Review

A systematic review of contributing factors of and solutions to electronic health record–related impacts on physician well-being

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ABSTRACT

Objective: Physicians often describe the electronic health record (EHR) as a cumbersome impediment to meaningful work, which has important implications for physician well-being. This systematic review (1) assesses organizational, physician, and information technology factors associated with EHR-related impacts on physician well-being; and (2) highlights potential improvements to EHR form and function, as recommended by frontline physicians.

Materials and methods: The MEDLINE, Embase, CINAHL, PsycINFO, ProQuest, and Web of Science databases were searched for literature describing EHR use by physicians and markers of well-being.

Results: After reviewing 7388 article, 35 ultimately met the inclusion criteria. Multiple factors across all levels were associated with EHR-related well-being among physicians. Notable predictors amenable to interventions include (1) total EHR time, (2) after-hours EHR time, (3) on-site EHR support, (4) perceived EHR usability, (5) in-basket burden, and (6) documentation burden. Physician recommendations also echoed these themes.

Conclusions: There are multiple complex factors involved in EHR-related well-being among physicians. Our review shows physicians have recommendations that span from federal regulations to organizational policies to EHR modifications. Future research should assess multipronged interventions that address these factors. As primary stakeholders, physicians should be included in the planning and implementation of such modifications to ensure compatibility with physician needs and clinical workflows.

Key words: electronic health record, physician burnout, subjective well-being

INTRODUCTION

Recent reviews show physician burnout has an overall prevalence ranging from 0% to 80.5%,[1] with an average across studies of 44%.[2] Physician burnout has become an important area of interest for healthcare administrators because it affects both physicians (via increased rates of depression, substance use, reduced work hours,

leaving medicine)[3–10] and their patients (eg, decreased quality of care).[11–14] Cost analyses suggest that the price of replacing a physician who quits due to burnout or job dissatisfaction ranges from $250 000 to $1 million per physician,[15,16] or about $4.6 billion in aggregate annually.[17] Indeed, there have been calls to revise the "triple aim" to include a fourth aim promoting clinician job satisfaction.[18–22]

One influential model, the Stanford Model of Professional Fulfillment, describes 3 components of well-being: personal resilience (ie, self-care strategies), culture of wellness (ie, the supportiveness of the work environment), and efficiency of practice (ie, the policies and systems in place within the organization which affect the practice of medicine).[23] Though many wellness interventions have focused on increasing personal resilience, those targeting practice efficiency are viewed as likelier to result in meaningful improvements to physician well-being. One area of practice inefficiency frequently noted by physicians is the cumbersome nature of the electronic health record (EHR), which many view as interfering with workflow and adding "busywork" to the job. Consequently, there has been an increase in the number of studies investigating how EHR use influences physician well-being. Because this literature has grown substantially in recent years, there is a need to summarize what we know about the association between physician EHR utilization and well-being. Given the important insights of frontline staff regarding EHR problems and potential solutions,[24,25] studies highlighting physician views provide crucial information to address specific challenges.

Our review has 2 objectives: (1) to assess the multilevel (organizational, physician, and information technology [IT]) factors associated with EHR-related impacts on physician well-being and burnout and (2) to identify promising potential EHR improvements, as recommended by physicians. Specifically, we will summarize the current evidence base regarding predictors of and potential solutions to EHR-related physician burnout, which may be useful for health system leaders, policymakers, and EHR vendors seeking to improve physician well-being.

MATERIALS AND METHODS

A systematic review was completed per the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines.[26] Pre-registration occurred with PROSPERO on November 4, 2019.

Search strategy

PubMed was used to identify all peer-reviewed literature and gray literature (eg, conference abstracts) that studied EHRs, physicians, and well-being. In addition, the Embase, CINAHL, PsycINFO, ProQuest, and Web of Science databases were searched to identify additional relevant studies. Databases were searched on October 31, 2019, using controlled vocabulary and subject headings and truncated and phrase-searched keywords in the title or abstract (as each database allowed). For instance, our search terms for well-being included concepts like "burnout," "stress," and "professional satisfaction." Detailed information on the search strategy is found in Supplementary Appendix 1. Each study included for full-text screening was backward and forward searched to identify additional citations. Finally, we added 6 studies to the list for screening based on personal contacts' recommendations. Duplicate studies were elimi-

nated from the list. Newer studies identified during the peer review process were added in August 2020.

