Journal of the American Medical Informatics Association, 28(5), 2021, 1009–1021
doi: 10.1093/jamia/ocab009
Advance Access Publication Date: 28 February 2021
Review

Review

Exploring the relationship between electronic health records and provider burnout: A systematic review

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Received 30 June 2020; Editorial Decision 9 January 2021; Accepted 26 January 2021

ABSTRACT

Objective: Stress and burnout due to electronic health record (EHR) technology has become a focus for burnout intervention. The aim of this study is to systematically review the relationship between EHR use and provider burnout.

Materials and Methods: A systematic literature search was performed on PubMed, EMBASE, PsychInfo, ACM Digital Library in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement. Inclusion criterion was original research investigating the association between EHR and provider burnout. Studies that did not measure the association objectively were excluded. Study quality was assessed using the Medical Education Research Study Quality Instrument. Qualitative synthesis was also performed.

Results: Twenty-six studies met inclusion criteria. The median sample size of providers was 810 (total 20 885; 44% male; mean age 53 [range, 34-56] years). Twenty-three (88%) studies were cross-sectional studies and 3 were single-arm cohort studies measuring pre- and postintervention burnout prevalence. Burnout was assessed objectively with various validated instruments. Insufficient time for documentation (odds ratio [OR], 1.40-5.83), high inbox or patient call message volumes (OR, 2.06-6.17), and negative perceptions of EHR by providers (OR, 2.17-2.44) were the 3 most cited EHR-related factors associated with higher rates of provider burnout that was assessed objectively.

Conclusions: The included studies were mostly observational studies; thus, we were not able to determine a causal relationship. Currently, there are few studies that objectively assessed the relationship between EHR use and provider burnout. The 3 most cited EHR factors associated with burnout were confirmed and should be the focus of efforts to improve EHR-related provider burnout.

Key words: electronic health records, health information technology, provider burnout, systematic review

INTRODUCTION

Provider burnout is a major concern in health care.[1] Burnout is defined by symptoms in 3 dimensions—feelings of energy depletion or exhaustion, increased mental distance from one's job or feelings of cynicism or negativism about one's job, and reduced professional efficacy.[2] Over 40% of U.S. physicians across all specialties have reported at least 1 symptom of burnout.[3,4] Similar burnout rates (35%-45%) have been reported among U.S. nurses.[5] Provider burnout negatively influences patient care, increases medical errors, and decreases patient satisfaction.[5–9] For providers, burnout is associated with increased risk of depression, substance abuse, and suicide.[1,9–11] Last, physicians and nurses with burnout are likely to reduce work hours or change careers, which would further aggravate the problem of the growing physician shortage that is estimated to be between 42 900 to 121 900 providers by the year 2032.[12–14]

With the implementation of the Health Information Technology for Economic and Clinical Health Act in 2009, there has been widespread adoption of electronic health records (EHRs) in health care.[15] In a 2017 survey, 96% of nonfederal acute care hospitals and 80% of office-based physicians had adopted certified EHRs.[16] Seventy percent of EHR users reported health information technology (HIT)–related stress, which is highly associated with burnout.[17] In addition, there have been numerous commentaries discussing the role of EHRs and their potential contribution to an increase in provider burnout.[18–20] There is a small corpus of studies that have objectively evaluated the association between EHR usage and burnout, but none have synthesized the current data into a systemic review.

The presence and needed interactions with an EHR can detract from direct patient care when providers spend a significant portion of their clinical time completing EHR tasks.[21] While prior studies have found mixed results regarding satisfaction with EHR implementation, studies that measured stress (defined as stress, psychological strain, and job stress) found increased stress among providers associated with EHR implementation.[22] Pressure to document, the stress associated with documentation, and the lack of time allocated for documentation were all aspects of EHR usage linked to poor job satisfaction and increased levels of provider burnout.[23] Two solutions to reduce burnout have been proposed to rectify provider stress and burnout: (1) clerical and scribe support to assist physicians with the documentation burden and (2) optimizing EHR workflows through education, workflow improvements, and technical enhancements.[23] However, while clerical and scribe support and optimizing EHR workflow have been associated with increased provider efficiency and improved user satisfaction, their implementation has not clearly demonstrated decreased rates of provider burnout.[23] Additionally, objective data exploring factors related to EHR component processes, such as order entry system, alert intrusions, total time spent on EHR, and percent of work time spent on EHR, have not been reviewed with regard to their association with objective measures of burnout. The aim of this study is to systematically search and review the literature on the relationship between the use of EHR and provider burnout and seeks to answer the following question: What is the relationship between EHR usage and provider burnout?

