

Perceived Value of the Electronic Health Record and Its Association with Physician Burnout

Maria Livaudais¹ Derek Deng² Tracy Frederick² Francine Grey-Theriot² Philip J. Kroth² 

¹Department of Public Health, California State University East Bay, California, United States

²Department of Biomedical Informatics, Western Michigan University Homer Stryker M.D. School of Medicine, Kalamazoo, Michigan, United States

Address for correspondence Philip J. Kroth, MD, MSc, Department of Biomedical Informatics, Western Michigan University Homer Stryker M.D. School of Medicine, 300 Portage Street, Kalamazoo, MI 49007, United States (e-mail: Philip.kroth@med.wmich.edu).

Appl Clin Inform 2022;13:778–784.

Abstract

Keywords

- ▶ people
- ▶ burnout
- ▶ documentation burden
- ▶ workflows and human interactions
- ▶ human–computer interaction
- ▶ interfaces and usability
- ▶ culture
- ▶ workarounds and unanticipated consequences
- ▶ user acceptance and resistance

Background There is a common belief that seniority and gender are associated with clinicians' perceptions of the value of electronic health record (EHR) technology and the propensity for burnout. Insufficient evidence exists on the relationship between these variables.

Objective The aim of this study was to investigate how seniority/years of practice, gender, and screened burnout status are associated with opinions of EHR use on quality, cost, and efficiency of care.

Methods We surveyed ambulatory primary care and subspecialty clinicians at three different institutions to screen for burnout status and to measure their opinions (positive, none, negative, don't know) on how EHR technology has impacted three important attributes of health care: quality, cost, and efficiency of care. We used chi-square tests to analyze association between years of practice (≤ 10 years or $11+$ years), gender, and screened burnout status and the reported attributes. We used a Bonferroni-corrected $\alpha = 0.0167$ for significance to protect against type I error among multiple comparisons.

Results Overall, 281 clinicians responded from 640 that were surveyed with 44% overall response rate. There were no significant associations of years in practice (≤ 10 years or $11+$ years) or gender ($p > 0.0167$ for both) with any of the health care attributes. Clinicians who screened burnout negative ($n = 154$, 55%) were more likely to indicate that EHR technology has a positive impact on both the quality ($p = 0.0025$) and efficiency ($p = 0.0003$) health care attributes compared with those who screened burnout positive ($n = 127$, 45%).

Conclusion Burnout status is significantly associated with clinicians' perceived value of EHR technologies, while years of practice and gender are not. This contests the popular notion that junior clinicians view EHR technology more favorably than their more senior counterparts. Hence, burnout status may be an important factor associated with the overall value clinicians ascribe to EHR technologies.

Background and Significance

The rate of physician burnout is alarmingly high. In a 2020 national survey, 38.2% of physicians screened positive for

burnout, compared with only 25.2% of the general working U.S. population.^{1,2} Professional burnout can have detrimental effects on a physician's mental and physical health, professional performance, job turnover, and quality

received

April 1, 2022

accepted after revision

July 1, 2022

© 2022. Thieme. All rights reserved.

Georg Thieme Verlag KG,

Rüdigerstraße 14,

70469 Stuttgart, Germany

DOI <https://doi.org/>

10.1055/s-0042-1755372.

ISSN 1869-0327.

of care.³ The comprehensive adoption of electronic health records (EHRs) has triggered many unintended consequences, including those contributing to physician burnout.^{3–10} A study conducted with 1,800 physicians from Rhode Island found that burnout prevalence was considerably higher among physicians who used EHRs, with 27.2% of the group reporting one or more burnout symptoms, compared with 13.6% of physicians who did not use EHRs.^{2,11} Another study showed that spending more than 6 hours per week on after-hours EHR work was strongly associated with the perception that EHR use affects both work–life balance and burnout.¹² Sinha et al showed how EHR use correlates with physician exhaustion,⁹ Marmor et al showed how time spent on EHR use during the day had an inverse relationship with patient satisfaction scores,¹³ and Frintner et al showed how EHR use by pediatricians was associated with worse work–life balance, stress in balancing responsibilities, and less career and life satisfaction.¹⁴

Studies have also shown differences between male and female clinicians on various factors associated with EHR use, including stress, frustration, and burnout rates.^{15,16} Other factors contributing to workload differences between gender can contribute to overall burnout. Rittenberg et al found that women primary care physicians receive 25% more requests from both office staff and patients, compared with men in the same practice.¹⁷ These differences may be related to aspects outside of EHR usability or efficiency, such as gender biases and discrimination, maternal discrimination, household obligations, and fewer mentoring and sponsoring opportunities available for women when compared with their male colleagues.¹⁵