Study selection

We included studies that examined broad EHR use or specific EHR elements (eg, in-baskets). We focused on studies that either measured burnout directly or assessed proxy measures of burnout (eg, frustration). We refer to this collection of variables in our reviewed studies as "EHR-related indicators of physician well-being." Table 1 displays each variable that falls under this construct and its definition. These variables were determined a priori with the assistance of a librarian, an IT manager (O.T.N.), and a clinical psychologist who specializes in physician well-being (L.J.M.). Broadly, these measures cover individual responses to the EHR (eg, satisfaction), health IT factors (eg, EHR usability) that impact efficiency of practice, and external factors influencing health IT use (eg, documentation regulations). Figure 1 presents how each measure fits into the overall picture of driving burnout as adapted from another model.[27]

Final inclusion criteria included (1) English language, (2) empirical study, (3) based in the United States, and (4) examined physician well-being. We limited analyses to studies conducted in the United States due to systemic differences in EHR documentation among countries (eg, documentation length in the United States is about 4 times longer than other countries).[28] Clinicians may interact with the EHR differently depending on their profession[29,30]; therefore, we limited the present review to studies involving physicians and physicians-in-training (eg, residents) to minimize the impact of profession on our results. Studies that combined physician data with nonphysicians were excluded.

A pair of reviewers independently screened all titles and abstracts to assess for relevancy. Articles identified for further reading were independently screened by pairs of reviewers to assess each article against the inclusion criteria. Reviewers agreed on inclusion in 7343 of 7388 (99.39%) instances. When disagreement occurred between the 2 reviewers, a third reviewer read the article and provided input.

Data extraction and synthesis

For included studies, we noted study design, medical specialties examined, sample size, and relevant findings. We adapted a previously developed risk of bias assessment for use in our review[31] and assessed for (1) thorough description of participant eligibility criteria, (2) bias from funding source, (3) indirectness bias from studying a sample different from the intended population, and (4) indirectness bias from participants commenting on EHRs they never directly used. For the qualitative studies, we also assessed (1) description of data collection methods, (2) reporting of a process used to analyze data, (3) mention of interrater reliability assessments during data coding, and (4) sufficiency of sample size to infer saturation. For the quantitative studies, we noted that almost all studies were observational and many used survey designs. Consequently, all quantitative studies were also assessed for (1) flawed measurements of variables (eg, asking participants to estimate time spent in the EHR instead of methods less prone to recall bias); (2) response rate of over 50% for surveys; (3) reporting of both significant and nonsignificant findings; (4) use of a combined sample size of at least 385 participants, which is a traditional threshold for studies on larger populations[32]; and (5) use of a validated instrument to measure burnout or the proxy measure. For mixed-methods studies, both quantitative and qualitative components were assessed individually.

Table 1. Variables that form EHR-related indicators of physician well-being in our reviewed quantitative studies

Measure Group	Variable	Definition
Direct measures of burnout	Reporting burnout	The endorsement of symptoms such as emotional exhaustion, depersonalization, and low personal accomplishment
	Work-related burnout	One of the domains of the Copenhagen Burnout Inventory that focuses on burnout in the occupational setting
	Emotional exhaustion scores	A state in which an individual is fatigued from chronic stress
	Depersonalization scores	A state in which an individual feels loses a feeling of self and experiences helplessness
	Personal accomplishment scores	A state in which an individual participates in meaningful work
Efficiency and resources	Perceived physician productivity from EHR	Overall level of productivity of EHR workflows felt by the physician
	Perceived ease of use of EHR	A measure of EHR usability
	Number of login events per day	Total amount of times an individual logs into the EHR with a username or password or with badge scanning
	SUS composite scores	A validated scale that measures usability of IT systems
	Amount of time to document	A measure of documentation burden
	QUIS scores	A validated measure of usability of IT systems
	User experience rating of EHR	An informal measure of IT systems that broadly covers usability and EHR satisfaction
	Time spent in EHR on days without appointments	One measure of EHR use patterns
	Minutes spent in EHR on orders per wRVU	Time spent on writing referrals and prescriptions in the EHR
	Minutes spent on clinical review in EHR per wRVU	Time spent reading a patient's chart in the EHR
	Minutes spent on in-basket in EHR per wRVU	Time spent looking at, answering, and composing in-basket messages in the EHR
	Minutes spent active in EHR on scheduled days after-hours per wRVU	Time spent on any EHR activity outside of normal work hours
	Minutes spent on EHR on unscheduled days per wRVU	Time spent on any EHR activity during days where the individual does not have patients scheduled
	Amount of inbox notifications	A measure of in-basket burden
Workload and job demands	NASA-TLX scores	A measure of cognitive workload induced from IT usage
	Effort level required	A measure of how much physical and mental work was needed to use the EHR
	Frustration level	A measure of EHR satisfaction that includes level of alignment of personal workflows with EHR workflows as well as overall usability
	Mental demand level	A measure that focuses on how much decision making, memory, and information processing was needed
	Cognitive load	An informal measure of how much the individual has to rely on memory to complete tasks
	EHR satisfaction	Focused satisfaction measure surrounding EHR systems' ease of use, efficiency, and ability to support workflows
	Satisfaction with level of computerization	Satisfaction with the digitization of healthcare processes
	Perceived cumbersomeness level	Extent an individual feels the EHR is slow or unusable
Work-life integration	Reporting work-life balance issues	The endorsement that EHR use at home has impacted satisfaction with one's work-life balance
Organizational culture and values	Staff satisfaction/job satisfaction	Broad measure encompassing an individual's perception at their ability to do a job per their expectations

