responses.

Gaps and Limitations

Gaps and Limitations of Scoping Review Included Studies

Despite a broad and deliberate search strategy to elicit studies for a broad range of HP fields, there was a general lack of studies addressing the trainee EHR burden. We identified few interventions to mitigate EHR burden ($n = 11$) and few health professions represented (i.e., physician, nursing, and pharmacy), potentially limiting the model applications to other fields. Included studies went beyond descriptions of the burden of EHR use, and the ways in which EHR burden impacts trainees, by offering interventions that often approached a narrow aspect of EHR use or the trainee workflow. We noted the majority of included studies had small sample sizes, focused on the inpatient setting ($n = 6$), and focused on physician trainees ($n = 9$). The reporting of limitations in several studies utilized heterogeneous terminology, rendering generalizations across studies more challenging. Studies frequently reported that the structure of health professions training, including trainee availability or lack thereof, impacted research participation. Several interventions were integrated into a required clinical rotation or a curriculum, so several studies might be considered through a lens of quality improvement. The rationale for the selection and mix of research methods was less frequently reported by included studies.

Nearly half of the studies ($n = 5$) were conducted prior to 2012.^{32,39,41,44–46} The target of the intervention and the rationale for intervention selection remain of interest in the categorization and model adaptation we performed, however the interventions themselves may have reduced applicability to current workflows.

Limitations of This Study

We performed a broad four-database search strategy. The lack of MeSH terms for EHR burden or documentation burden can affect search strategies in this domain. We were inclusive of a wide range of potential synonyms and terms for EHR burden. Many studies in the corpus employed quasi-experimental results, so our analyses and extraction of studies captured the topics of interest to the included studies and

EHR burden measurements. We anecdotally observed that a large number of excluded studies in nursing, pharmacy, and other HPs presented more observational and descriptive data.^{16,33,54} A focus on intervention studies may not have resulted in a complete list of trainee EHR workflow, steps which may impact the precision of the resulting model. We included studies from trainees at all stages of training in their health profession. All included studies except one were conducted in the United States,⁴⁶ although our search strategy included all English language publications. Lastly, we intentionally did not date-delimit the searches, however as anticipated there is an inflection point after wider implementation of EHRs with federal legislation.¹⁷ Therefore, some earlier studies in our corpus explore functionalities and interventions that may now be integrated into available EHR products and may not require separate consideration. We identified the timeframe of these studies as a gap in the current literature, with nearly half of the studies published over 10 years ago. We note that these topics focused on in the past warrant updated exploration now, but thoughtful consideration of the original studies is still worthwhile.

How Can the Identified Interventions Impact Future Research?

We recognize that some of the interventions aiming to mitigate EHR burden in older studies may not be relevant today. For example, sign-out tools⁴⁴ are now integrated in some EHRs, so a separate functionality may not be necessary. However, the fact that handoffs were identified as a point of interest may still be of interest for generation of the *Trainee EHR Burden Model*, given the role of handoffs in improving patient safety. Similarly, an EHR-integrated paging system⁴⁷ may be less relevant today than when this study was published in 2018, but team communication and the impact on task-switching remains a point of interest.⁵⁵ Several interventions involved additional training on existing systems, or assessing functionalities that were implemented in support of patient care. Limited resources were cited by several studies as both a limitation to wider technology adoption⁴³ and the impacting studies with large sample sizes.

Increasing available hardware or adding access to mobile devices was offered by several interventions. However, if usability is a similar EHR burden concern for trainees as for experienced HP,⁶ then increasing access to the same EHR may not address the greater opportunity to address what might be unique about how trainees interact and consume EHR data. We reflect some user-centered design approaches might require institutional or interdisciplinary team level of intervention (e.g., interventions that approach tasks of documenting, team-based communication, and order entry could reduce the challenge of redundancy reported by a number of studies).

Trainee EHR Burden Model: Implications and Next Steps

Modeling clinical workflow can help identify usability opportunities during EHR implementation.⁵⁶ We developed the *Trainee EHR Burden Model* with the aim of providing a framework for researchers, operational leaders, and EHR

designers to develop interventions to mitigate trainee EHR burden. The Unertl model²⁹ has strengths in terms of clearly identifying a workflow for HPs, and model elements aligned well with the development of the adapted *Trainee EHR Burden Model*. We recognize the limited number of studies identified to categorize and map to adapt the model. However, given the current lack of a model of EHR burden for trainees, this work could serve as a foundation. When compared with interventions available for experienced HP, we identified gaps for trainees. For example, we noted a lack of usability and human factors engineering applied in solution development to improve usability and few interventions tried to improve presentation of clinical data to trainees.

Further intervention studies in different clinical settings, team structures, and health professions could enable the development of Trainee EHR Burden Models applied to those settings. A priori, we anticipated this model could help researchers be more systematic and deliberate in designing future interventions aiming to mitigate trainee EHR burden. Many included studies did not describe a rationale for picking the point of workflow examined. We see the opportunity for the *Trainee EHR Burden Model* (→ Fig. 3) and its elements to encourage future studies to situate the measurement and research of trainee EHR burden within the context of trainee workflow. For example, if developing an intervention on entering orders, researchers and operational leaders could take into account the *context* (e.g., level of seniority and training experience, the potential role of simulation), the *aggregation* (e.g., team structure), the *temporality* (e.g., clinical setting and day/night shift), and measure potential outcomes (e.g., patient safety and trainee experience of EHR burden).