Similarly, there is a belief that senior physicians view EHRs less favorably and struggle with the technology more than their younger counterparts, a factor that may contribute more to physician burnout in older physicians.^{7,18} This notion stems from the “generational divide” between older physicians or “digital immigrants” (individuals who did not grow up with technology but currently use it during their adult life) and younger physicians or “digital natives” (individuals who grew up with technology and are perceived to be familiar with the digital world).¹⁹ There is good evidence that in the general workforce, age seems to be negatively associated with the probability of technology or software adoption and use.^{20–22} Other studies have also shown that physicians with more EHR experience were more likely to hold positive views on the EHR.²³ Then, are younger physicians who trained with EHRs early on more adept at using the technology, hence making them more resilient to EHR-related burnout? Likewise, does the older generation’s experience with paper charts and its use inefficiencies make them more welcoming of the more unified and accessible EHR system?

Insufficient evidence exists on the relationship between clinician seniority, gender, and burnout status and the perceived value of EHR technology.

Objectives

The objective of this study was to investigate how clinician seniority (measured by years of practice), gender, and burn-

out status associate with clinician perceptions of the EHR’s impact on three important attributes of health care: quality, cost, and efficiency of care.

Methods

Survey and Sampling

This study analyzed unpublished survey data from the Minimizing Stress, Maximizing Success of Clinicians’ Use of the Electronic Health Record (MS-Squared) study. A copy of the survey instrument²⁴ and a more detailed description of the methods are freely available.^{4,24} In summary, between August 2016 and July 2017, 640 clinicians (physicians, nurse practitioners, and physician assistants) in 5 disciplines (general internal medicine, medical subspecialties, general pediatrics, pediatric subspecialties, and family medicine) at 3 institutions were surveyed as part of the MS-Squared project. Surveys were sent electronically using the survey function in the REDCap (Research Electronic Data Capture) electronic data capture tool.^{25,26} All clinicians surveyed worked in the outpatient setting. The institutions employed three different EHR systems (Epic, Cerner, and Meditech). Survey solicitations were first deployed via email with additional paper copies posted to nonresponders. **Table 1** summarizes the demographics of those surveyed.

This analysis focuses on clinician opinions on how EHR technology has impacted three specific attributes of health care (“quality,” “cost,” and “efficiency of care”) based on their background characteristics of years of practice,

Table 1 Reported demographic characteristics (*n* = 281)

Characteristic	<i>N</i> (%)
Age, y, mean (SD)	50 (11)
NR, <i>N</i> (%)	5 (1.8%)
Gender	
Male	117 (41.6%)
Female	160 (56.9%)
NR	4 (1.4%)
Clinician type	
MD	240 (85.5%)
PA	20 (7.1%)
NP	14 (5.0%)
DO	6 (2.1%)
NR	1 (0.4%)
Practice type	
Primary care	196 (69.8%)
Roles	
Full time	225 (80.1%)
Part time	54 (19.2%)
NR	2 (0.7%)

Abbreviations: NP, nurse practitioner; NR, no response; PA, physician’s assistant; SD, standard deviation.

gender, and screened burnout status. Burnout status was assessed by a validated single-item screening measure of burnout included in the survey questionnaire, in which a score of 3 or more indicates a positive screen for burnout. This single-item measure originated from the Physician Worklife Study²⁷ and has been validated for clinicians.²⁸ The MS-Squared survey asked respondents to select “positive,” “none,” “negative,” or “don’t know” on how increased EHR use affected the “quality of care you are able to deliver to your patients,” the “cost of care,” and the “efficiency of care.”

Statistical Analysis

We reported categorical data, including gender and clinician opinions on how EHR technology impacted the three specific attributes of health care, as frequency (percent). We converted clinician years of practice into a binary variable with an a priori cutoff of <10 years or 11+ years based on the overall adoption of EHR technology in the clinical settings.²⁹ We analyzed burnout as a binary variable with scores of 3 or higher indicating a positive burnout screening and scores of 2 or lower indicating a negative burnout screening. Analyses did not use a model that controlled for other clinician characteristics beyond years of practice, gender, and screened burnout status.

Chi-square tests were used to evaluate the association between years of practice, gender, and burnout and the perceived effect increased EHR usage had on each attribute of health care: quality of care, cost of care, and efficiency of care. To protect against type I error that could result from multiple testing across the three E7 survey items, Bonferroni-corrected α of $0.05/3 = 0.0167$ was used to declare significance. SAS v9.4 was utilized for data analysis.

Results

Of 640 clinicians surveyed, 281 (44%) responded. One respondent did not answer the quality-of-care item, two did not provide a response for the cost of care, and two did not indicate their years of practice. Four respondents did not indicate their genders. One respondent did not complete the burnout screen. **Table 2** contains a summary of the responses from all respondents combined.