EHR: electronic health record; IT: information technology; NASA-TLX: NASA Task Load Index; QUIS: Questionnaire for User Interface Satisfaction; SUS: System Usability Score; wRVU: work relative value unit.

For each criterion, 1 point was given if the study possessed the characteristic. No points were given if the study lacked the characteristic, if it was deemed unclear, or if it was not applicable. Quantitative components could score up to 9 points; those employing surveys could score up to 10 points. Qualitative components could score up to 8 points. Total scores were used to classify an article as low risk of bias (7-10 points), moderate risk of bias (5-6 points), or high risk of bias (1-4 points). To classify a mixed-methods study, we used the most severe classification given to either the quantitative or qualitative component to calculate the total quality score.

We grouped major findings by predictor and themes described in physicians' recommendations that originated from the results reporting. We followed the conventional standard of $P < .05$ to indicate significance of findings.

RESULTS

We screened 7388 unique articles. Of these, 81 met our inclusion criteria based on initial review. On further reading, 35 articles ultimately met our inclusion criteria. Figure 2 presents our PRISMA flowchart.
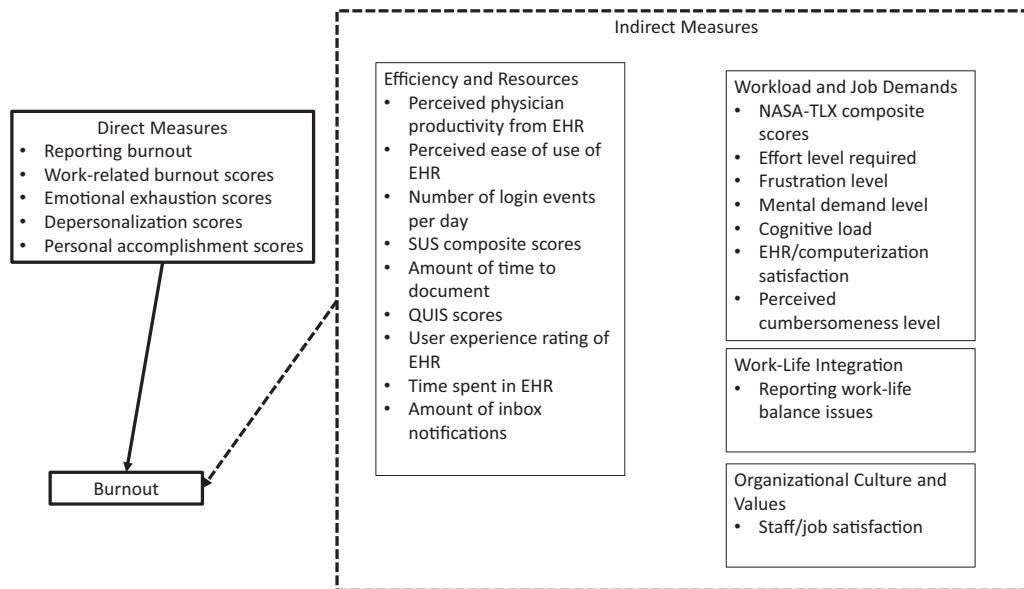