MATERIALS AND METHODS

Study identification and inclusion

A systematic literature review was performed on 4 databases (PubMed, EMBASE, PsychInfo, ACM Digital Library), from database inception to September 5, 2020, in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines on systematic reviews (the PRISMA checklist can be seen in Supplementary Appendix 1).[24] There was no review protocol for this study. The search strategy was developed with the help of a librarian using a Boolean strategy. A combination of terms *electronic*; *computerized*; *health*; *medical*; *record*; *records*, and "*decision support system*; *medical order entry system*; *CPOE*; *computerized physician order entry*; *medical record system, computerized*" were used to capture EHR-related articles. A combination of "*work*", "*workplace*", "*job*", "*occupational*" and "*stress*", "*frustration*", "*exhaustion*" in addition to terms *burnout*, *emotional exhaustion*, *depersonalization*, and *burnout, professional* were used to capture burnout. MeSH (Medical Subject Heading) terms in PubMed were translated to corresponding subject headings in EMBASE and PsychInfo. MeSH terms were removed for the search in the ACM Digital Library because the ACM Digital Library does not perform indexing with subject heading. The detailed search strategies are presented in Supplementary Appendix 2. Publications for analysis met the following criterion—original research investigating the association between EHR and provider burnout. A provider was defined as anyone who provides direct patient care, including physicians, physician assistants, nurse practitioners, allied professionals, and nurses. Exclusion criteria included (1) not original research, (2) studies that did not use a well-described method to measure burnout, (3) conference abstracts only, (4) studies that did not objectively evaluate the relationship between EHR usage and burnout (eg, cross-sectional studies that only provided the prevalence of burnout and participant opinions of EHR, intervention studies that did not report pre- and postintervention burnout), (5) studies unrelated to EHR, and (6) studies not focused on providers. The review was limited to studies that objectively measured burnout because burnout, stress, and dissatisfaction, although closely related, are not interchangeable concepts.[2,25] The following definitions were adopted: stress is a very general concept that is poorly defined but is driven mainly by job stressors, satisfaction is driven by a sense of belonging and successful completion of a healing mission, burnout is a triad of symptoms caused by a mismatch of high efforts with poor satisfaction in addition to workplace stress.[25–27] Burnout is considered to be measured objective if the study used a well-described methodology or tool. We excluded conference abstracts due to the limited information provided and inability to perform quality assessments. We excluded studies that only provided descriptive data on provider opinions of EHR and burnout rate or provider subjective attribution of burnout to EHR; thus, qualitative studies were excluded from this review. The evaluation of the association between EHR variable (including provider opinion of EHR) and burnout was considered objective if 1 or more statistical tests were used to evaluate the relationship or if the study reported preintervention and postintervention burnout rate when an EHR related intervention was present. Two independent reviewers, Z.H. and P.H.T., performed title and abstract screening. Full-text screening was then performed also by 2 independent reviewers (Q.Y. and Z.H. or Q.Y. and P.H.T.) on studies that were not unanimously excluded during title and abstract screening. Disagreement during full text screening were resolved by discussion between the 2 raters and M.G.D. until consensus was reached. Reference lists of included articles were also screened manually as a secondary search strategy.

Study outcomes

Data collection was performed by 2 reviewers (Q.Y. and J.Z.) independently with discrepancies resolved by consensus with a third person (M.G.D.). Data variables collected included sample size, response rate, study design, gender, age, specialty, practice model, provider practice setting, provider type, EHR measures, burnout measures, prevalence of burnout, and type of statistical analysis performed evaluating the relationship between EHR and burnout, including results and *P* values (for multivariate analysis, other predictors included in the model were also collected). Effective sample size was defined as the number of respondents or the number of participants included in the analysis. Family medicine, general medicine, and general pediatrics in outpatient settings were grouped as primary care physicians (PCPs) in our review if the percentage of PCP was not reported. The primary study outcome was objectively measured burnout linked to EHR usage as determined by correlation between 1 or more EHR measures and burnout, odds ratio (OR) for logistics regression, regression coefficient for linear regression, and burnout prevalence before and after intervention or in the control group and the intervention group. Burnout prevalence in the study population was the total number of participants determined to be burned out divided by the total number of participants and was limited to the studies reporting such outcome. The secondary study outcomes included the prevalence of provider burnout and other predictors of burnout including HIT-related stress, which is defined as presence of 1 of the following: poor or marginal time for documentation, moderately high or excessive time spent on EHR at home, and agreement that EHR adds to daily frustration.[17] Meta-analysis was not performed because there was significant heterogeneity between studies in terms of method of analysis, predictor used, and outcome used. To summarize categorical data such as the percentage of males or provider type, summing of the denominator and numerator was performed to calculate the overall percentage. To summarize continuous data such as age of the participants, the combined mean was calculated by dividing the sum of individual study mean multiplied by sample size, by the sum of the sample sizes. If the mean was not reported, the median was used as an alternative.

Study quality and bias

The qualities of the included studies were assessed using a validated tool—Medical Education Research Study Quality Instrument (MERSQI).[28] MERSQI evaluates the methodology of a study in 6 domains—study design, sampling, type of data, validity of evaluation instrument, data analysis, and outcomes—with possible maximum score of 3 for each domain for a total possible score of 18.[28] The total MERSQI score was calculated as the percentage of the total achievable score (accounting for "not applicable" responses) and then adjusted to a standard denominator of 18 to allow for comparison.[28] For those studies that utilized a survey instrument to measure EHR usage or impression, an additional validity of evaluation instrument was added. Selective reporting was assessed in addition to MERSQI. Selective reporting is considered present if some predictors of the statistical model were not reported or if specific *P* values were not reported.

Interrater reliability

Absolute percentage agreement and weighted kappa coefficient was calculated to measure interrater reliability for MERSQI scoring between 2 raters.[29] The reliability between raters was high, with 88% absolute agreement and weighted kappa of 0.88.

RESULTS

Study description

A total of 26 studies met inclusion criteria (Figure 1) with a total effective sample size of 20 885 participants (median 810 [range, 6-35 922] participants). Response rates in these studies ranged from 3.8% to 100%. Characteristics of included studies are described in Table 1.

Forty-four percent of the participants (9 093/20 590 in 21 studies) were male. The estimated mean age of the participants was 53 (range, 34-56) years across 7 studies. A total of 34.4% (6 768/19 661 in 24 studies) of the participants were PCPs, 32.9% (3 659/11 115 in 16 studies) practiced in an academic setting, and 89.2% (18 030/20 213 in 24 studies) were physicians, 2.6% were advanced practitioners, 6.8% were nurses, and 1.4% were allied professionals. Of 15 studies that specified the rank of the physicians (trainee vs faculty), only 10.5% (754/7 195) were trainees. Twenty-three studies were cross-sectional studies, and 3 were prospective studies that had a pre- and postinterventional design.