Conclusion

We identified interventions that mitigate health professions trainee EHR burden, and then developed an adapted *Trainee EHR Burden Model*, building on an existing workflow model.²⁹ Further studies are needed to develop interventions for model elements that have not yet been studied. This model could be further adapted to other clinical settings and health professions. We recognize that despite a broad search strategy with deliberate sampling inclusive of all trainees, we did not identify interventions for a range of health professions, and further work is warranted to understand potential interventions in those fields. We consider this scoping review a call to action for further studies to explore interventions that could mitigate EHR burden.

After Reading This Work

Readers will understand the concept of EHR or documentation burden affects health professions trainees and be able to identify how a model of trainee EHR workflow can support development of interventions to mitigate trainee EHR burden.

Clinical Relevance Statement

From this scoping review, we identified a few interventions targeted to mitigate HP trainee EHR burden. Of the included

studies, many used quasi-experimental design, and they had potential limitations including generalizability, measurement bias, selection bias, and lack of control or comparator groups. We adapted an existing workflow model to develop the Trainee EHR Burden Model. We categorized potential points of intervention to mitigate EHR burden for trainees in the concept clarification phase. Research is needed to evaluate interventions at various stages of the HP trainee workflow.

Multiple-Choice Questions

1. Is the following statement true or false? “Health professions trainees perform similar EHR tasks during their training, in preparation for postgraduate careers.”
 - a. True, most health professions trainees can perform and access all of the EHR tasks they will need after they complete their training.
 - b. False, trainees are often not allowed to access the EHR during training.

Correct Answer: The correct answer is option b. We found that trainee access to the EHR varies across health professions, where many trainees do not have full access to perform the EHR tasks that they will complete once they have finished their training program. In particular, pharmacy trainees may have reduced access to the same EHR tasks they may need to perform after entering the workforce. A number of the EHR burden-mitigating interventions we identified were focused on applying specially designed curricula⁴⁵ or simulation training to the EHR setting, to help trainees prepare for their postgraduate careers.

2. For which of the following health professions categories are the unique aspects of trainee EHR burden well-understood? (Select all that apply)
 - a. Nursing
 - b. Physician
 - c. Allied health professionals
 - d. Pharmacy
 - e. None of the above.

Correct Answer: The correct answer is option e. EHR burden⁶ is well-understood for an experienced HP, including the links to stress and burnout. Trainees in health professions are noted to be different than experienced HPs, as they are both learning their chosen profession while performing EHR tasks. EHR burden has been described as existing in HP trainee populations,⁴⁷ but few studies identify solutions or interventions to mitigate trainee EHR burden. We identified 11 interventions through a scoping review (→Table 4), and mapped these studies to develop an adapted workflow model of trainee inpatient activities (see →Fig. 2). Future work is needed to develop targeted interventions to mitigate trainee EHR burden, addressing the time-tradeoff for other training-related activities due to EHR burden.

3. Which of the following factors are unique to health professions trainees and *may* impact the study design of interventions to mitigate trainee EHR burden?
 - a. Scheduling of trainee rotations
 - b. EHR tasks trainees' access during training
 - c. HP roles on the clinical team
 - d. The size of a health professions training program
 - e. All of the above.

Correct Answer: The correct answer is option e. Studies included in the scoping review reported a variety of factors that impacted their study designs, related to HP trainee factors. The size of a training program, the variable availability of HP trainees during different shifts and days, and the variable access to EHR tasks and roles were cited. Further, as trainees are functioning within an interdisciplinary team, several studies that used a control group needed to control the level or unit of the whole team because of trainee rotation schedules.

Authors' Contributions

D.R.L. conceptualized the project with the advice of D.W. and V.M., as her independent study (2021, V.M.) and capstone (2023–2024, D.W. and V.M.) faculty advisors. The authors (D.R.L., D.W., and A.H.) designed the search strategies. D.R.L. and D.W. independently evaluated the titles and abstracts for inclusion and exclusion criteria. Data were extracted by D.R.L. and D.W. in joint sessions, due to the small corpus. All authors contributed to the concept clarification phase. The manuscript was drafted by D.R.L., with detailed feedback from D.W. and V.M. for early drafts and all coauthors for later drafts. The workflow model was adapted by D.R.L. and D.W., which was then reviewed in detail by expert coauthors (C.A.B., E.R.M., S.C.R., and S.T.R.). The complete manuscript (drafts and final version) was reviewed in detail by all the coauthors.

Protection of Human and Animal Subjects

Human and/or animal subjects were not included in the project.

Data Availability Statement

The data underlying this article including the detailed search strategy are available in the article and its online supplementary appendix information.

Disclaimer

The contents of this manuscript represent the view of the authors and do not necessarily reflect the position or policy of the U.S. Department of Veterans Affairs or the United States Government.

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Conflict of Interest

The authors have no conflicts of interest to report related to this work. E.R.M. reports grants and contracts from NIH, the Agency for Healthcare Research and Quality (AHRQ), and the American Medical Association unrelated to this analysis. E.R.M. also reports receiving stock options/equity for serving as an advisor for Iolite Health, Inc. S.C.R. reports grant funding from AHRQ, National Institute of Nursing Research (NINR), and a leadership role for the American Medical Informatics Association (AMIA; Chair of AMIA's 25 × 5 Task Force) unrelated to this analysis. V.M. reports funding from NIH and AHRQ, unrelated to this analysis.

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