Figure 1. Drivers of electronic health record (EHR)–related indicators of physician well-being. NASA-TLX: NASA Task Load Index; QUIS: Questionnaire for User Interface Satisfaction; SUS: System Usability Score. Adapted with permission from Shanafelt and Noseworthy.[27]
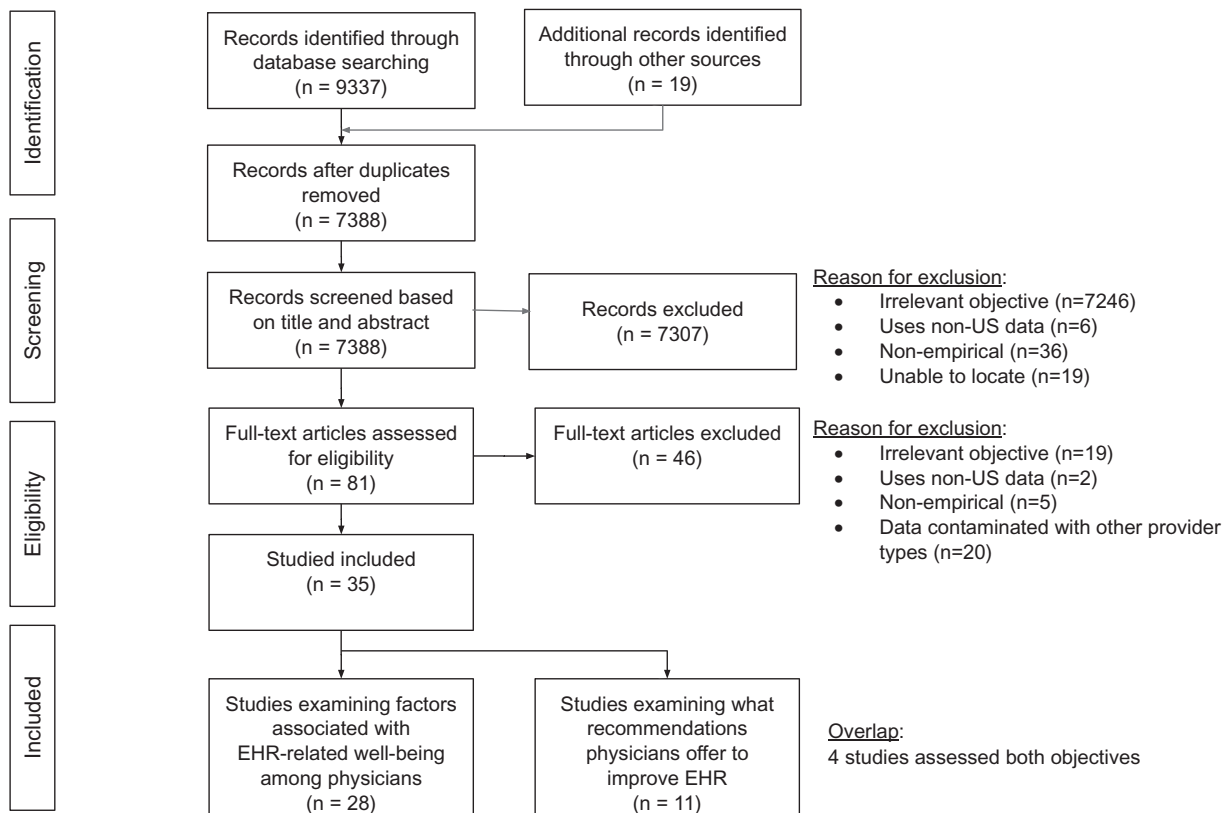

Figure 2. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart detailing the study screening process. EHR: electronic health record. Adapted with permission from Moher et al.[26]

Study quality assessment results

Across the 35 included studies, we found that none were of high risk of bias, 17 were of moderate risk of bias, and 18 were of low risk of bias. Detailed information of the assessment can be found in Supplementary Appendix 2.

There are several methodological challenges uncovered during quality appraisal. First, about a third of the studies concentrated on a singular medical specialty, which may decrease generalizability. Other studies pooled data from physicians across specialties, preventing analysis of differences in EHR-related burden. Second, most

studies used cross-sectional designs, limiting insights on how well-being changed over time. Third, about two-thirds of the studies used self-reported data, which may reflect recall bias. However, most studies used validated scales or items that were unlikely to be impacted by memory (eg, satisfaction ratings), which should mitigate this concern. Finally, as is typical in physician samples,[33] only about half the survey studies had a response rate of over 50%, introducing questions about the representativeness of results.