Study quality

Study quality was acceptable, with a median of 13.2 of 18 on MERSQI (Supplementary Appendix 3). No study scored <50% on the MERSQI scale. Most studies had low response rates for usable data, with only 4 studies reporting participation above 75%. Within the MERSQI scale, the validity of evaluation instruments for burnout employed was high with 96.2% of the studies scoring a 3 out of 3. The validity of evaluation instruments for EHR-associated variables was lower, with 61.1% (11/18) scoring a 3 out of 3. Most studies (96.2%) used appropriate statistical analysis, with only 2 (7.7%) studies being purely descriptive. Selective reporting was present in 15 (57.7%) of 26 studies.

Electronic health record

There were multiple approaches to assess EHR usage by providers. Most studies (n = 18) used subjective EHR data, 5 studies used EHR-derived data, and 3 studies used EHR-related interventions. The types of EHR data assessed included: general EHR use factors (14 studies), opinions of EHR (5 studies), EHR usability (4 studies), EHR user proficiency or efficiency (4 studies), messaging or communication within EHR (5 studies), EHR chart review (2 studies), EHR documentation (10 studies), and last, EHR order entry function (2 studies). Some studies (n = 12) evaluated various panels of these aforementioned measurements (Table 2).

Burnout

Burnout was assessed using various validated instruments. Nine studies used instruments based on the Maslach Burnout Inventory (MBI), 9 used the single-item measure, 5 used the Mini-Z survey, 1 used an adapted Shirom-Melamed Burnout Measure (SMBM), 1 used both the MBI and the single-item measure, and 1 used an internally developed single item measure (Table 2). The MBI is a 22-item questionnaire that is divided into 3 subscales: emotional exhaustion (9 items), depersonalization (5 items), and personal accomplishment (8 items).[53] It is internationally recognized as the standard measure of burnout.[8] The single-item measure of burnout is based on a 5-point Likert-type scale and has been validated against MBI, providing good correlation with emotional exhaustion and depersonalization subscales of the MBI.[54,55] However, while the single-item measure has a high specificity of over 90%, the sensitivity was only 50% for clinicians, and thus it may yield a more conservative result.[56] The adapted SMBM also

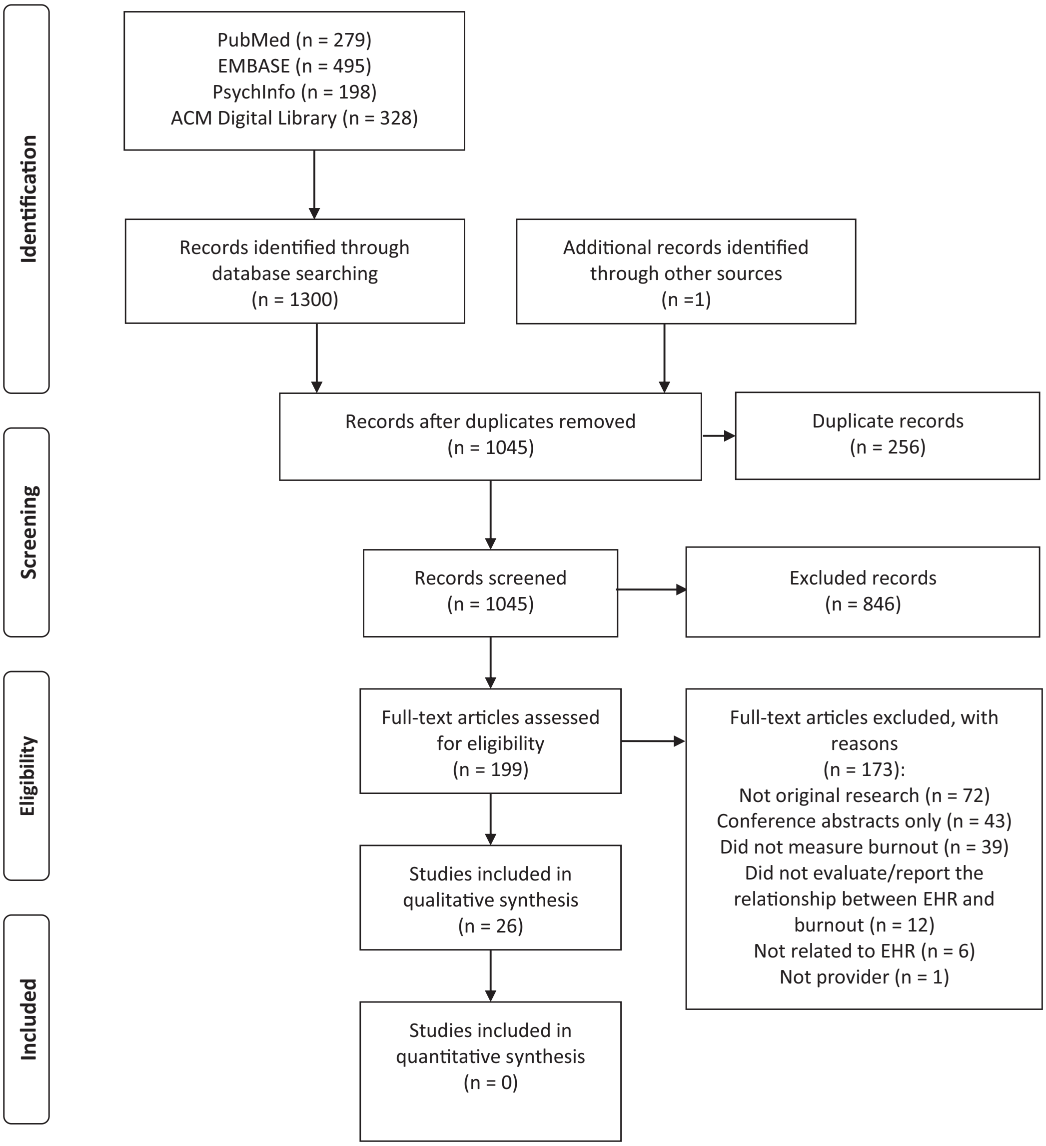

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram for search and selection process.