Study characteristics

The initial publication years ranged from 2010 to 2019. In response to a request during the peer-review process, an additional search was completed to assess for eligible studies published in 2020. There were 21 quantitative studies, 7 qualitative studies, and 7 mixed-methods studies. Notably, 14 studies measured burnout directly with validated scales, but 4 different scales were used. Physician specialties included in the studies varied, with 14 studying only 1 specialty. The table summarizing study characteristics is included in the Supplementary Appendix 3.

Organization-level characteristics

Twelve studies assessed the association between organizational factors and well-being. Supplementary Appendix 4 summarizes these findings.

Practice setting

When compared with hospital-based practices, office practices were associated with fewer daily logins.[34] Private group practices were associated with higher ease of use. Private and hospital group practices were associated with perceived physician productivity.[35]

Larger organizations were associated with lower perceived EHR productivity and more difficulty using the EHR.[35] Another study showed that the number of physicians in the practice was unrelated to burnout or EHR satisfaction.[36]

Physician characteristics

Twelve studies assessed the association between physician demographics and well-being. Supplementary Appendix 5 summarizes these findings.

Physician age

Older age was associated with lower usability scores, perceived ease of EHR use, perceived physician productivity, and overall EHR satisfaction.[35,37,38] However, a more recent study found no differences in the likelihood of reporting satisfaction with EHR remote access and utilization of computers in patient rooms.[39]

Professional specialty

One study reported specialists had received fewer in-basket messages when compared with generalists.[40] Another found differences in usability scores among the specialties, with general internal medicine physicians rating the EHR usability higher than their colleagues in family medicine, radiology, general surgery, and orthopedic surgery.[37] However, another study observed no differences among specialties in work-life balance or EHR-related burnout,[41] and another concluded that perceived EHR productivity and ease of EHR use were mixed among different specialties.[35]

Assigned patient care responsibility

One study reported no association with work-life balance or burnout stemming from EHR use,[41] and one noted that physicians with more patient care responsibility typically spend more time using the EHR on days that they are not scheduled to see patients.[42] Another study reported that having more patient care responsibility was associated with fewer in-basket messages.[40]

Physician EHR attitudes and behaviors

Sixteen studies focused on the association between physicians' attitudes and behaviors involving the EHR and their well-being. Supplementary Appendix 6 summarizes these findings.

Satisfaction with in-house IT support

One study reported that satisfaction with the in-house EHR support team was associated with higher EHR satisfaction.[34]

Usability perceptions

Believing that the EHR displayed clear prompts on the interface and that information was presented clearly were both associated with higher perceived ease of EHR use and lower levels of perceived cumbersomeness.[43] Intuitive interfaces were associated with lower levels of perceived effort.[43] Higher usability scores and ease of EHR use were associated with improved perceptions of EHR remote access and computer use as well as lower reported burnout, emotional exhaustion, and depersonalization scores.[37,43] Non–user-friendly EHRs were associated with burnout.[44] Perceptions that the EHR is cumbersome were associated with higher frustration levels.[43]

Work volume

Higher in-basket burden was associated with higher reported burnout and lower job satisfaction scores.[4,6] Higher documentation burden was associated with burnout but was unrelated to EHR satisfaction. Frequent clicking activity in the EHR was associated with higher burnout scores, but frequency of keystrokes was unrelated to EHR satisfaction.[34,36]

Time spent in EHR weekly

One study reported more time spent in the EHR each week was associated with worse emotional exhaustion and depersonalization scores. Personal accomplishment scores were moderated by training level (ie, resident vs attending), with residents generally reporting lower scores compared with attending physicians.[45] In contrast, a study using a different burnout instrument found that spending more time in the EHR each week was associated with lower work-related burnout.[35] A third study found that increased time spent in the EHR was related to higher satisfaction with the user interface.[43]

Increased time spent using the EHR after hours was related to higher burnout scores, worse EHR frustration levels, and more work-life balance concerns.[40,42,45,46] However, one study found residents reported higher depersonalization and lower personal accomplishment scores as EHR typing time spent after-hours working in the EHR increased, compared with attending physicians who reported no association with depersonalization scores and higher personal accomplishment scores.[45] Last, a more recent study reported EHR time on weekends, holidays, and days with patient appointments was associated with reported burnout. However, EHR time on days without patient appointments (eg, administrative time) or on weeknights was unrelated to burnout.[47]

EHR functionality

Eleven studies looked at EHR functionality and its effect on well-being. Supplementary Appendix 7 summarizes these findings.