contains 3 subscales, each containing 3 items: physical fatigue, cognitive weariness, and emotional exhaustion.[33] The SMBM was validated by the creator against MBI.[57] The full Mini-Z assesses burnout based on 2 single-item measures similar to the previously mentioned single-item measure.[58] The additional components of Mini-Z assess other factors associated with provider burnout such as satisfaction, stress, work control, chaos, etc.[58] The burnout prevalence among study participants was between 16.7% and 63.5%, with a mean of 39.7% (8 679/21 867 in 22 studies).

Statistical design

Fifteen studies treated burnout as a binary variable and reported the ORs of burnout associated with EHR characteristics after adjusting for covariates. Two studies treated burnout as a continuous variable and reported beta coefficients associated with EHR characteristics from linear regression after adjusting for covariates. Six studies assessed the association between burnout and EHR without adjustment for covariates using various statistical methods (Table 2). Two studies reported purely descriptive data. Last, 1 study used burnout as a predictor to evaluate the time spent on the EHR and the percentage of EHR tasks completion.

Factors associated with burnout

General use of EHR, EHR usability, user proficiency and efficiency

The amount of time spent on EHR and time spent at home or after work hour were a popular focus of investigation; however, the results across the studies were equivocal (Table 3). Five studies found that time on EHR at home or after work was associated with burnout—self-reported high or excessive time on EHR (OR, 1.46-2.90) and[17,35,39,43] objective EHR data highest quartile vs lowest quartile (OR, 12.52).[47] In contrast, 4 studies did not find a statistically significant association.[31,34,37,42] Gilleland et al[31] found a positive correlation ($r = 0.2$, $P = .02$) between burnout and the percentage of hours spent on EHR after 5 PM out of total time spent on EHR daily, although this was a very weak association. General user proficiency[34,43,47] and efficiency[47] measures were not associated with burnout. Melnick et al[50] found that the more user friendly an EHR was considered, as measured by a system usability scale, the

Table 1. Characteristics of included studies

Author	N	RR	Study design	Male	Age	Specialty	Practice Model	Provider Type	Practice setting	MERSQI
Babbott, 2014[30]	379	50.3%	Cross-sectional	55.9%	Mean 43 y	PCP	Mixed	Physicians	Outpatient	13.7
Gilleland, 2014[31]	139	NR	Cross-sectional	NR	NR	Non-PCP	Academic	Physicians (trainees only)	Outpatient	10.7
Shanafelt, 2016[4]	6560	18.3%	Cross-sectional	31.6% (3% NS)	Median 56 y	23.3% PCP, 3.3% NS	24.9% Academic 17.5% NS	Physicians	Unselected	11.4
Contratto, 2017[32]	7	100%	Pre- and postintervention survey	NR	NR	PCP	Academic	Physicians (attendings only)	Outpatient	13.2
Gregory, 2017[33]	16	NR	Cross-sectional	NR	NR	PCP	Nonacademic	Physicians, NP, PA	Unselected	11.8
Rassolian, 2017[34]	1752	91.1%	Cross-sectional	58.3%[c]	NR	PCP	Mixed	Physicians (attendings)	Unselected	14.2
Robertson, 2017[35]	585	67.6%	Cross-sectional	45.2%	34	PCP	34.5% academic	Physicians (41.9% attendings)	Unselected	11.8
Tawfik, 2017[36]	1934	70.0%	Cross-sectional	18.1%	NR	Non-PCP	29% academic hospitals	Physicians (trainees and attendings): 11.5%, NP: 1.7%, Nurses: 72.2% Other: 14.7%	Inpatient	11.8
Domaney, 2018[8]	52	61.2%	Cross-sectional	NR	NR	Non-PCP	Academic	Physicians (23.1% attendings)	Outpatient: 46%, ED/consult: 26%, Inpatient: 30%	11.8
Harris, 2018[37]	371	31.0%	Cross-sectional	11.6%	24-40 y: 29.1% 41-60 y: 47.7% 61-80 y: 23.2%	32.3% PCP, 30.5% NS	Mixed	NP	Outpatient: 38.0% inpatient: 62.0%	13.3
Pozdnyakova, 2018[38]	6	100%	Pre- and postintervention survey	50%	NR	PCP	Academic	Physicians (attendings only)	Outpatient	13.2
Privitera, 2018[39]	1048	3.8%	Cross-sectional	63.0%	Mean 55.1 y (SD = 11.3 y)	Mixed	40.4% academic	Physicians (attendings only)	Unselected	11.4
Gardner, 2019[17]	1792	42.7%	Cross-sectional	64.3%	30-50 y: 42.5%, 51-64 y: 39%, 65-90 y: 18.5%	29.4% PCP	Mixed	Physicians (attendings only)	Outpatient: 67.6%, inpatient: 32.3%	13.3
Kroth, 2019[40]	282	44.1%	Cross-sectional	36.4% (14% NS)	Mean 50 y (SD = 11 y)	68.4% PCP, 1.1% NS	Mixed	Physicians (attendings only): 85.5%, NP: 5%, PA: 7.1%, NS: 0.4%	Outpatient	13.3
Marckini, 2019[41]	110	28.7%	Cross-sectional	71.8%	<55 y: 70%	Non-PCP	80.7% academic	Physicians	Unselected	11.4
Mehta, 2019[42]	2274	21.1%	Cross-sectional	58.1%	NR	Non-PCP	Mixed		Unselected	13.3