Several studies looked at individual EHR functions. Most functions had no association,[48] but computerized provider order entry was associated with higher burnout scores.[49] Inversely, patient care summaries, clinical notes, and diagnosis features were associated with lower burnout scores.[35,36,48] Generally, having an EHR with a low number of functions was associated with lower stress scores and higher job satisfaction scores but was unrelated to burnout or intent to leave the practice.[50]

Physicians' recommendations to improve EHR-related indicators of well-being

Twelve studies presented physicians' recommendations on how to improve well-being and EHR-related burden. All recommendations primarily focused on improvements in the "efficiency of practice" domain. As seen in Table 2, physician recommendations spanned across 3 themes: federal policy, organizational policy, and IT. For instance, federal policy interventions focused on decreasing documentation requirements, organizational policy suggestions focused on implementing team-based care or documentation models, and proposed IT solutions were aimed at usability issues and tools to improve personal productivity.

We also report in Table 2 on how each intervention theme is connected to the sociotechnical model for health IT to illustrate the extent the interventions address each component in this model.[59] In aggregate, physicians' recommendations were relevant to all 8 dimensions, illustrating diverse origins of identified pain points.

DISCUSSION

The goal of this systematic review was to assess organizational-, physician-, and IT-related factors associated with EHR-related impacts on physician well-being and highlight potential improvements to EHR form and function, as recommended by frontline physicians. To our knowledge, this is the first systematic review describing (1) ways the EHR affects burnout and well-being among physicians and (2) interventions suggested by physicians to minimize difficulties associated with the EHR. Overall, our review found that key organizational factors, such as in-house EHR support and use of scribes, improve physician well-being. Furthermore, our review found that IT-related factors, such as EHR usability and resulting documentation burden, remain key factors in influencing physician well-being. Our review also identified a number of strategies recommended by physicians, such as use of shared templates and team-based documentation, that could be tested to improve physician well-being. We provide implications for practice and policy in the following paragraphs.

Having an on-site EHR support team appears to be beneficial, which is consistent with previous studies assessing the effect of in-house EHR support and EHR optimization capacities (ie, streamlining physicians' EHR workflows).[60] Prior research has also shown that local IT support can improve physicians' attitudes toward the EHR,[61] and organizational responsiveness to physician needs.[62] Conversely, lack of IT support can negatively affect EHR usage and patient outcomes.[63] Providing local EHR support and optimization services could free up physician time, leaving more room for professionally fulfilling tasks (eg, direct patient care). In fact, one recent study found that EHR optimization was associated with improved EHR satisfaction and decreased burnout among several clinician types.[64] This EHR support team can also provide EHR training to clinicians, with evidence suggesting that high-quality EHR training may improve EHR satisfaction.[65] Given the apparent importance and expense of on-site EHR support, future studies should examine its cost-benefit ratio and explore more affordable alternatives (eg, virtual EHR support) that could be utilized in underresourced healthcare settings.

A second key finding highlighted the value of involving support staff or scribes in the EHR documentation process, suggesting that team-based care models may improve well-being. There is growing evidence that these models are associated with lower burnout and higher job satisfaction scores.[66–68] Notably, these models are endorsed by the American Medical Association.[69] In the EHR context, support staff could address administrative tasks that do not require a physician's expertise. This may address in-basket burden and after-hours EHR use. Similarly, scribes may help reduce documentation burden and time spent using the EHR during patient visits or after-hours. EHRs can support these team models by offering functionalities that allow nursing staff to enter or prepare orders for physicians' reviews, permit team members to share in-basket folders, and provide routing rules that allow support staff to screen incoming in-basket messages and telephone encounters. The Ambulatory Process Excellence project at the University of Colorado is one promising model for redistributing clerical workload to reduce physician documentation burden and information overload.[70]