(continued)

Table 1. continued

Author	N	RR	Study design	Male	Age	Specialty	Practice Model	Provider Type	Practice setting	MERSQI
								Physicians (trainees and attendings)		
Olson, 2019[43]	475	37.9%	Cross-sectional	59.2% (4.4% NS)	25-34 y: 6.7%, 35-44 y: 26.1%, 45-54 y: 24.4%, 55-65 y: 16.0%, >65 y: 8.4% NS: 18.3%	17.1% PCP, 4.4% NS	72% academic	Physicians (attendings only)	Outpatient: 42.1%, inpatient: 21.9%, both: 35.4%, NS: 0.6%	12.8
Sieja, 2019[44]	113	55.1%	Pre- and postintervention survey	NR	NR	Non-PCP	Mixed	Physicians: 73%, NP/PA: 27%	Outpatient	13.8
Tai-Seale, 2019[45]	934	72.3%	Cross-sectional	45.0%	Mean 50 y (SD = 11 y)	Mixed	Nonacademic	Physicians	Unselected	14.1
Tran, 2019[46]	107	56.3%	Cross-sectional	29.0% (6% NS)	NR	PCP	Academic	Physicians (attendings only): 80.4% NP/PA: 17.8%, NS: 1.8%	Outpatient	14.1
Adler-Milstein, 2020[47]	87	66.9%	Cross-sectional	15.6% (3.9% NS)	NR	PCP	Academic	Physicians (attendings only): 90% NP or PA: 10%	Outpatient	12.9
Giess, 2020[48]	159	77.9%	Cross-sectional	51.6%	<40 y: 22.8% 40-49 y: 29.1% ≥50 y: 27.2% Other: 20.9%	Non-PCP	96.8% academic	Physicians (attendings only)	NR	13.3
Hilliard, 2020[49]	422	7.2%	Cross-sectional	45.0%	<40 y: 27.7% 40-60 y: 56.6% >60 y: 15.6%	25.8% PCP	Mixed	Physicians (attendings only): 84.8% NP: 11.1% PA: 4.0%	Outpatient	14.1
Melnick, 2020[50]	870	69.9%	Cross-sectional	58.5% (0.8% NS)	Median 53 (interquartile range, 42-61) y	25.5% PCP, 0.1% NS	32.2% academic, 19.1% NS	Physicians	Unselected	13.3
Somerson, 2020[51]	203	5.8%	Cross-sectional	79.8%	NR	Non-PCP	Mixed	Physicians (trainees only)	Unselected	11.4
Tajirian, 2020[52]	208	44.5%	Cross-sectional	50.5%, (4.3% NS)	<30 y: 8.2% 31-40 y: 38.9% 41-50 y: 28.4% 51-60 y: 11.1% ≥61 y: 13.5%	Non-PCP	Academic	Physicians (84.6% attendings)	Outpatient: 76.4%, inpatient: 39.4%, ED: 19.2%, other: 16.8%	12.3

[a]The percentage of males in the group of providers that were given the survey, not the respondents.

ED: emergency department; MERSQI: Medical Education Research Study Quality Instrument; NA: not applicable; NP: nurse practitioner; NR: not reported; NS: not specified; PCP: primary care provider; PA: physician assistant; RR: response rate.

Table 2. Aspects of EHR assessed, type of burnout survey used, and statistical method utilized.

Author, Year	EHR Use Measure	Burnout Measure	Statistical Analysis
Babbott, 2014[30]	• Clinics sorted into 3 clusters based on the number of EHR functions present: high, moderate, and low	The single-item measure	Cohen's *d* family effect size
Gilleland, 2014[31]	*EHR derived data on:* • Total time logged on EHR (hours/week) • Average # of logons after 5 PM/week • Average # of hours spent in EHR after 5 PM/week • Average # of hours spent in EHR after 5 PM/week/total time logged on	Internally developed 5-point burnout survey	Spearman correlation
Shanafelt, 2016[4]	• Use of EHR • Use of CPOE • Use of patient portal	Maslach Burnout Inventory	Logistic regression
Contratto, 2017[32]	Intervention: • Physician order entry clerical support staff	2 questions (1 burnout, 1 depersonalization) adapted from Maslach Burnout Inventory	Descriptive
Gregory, 2017[33]	• Subjective alert workload (perception of having insufficient time to complete work tasks) • Objective alert workload (number of hours spent on work and work activities)	Adapted Shirom-Melamed Burnout Measure	Linear regression
Rassolian, 2017[34]	• Perceived EHR proficiency • Insufficient time for documentation • Perceived burden of time spent on EHR at home	Mini-Z Survey	Logistic regression
Robertson, 2017[35]	• Self-reported hours of EHR work outside of normal work hours in a week	The single-item measure	Logistic regression
Tawfik, 2017[36]	• Use of EHR	Maslach Burnout Inventory (emotional exhaustion subset)	Linear regression
Domaney, 2018[8]	• Self-reported time spent on EHR at home	Maslach Burnout Inventory Human Services Survey	Spearman correlation
Harris, 2018[37]	*HIT-related stress:* • Insufficient time for documentation • Perceived burden of time spent on EHR at home • Agreement that using an EHR adds to daily frustration	The single-item measure	Logistic regression
Pozdnyakova, 2018[38]	*Intervention* • Scribe	The single-item measure	Descriptive
Privitera, 2018[39]	• Self-reported EHR use at home • Insufficient time for documentation	Mini-Z Survey	Logistic regression
Gardner, 2019[17]	*HIT- related stress:* • Insufficient time for documentation • Perceived burden of time spent on EHR at home • Agreement that using an EHR adds to daily frustration	The single-item measure	Logistic regression
Kroth, 2019[40]	• EHR design and use factors identified in prior qualitative study	The single-item measure	Logistic regression
Marckini, 2019[41]	• Dissatisfaction with EHR • Perception that EHR has improved efficiency • Perception that patient portal has improved efficiency	Maslach Burnout Inventory	Wilcoxon
Mehta, 2019[42]	• Perceived EHR proficiency • Insufficient time for documentation • Perceived burden of time spent on EHR at home	Mini Z Burnout Survey	Logistic regression
Olson, 2019[43]	• Perceived EHR proficiency • Insufficient time for documentation • Perceived burden of time spent on EHR at home	Maslach Burnout Inventory, Mini Z Burnout Survey	Logistic regression
Sieja, 2019[44]	*Intervention*	Maslach Burnout Inventory (emotional exhaustion subscale)	Chi-square

(continued)

Table 2. continued

Author, Year	EHR Use Measure	Burnout Measure	Statistical Analysis
	• Team-based intervention to optimize EHR efficiency		
Tai-Seale, 2019[45]	• EHR derived in-basket message volume	The single-item measure	Logistic regression
Tran, 2019[46]	*EHR derived data on:* • % of same day chart completion • Median time spent managing inbox for each scheduled day • Incomplete result messages • Incomplete patient call messages	Mini Z Burnout Survey	Logistic regression (outcome = EHR)
Adler-Milstein, 2020[47]	*EHR derived data:* • Mins active on scheduled days after hours per clinical full-time equivalent week • Mins active on unscheduled days per clinical full-time equivalent week • Message volume per clinical full-time equivalent week • Proficiency composite • Efficiency composite *Subjective data:* • Perceived burden of time spent on EHR at home • Perceived EHR proficiency	Maslach Burnout Inventory survey (emotional exhaustion and cynicism subscale)	Logistic regression
Giess, 2020[48]	The Stanford Physician Wellness Survey—EHR experience: • Perception of EHR (help enter orders efficiently, help coordinate care efficiently, makes it hard to pay undivided attention to patients) • Perceived burden of time spent on EHR on tasks that other team members should do • Perceived amount of work in the EHR being excessive	The single-item measure	Logistic regression
Hilliard, 2020[49]	*EHR-derived data:* *Workload variables* • Average # of daily appointments over study period • Average mins spent reviewing patient charts/week • Average medication orders authorized by the clinician/week • Average nonmedication orders authorized by the clinician/week • Average patient call messages/week • Average results messages/week • Average note length per visit over study period *Efficiency variables* • Use of precharting • Use of Chart Search function • The # of SmartPhrases • % of orders placed from a preference list or SmartSet • % of notes entered using SmartTools • % of notes entered using copy and paste • % of notes entered using dictation	The single-item measure	Logistic regression
Melnick, 2020[50]	• System usability scale score	Maslach Burnout Inventory	Logistic regression
Somerson, 2020[51]	• Subjective time spent on EMR	Maslach Burnout Inventory Human Services Survey	Logistic regression
Tajirian, 2020[52]	Perceived Usefulness of EHR • Perception that EHR adds to daily frustration • Satisfaction with EHR • Agreement with EHR helps keep patients safe • Agreement with communication regarding EHR changes is efficient	The single-item measure	Chi-square/Fisher

Only EHR measures used to assess its relationship with burnout were included in the table.

CPOE: computerized provider order entry; EHR: electronic health record; EMR: electronic medical record; HIT: health information technology.

Table 3. Association of EHR variables and burnout

	Reference number		
	Positive Association	Negative Association	Not Significant
General EHR use factors			
EHR use	36[a]		4,36[b]
Remote EHR use			17,37
Time spent on EHR	51		31
EHR at home	17,39,43[c]		34[d],37,42
EHR after work hour	35,47		31
Time spent on EHR on unscheduled days			47
Average # of logons after work hour		31	
High % of time spent on EHR after work hour/total time logged on	31		
Negative health consequences from EHR use	40		
Intervention—EHR training, workflow redesign, and addition of specialty-specific EHR functions			44
Opinions of EHR			
General opinions of EHR			48
Belief that EHR adds frustration	17,37,52		
Disagree that EHR keeps patient safe	52		
Disagree that EHR communications are efficient	52		
Disagree that EHR improved efficiency	41		
Dissatisfaction with EHR	52		
Dissatisfaction with patient care related clerical tasks on EHR	41		
Dissatisfaction with patient care unrelated clerical tasks on EHR	41		
EHR usability			
# of EHR features available			30
High EHR usability		50	
EHR user proficiency/efficiency			
EHR proficiency			34[d]43[c]47
EHR efficiency			42,47
Greater # of different EHR system used			35
Longer experience with any specific EHR			35
Length of current EHR in place			35
Messaging or communication within EHR			
Time spent on inbox alert messages			33
High # of inbox messages	45,47		
High # of patient call messages	49[ef]		
High # of result messages			49[ef]
Insufficient time to deal with inbox alert messages	33		
Patient portal use			4
Disagree that patient portal has improved efficiency	41		
EHR chart review			
Time spent on chart review			49[ef]
Use of Chart Search function			49[ef]
EHR documentation			
Insufficient time for documentation	17,34[d]37,39,42,43[c]		
Note length in EHR			49[ef]
Precharting of visit notes			49[ef]
High % of note entered using copy and paste		49[b]	
High % of note entered using SmartTools			49[f]
High # of user SmartPhrases			49[ef]
Use of transcription or voice recognition for notes			49[f]
Uses scribes			17,37,47,49[ef]
EHR order function			
High # of medication orders authorized			49[ef]
High # of nonmedication orders authorized			49[ef]
CPOE use	4		
% of orders placed from preference list or SmartSet			49[ef]