Low EHR usability was also identified as a significant pain point, demonstrating the importance of obtaining physician input when identifying areas for improvement to the EHR. Such targeted improvements should be based in user-centered design and guided by ongoing physician feedback. Unfortunately, 66% of physicians reported that they had not been included in conversations related to improving their organization's EHR.[71] Additional participatory approaches are needed to integrate physician feedback to successfully address EHR usability problems, and including psychologists in the discussion may help with incorporating cognitive sciences into EHR design.[72] We also recommend multilevel interventions to improve EHR usability. At the policy level, the Office of the National Coordinator for Health Information Technology has recently closed their public feedback period for criteria development of the EHR Reporting Program. Comparative information on EHRs from the program is planned to be made publicly available in 2022.[73] Upon the release of these data, researchers can study correlates of levels of usability testing performed by EHR vendors and study gaps in usability between EHR products. At the organizational level, the use of voice dictation and virtual scribes have been suggested to reduce clicking and typing activity.[74] Furthermore, the Pew Charitable Trusts recommend developing an internal review committee to assess safety incidents for EHR-related factors.[75] We also advocate for the usage of an interdisciplinary committee to review proposed EHR build changes for workflow mismatches, usability risks, and compliance with best practices (ie, published usability heuristics).[76,77] At the IT level, artificial intelligence (eg, predictive text) may address documentation burden by decreasing typing needs. Some strategies outlined in the recently enacted 21st Century Cures Act that target typing and clicking burden, cognitive overload, and EHR usability include using biometric authentication processes, restructuring the reporting of lab result by order of criticality, and ensuring a consistent user interface throughout the EHR.[78]

Physicians also offered other recommendations for improving EHRs, such as reducing regulatory requirements that result in documentation burden. The Affordable Care Act introduced numerous value-based payment programs, such as the Hospital Value-

Table 2. Summary of recommendations by physicians to address EHR-related burnout and connection to the sociotechnical model

Recommendation Level	Intervention Theme	Specific Interventions Suggested by Physicians	Sociotechnical Domain(s) Addressed	Citations
Policy	Reduce regulatory burden for documentation	• Evaluate impact of documentation regulations • Consider implementing regulations to permit progress notes to be shorter • Redesign or discontinue Meaningful Use requirements	External rules, regulations, and pressures; workflow and communication	Holden et al,[51] Copley et al,[34] Flanagan et al,[52] Colligan et al[53]
Organizational	General EHR training and technical support	• Provide EHR training to address steep learning curves associated with learning how to use the EHR • Provide ample time for EHR training • Offer on-site EHR support services	Internal organizational policies, procedures, and culture; workflow and communication; human-computer interface	Holden et al,[51] Copley et al,[34] Ayers,[54] Khairat et al[43]
	Implement organizational and management policies on EHR usage	• Use support staff to triage in-basket messages • Use scribes and support staff to assist in writing notes and orders • Shorten the length of patient visits • Track prevalence of after-hours EHR use • Implement protected time to complete visit notes • Design and deliver patient education that focuses on appropriate messages to send via patient portals	Internal organizational policies, procedures, and culture; people; workflow and communication; system measurement and monitoring	Holden et al,[51] Miyasaki et al,[55] Contratto et al,[56] Ayers,[54] Copley et al,[34] Flanagan et al,[52] Colligan et al,[53] Dillon et al[57]
IT	Tools to help the physicians document and enter orders	• Offer capabilities to automatically prepopulate visit notes with select content from prior visits • Develop and offer preference lists/bookmarks • Enable documentation templates/dot phrases • Allow remote EHR access • Implement e-prescribing • Offer voice dictation systems that integrate with the EHR	Workflow and communication; clinical content	Holden et al,[51] Contratto et al,[56] Copley et al, 2017,[34] Khairat et al,[43] Hauer et al,[46] Flanagan et al,[52] Ward[36]

(continued)

Table 2. continued

Recommendation Level	Intervention Theme	Specific Interventions Suggested by Physicians	Sociotechnical Domain(s) Addressed	Citations
	Data management and sharing capabilities	• Develop and refine interoperability capabilities within EHR to share information • Develop patient summary dashboards • Implement flowsheets for efficient downstream research and quality improvement	Hardware and software computing infrastructure; workflow and communication	Copley et al,[34] Ayers,[54] Colligan et al,[53] Ward[36]
	Streamline global usability features of the EHR and optimize how patient information is displayed to make chart review and navigation more efficient	• Reduce number of clicks and typing • Limit displaying irrelevant information on screen • Moderate the amount of information on screen to improve information clutter • Ensure consistent user interface designs and color-codes • Place Assessment and Plan sections of signed visit notes at top of note for easier review	Human-computer interface; workflow and communication; clinical content	Holden et al,[51] Koopman et al,[58] Colligan et al,[53] Miyasaki et al,[55] Ayers,[54] Khairat et al,[43] Ward,[36] Copley et al[34]
	Re-examine EHR workflows for fit to physician's workflows	• Adjust sensitivity of automated pop-ups and alarms • Design specialty-specific EHR content rather than "one-size-fits-all" content	Workflow and communication; system measurement and monitoring	Holden et al,[51] Copley et al,[34] Ayers,[54] Khairat et al[43]

EHR: electronic health record; IT: information technology.