Statistically significant results on bivariate analysis but not significant on multivariate analysis were considered not significant. Not significant results from bivariate analysis not included in multivariate analysis are included in this table as not significant. For studies reporting each subdomains of burnout as outcome separately, statistically significant outcome in any one domain is considered significant result for the study. *P* value<.05 is considered significant.

CPOE: computerized provider order entry; EHR: electronic health record.

[a]Multivariate modal with prevalence of burnout on neonatal intensive care unit level as outcome.

[b]Mixed effect modal with neonatal intensive care unit as random effect and individual burnout as outcome.

[c]Multivariate modal with burnout as outcome measured by Maslach Burnout Inventory and multivariate modal with burnout as outcome measured by Mini-Z showed consistent results thus were not reported separately in this table.

[d]The modal with demographic, practice characteristics, and other variables of the survey all included in the model is used.

[e]Multivariate modal with complete sample without note composition data.

[f]Multivariate modal with subset of clinicians with note composition data.

lower the risk of burnout was. However, another study, which evaluated provider user difficulty with various EHR functions and its association with burnout, did not find any association.[40] The number of EHR features available also was not associated with burnout.[30]

Messaging or communication volumes within EHR

A high number of inbox messages (above average vs below average: OR, 2.06; physical exhaustion subscale, highest quartile vs lowest quartile: OR, 6.17),[45,47] patient call messages (highest quartile vs lowest quartile, without note composition variables: OR, 3.81; highest quartile vs lowest quartile, with note composition variables in a subset of clinicians: OR 6.59),[49] and insufficient time to deal with the volume of inbox alert messages (physical fatigue: $\beta = 0.58$, $t = 2.56$; cognitive weariness: $\beta = 0.53$, $t = 2.23$)[33] have been associated with increased burnout. However, time spent on inbox alert messages,[33] number of result messages,[49] and patient portal usage[4] were not associated with burnout.

EHR chart review and documentation

Time spent on EHR documentation (emotional exhaustion: $r = 0.4$ in residents, $r = 0.38$ in attendings)[8] and insufficient time for documentation (OR, 1.40-5.83; 6 studies)[17,34,37,39,42,43] were associated with increased burnout. However, results on time spent on chart review was inconclusive.[8,49] A large percentage of notes entered by "copy and paste" was associated with a lower rate of burnout (highest quartile vs lowest quartile: OR, 0.22).[49] Other specific EHR use habits such as methods of EHR documentation, such as dictation,[49] use of a scribe,[17,37,47,49] or use of SmartTools[49]; length of EHR note[49]; precharting[49]; writing EHR notes while with patients[8,49]; and use of the ChartSearch function, were not associated with burnout.[49]

EHR order function

Shanafelt et al[4] associated computerized provider order entry use with increased burnout. However in contrast, Hilliard et al[49] did not find any association between burnout and the number of medication or nonmedication orders authorized or the percentage of order placed from preference lists or SmartSets. Contratto et al[32] found that the number of physicians with significant burnout decreased from 3 to 1 (of 7) physicians after a physician order entry clerical support staff member was hired; however, the study was only descriptive.

Provider opinion of EHR

Tajirian et al[52] found that 88.2% of burned out providers believed that EHR usage adds frustration compared with 56.8% of providers not burned out believed that EHR usage adds frustration ($P < .001$). Providers that believed the EHR contribute to feelings of frustration had 2.17 to 2.44 odds of being burned out in 2 other studies.[17,37] Higher burnout rates were also seen in providers with other negative perceptions of EHR: disagreed that EHR kept patients safe,[52] disagreed that EHR communications were effective,[52] disagreed that EHR improved efficiency,[41] and dissatisfied with clerical tasks on EHR related or unrelated to patient care.[41]

Other factors such as provider, work environment, workflow, and workload factors related with burnout are summarized in Supplementary Appendices 4 and 5.

DISCUSSION

This analysis has shown that there are few studies that have objectively evaluated the relationship between EHR and provider burnout. Insufficient time for documentation, high volumes of inbox or patient call messages, and negative perceptions of EHR were the 3 most cited EHR related factors associated with increased measures of burnout among providers.

The presence of an EHR can generate significant clerical and cognitive burdens. A previous study has shown that for every hour of direct patient care, 2 hours were spent on the EHR and associated clerical work.[59] Almost half of the providers using an EHR (46%) believe that they have insufficient time for documentation, vs only 13.6% among those without an EHR.[17] This high demand of EHR documentation carries over to providers' personal time, leading to over a third of providers reporting excessive amount of time spent on the EHR at home, contributing to dissatisfaction and poor work-life balance, which contributes to a higher incidence of burnout.[17,35,39,47] While the use of an EHR at home or after work is a frequently cited factor associated with burnout, a review of evidence from the available literature was equivocal and did strongly support this contention.

The burden of a high inbox message volume was isolated as a contributor to burnout by several studies.[33,45,47] Providers spent approximately 20 to 42 minutes per clinic day managing their inbox during their "free time."[46] Inbox messages includes communications from patients, other providers, and alert messages generated from EHR algorithms. EHR-generated alerts can account for almost half of the inbox messages.[45] Studies have reported that providers desire protected time to manage alert messages as well as seeking improvements in EHR features to decrease alert burden and to assist with the management of inbox alert messages.[33] Of note, Gregory et al[33] did not find an association between the reported number of hours spent on managing inbox alert messages and burnout but found that a perceived excess of alerts was associated with increased burnout. Gregory et al[33] did not evaluate the quantity of alerts received by providers, which was positively associated with higher burnout in all 3 studies that utilized EHR-based objective data.[45,47,49]

Current recommendations to reduce provider burden include medical scribes, team approach to care, EHR improvement, and EHR proficiency training.[35,47] A systematic review of the use of scribes in healthcare settings suggested that it improved clinician satisfaction, productivity, time-related efficiency, revenue, and patient-clinician interactions.[60] However, scribe use has not been associated with burnout in our review.[17,37,47,49] Another strategy to decrease physician burnout is the team approach to care. This approach focused on offloading clerical burden (including documentation, nonphysician order entry, inbox management, health coaching, and care coordination) to nurses, medical assistants, or specialty technicians.[4] Sieja et al[44] reported a series of EHR improvement interventions performed by an 11-member team that led to a decrease of reported burnout from 39% to 34%, although statistical significance was not achieved. Forty-three percent of clinicians agreed that documentation time decreased after the intervention.[44] EHR proficiency training was also proposed as a method to prevent burnout; however, in our review, EHR proficiency and efficiency measures were not linked to burnout.

Through our review, we have identified several deficiencies in the research on EHR and burnout. There is a paucity of research in the nursing and advanced practitioners user groups. This is especially important for nurses due to their heavy use of EHR and different workflow from physicians and advanced practitioners. Only Melnick et al[50] evaluated EHR usability and found that EHR usability was very poor compared with other sectors indicating that this topic deserves more attention. Additionally, while Gregory assessed EHR generated inbox alerts, there were very few studies that evaluated[4,33,49] COPE and associated synchronous alerts. Providers, on average, received over 4000 best practice advisories and 1000 drug alerts per year.[61] Most of these alerts were overridden, and most alert overrides were appropriate.[62] Whether this significant alert burden contributed to provider burnout would be worthy of further exploration.[4] Only 5 studies used EHR-generated objective data, whereas most studies used provider-reported EHR use or workload. Providers' self-reported time spent on EHR was only weakly correlated with objective data and tend to be overestimated thus more using EHR-derived objective data may provide more insights.[31,47,52]

The novelty of this review is that the search strategy only selected articles that used an objective measure of burnout. This process confirmed that insufficient documentation time, high inbox or patient call messages, and negative perception of EHR were associated with burnout. While the use of EHR at home or after work was also a frequently cited factor associated with burnout, evidence from available literature does not support this contention. The current study extends the level of knowledge on burnout by concentrating on objective measures of burnout and synthesizing the current quantitative literature on burnout. This study reenforces that the cumulative findings in the literature continued to support the 3 factors identified from prior research but demonstrates that the literature is too heterogeneous to allow a meta-analysis, which would increase the level of evidence supporting these factors. As such, we recommend more uniform methodology and standardized reporting of these factors in the future literature.

The quality of this review is governed by the quality of the included studies. Some degree of selective reporting was present in over half of the studies. A high number of studies used subjective EHR data introducing recall bias and most studies had poor response rates leading to selection bias. Owing to the observational nature of the included studies, we were not able to determine any causal relationships. There were only 3 interventional studies, and all had very small samples sizes. In addition, we were not able to perform a meta-analysis due to significant heterogeneity between studies. Some studies analyzed burnout as a continuous variable, while others as a binary variable, making it difficult to compare the results between these studies. Last, studies adjusted for various covariate factors; however, not all studies adjusted for provider or work-related factors that may affect burnout.

CONCLUSION

There are few studies that objectively evaluated the relationship between EHR usage and provider burnout. Insufficient time for documentation, high inbox or patient call message volume, and provider negative perceptions of EHR were the 3 most reported EHR-related factors associated with increased burnout in providers. The current data in the literature are insufficiently robust to allow a meta-analysis of the data. Future studies should use objective EHR measures, investigate computerized provider order entry system and synchronous alerts, and explore burnout in advanced practitioners and nursing population.

FUNDING

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

AUTHOR CONTRIBUTIONS

QY and MGD contributed to substantial contributions to the conception or design of the work.

QY, ZJ, ZH, PHT, and MGD made substantial contributions to the acquisition, analysis, or interpretation of data for the work.

QY drafted the work.

ZJ, ZH, PHT, and MGD revised it critically for important intellectual content.

QY, ZJ, ZH, PHT, and MGD Gave final approval of the version to be published.

QY, ZJ, ZH, PHT, and MGD gave agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

SUPPLEMENTARY MATERIAL

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

DATA AVAILABILITY STATEMENT

The data underlying this article are available in the article and in its online supplementary material.

ACKNOWLEDGMENTS

We thank the librarians at University of Texas Health Science Center at San Antonio for their help with the literature search.

CONLICT OF INTEREST STATEMENT

The authors have no competing interests to declare.

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