Based Purchasing Program,[79] which has improved care delivery but also increased documentation burden.[80] Although the previous discussion points may improve efficiency of the documentation process, the feedback from physicians also reflected frustration with the regulations that mandate the burdensome requirements. This frustration has persisted since the initial implementation of the Centers for Medicare and Medicaid Services Evaluation & Management guidelines.[4,81–83] Notably, the Centers for Medicare and Medicaid Services will implement a component of the Patients Over Paperwork initiative that modifies the Evaluation & Management guidelines in order to reduce documentation burden effective January 2021.[84] This policy change is intended to limit unnecessary documentation in outpatient settings, decreasing physician time spent in the EHR (including after-hours EHR use). However, much work remains around building similar policies for private payers and for other care settings.[82] Thus, several leading professional associations have advocated for the use of a "minimum data set," with which payers would automatically receive structured EHR data that used for reimbursement decisions.[85] Although this could reduce clerical burden on physicians, additional work in interoperability capacities among EHRs may be necessary to further implement this suggestion.

Physicians also recommended numerous organization- and IT-level recommendations connected to culture of wellness influences (eg, use of shared templates and team-based documentation) and personal resilience interventions (eg, setting boundaries regarding work outside of work). Consistent with current theory regarding drivers of physician burnout (ie, the Stanford Model of Professional Fulfillment),[23] results highlighted EHR-related impacts on "efficiency of practice" (ie, ability to complete work quickly and without unnecessary obstacles), "culture of wellness" (ie, level of cooperation and support within the healthcare team and work environment), and "personal resilience" (ie, physician efforts at work-life integration and self-care). Indeed, most findings connected EHR use to personal productivity and degree of work-life balance. However, current theory also suggests that interventions targeting all 3 drivers of physician burnout may lead to the most meaningful change for physicians. Thus, the evaluations of the impact these multidimensional interventions may have on physician well-being represent fertile ground for future research.

Additionally, there were important limitations of this systematic review. First, the lack of rigorous study designs (eg, randomized controlled trials, quasi-experimental studies) precluded us from drawing definitive conclusions based on the current evidence. Second, we included both articles that assessed burnout directly through a validated tool and those that assessed a proxy measure for burnout, which may influence the interpretation of results. Because burnout generally reflects the cumulative effects of a series of factors or events impacting well-being, we included these indirect measures in order to provide insights regarding physicians who have not yet developed burnout but are displaying intermediary symptoms that could lead to burnout if left unchecked. Third, it was not possible to pool estimates across the quantitative studies due to the heterogeneity in types of measures used. Fourth, the inclusion of gray literature may have altered our findings. However, we believe that their inclusion provides a more comprehensive picture regarding EHR-related indicators of physician well-being. Fifth, while articles included in this study spanned almost a decade, we recognize that significant advances in EHR development and best practices have occurred since 2010. We noted minimal differences in how the literature and findings have evolved over time, with notable exceptions that more recent studies have focused on after-hours EHR time and usability metrics. As the field changes, this review will need to be updated.

Last, because our review included only data from U.S. physicians, our results may not be generalizable outside the United States

CONCLUSION

The findings of this review suggest that EHR-related physician well-being is determined by multiple factors including EHR usability, EHR system features, and physician-level characteristics and beliefs. At the same time, our study suggests that physicians have specific and feasible suggestions regarding ways to reduce EHR-related burden. Future efforts should focus on implementing the strategies and upgrades requested by these frontline users. More research is needed to test multicomponent interventions that address these complex factors and engage physicians in designing the interventions.

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AUTHOR CONTRIBUTIONS

This work represents the original research of the authors. This work has not been previously published. OTN, KT, and LJM conceptualized the study. OTN, AJG, KT, and LJM drafted the manuscript. All authors participated in the analyses and interpretation of data. SS, KT, and LJM provided critical revisions to the manuscript. All authors approved the submission.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Journal of the American Medical Information Association* online.

DATA AVAILABILITY

Data available upon request.

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CONFLICT OF INTEREST STATEMENT

None declared.

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