Perceived Impact of Increased EHR Use on Quality, Cost, and Efficiency of Care by Clinician Years of Practice

The overall distribution of perceived impact of increased EHR use on quality, cost, and efficiency of care did not differ significantly ($p = 0.3984$, 0.7638 , and 0.9586 , respectively) by clinician years of practice ($\alpha = 0.0167$). Sensitivity analysis evaluating years of practice as a continuous variable using analysis of variance (ANOVA) indicated that years of practice did not significantly differ across response options for the perceived impact of increased EHR use on the cost, efficiency, and quality of health care (**Table 3**).

Table 2 Frequency (percent) of perceived impact of EHR use on quality, cost, and efficiency from all respondents combined

Perceived EHR impact	Overall responsesn (%)
Quality	
Positive	113 (40.6)
None	43 (15.5)
Negative	98 (35.3)
Don't know	24 (8.63)
Cost	
Positive	37 (13.9)
None	64 (24.0)
Negative	92 (34.5)
Don't know	74 (27.7)
Efficiency	
Positive	75 (27.0)
None	34 (12.2)
Negative	146 (52.3)
Don't know	24 (8.60)

Abbreviation: EHR, electronic health record.

Table 3 Frequency (percent) of perceived impact of EHR use on quality, cost, and efficiency by clinician years of practice

Perceived EHR impact	Years in practice		p-Value ^a
	≤10 y (n = 102)	11+ y (n = 177)	
Quality			
Positive	39 (38.61%)	74 (41.81%)	0.3984
None	20 (19.80%)	23 (12.99%)	
Negative	32 (31.68%)	66 (37.29%)	
Don't know	10 (9.90%)	14 (7.91%)	
Cost			
Positive	15 (14.71%)	22 (12.57%)	0.7638
None	26 (25.49%)	38 (21.71%)	
Negative	24 (33.33%)	68 (38.86%)	
Don't know	27 (26.47%)	47 (26.86%)	
Efficiency			
Positive	27 (26.47%)	48 (27.12%)	0.9586
None	12 (11.76%)	22 (12.43%)	
Negative	53 (51.96%)	93 (52.54%)	
Don't know	10 (9.80%)	14 (7.91%)	

Abbreviation: EHR, electronic health record.

^ap-Value provided for chi-square test of independence significant at Bonferroni-corrected $\alpha = 0.0167$.

Perceived Impact of Increased EHR Use on Quality, Cost, and Efficiency of Care by Gender

The distribution of perceived impact increased EHR use has on quality, cost of care, and efficiency of care did not differ

Table 4 Frequency (percent) of perceived impact of EHR use on quality, cost, and efficiency by gender

Perceived EHR impact	Gender		p-Value ^a
	Male (n = 117)	Female (n = 160)	
Quality			
Positive	50 (42.74%)	64 (40.25%)	0.3497
None	19 (16.24%)	23 (14.47%)	
Negative	42 (35.90%)	54 (33.96%)	
Don't know	6 (5.13%)	18 (11.32%)	
Cost			
Positive	16 (13.79%)	22 (13.84%)	0.1229
None	32 (27.59%)	32 (20.13%)	
Negative	45 (38.79%)	54 (33.96%)	
Don't know	23 (19.83%)	51 (32.08%)	
Efficiency			
Positive	37 (31.62%)	39 (24.38%)	0.0348
None	17 (14.53%)	17 (10.63%)	
Negative	59 (50.43%)	84 (52.50%)	
Don't know	4 (3.42%)	20 (12.50%)	

Abbreviation: EHR, electronic health record.

^ap-Value provided for chi-square test of independence significant at Bonferroni-corrected $\alpha = 0.0167$.

significantly ($p = 0.3497, 0.1229$, and 0.0348 , respectively) by gender ($\alpha = 0.0167$; **Table 4**).

Perceived Impact of Increased EHR Use on Quality, Cost, and Efficiency of Care by Burnout Screening

The overall distribution of perceived impact of increased EHR use on quality of care differed significantly ($p = 0.0025$) by burnout status. Specifically, a greater proportion of burnout-negative respondents perceived increased EHR use as having a positive impact on quality of care. Moreover, a greater proportion of burnout-positive respondents perceived increased EHR use as having a negative impact on quality of care (**Table 5**).

Similarly, the overall distribution of perceived impact increased EHR use has on efficiency differed significantly ($p = 0.0003$) by burnout screen. A greater proportion of burnout-negative respondents perceived increased EHR use as having a positive impact on efficiency. Additionally, a greater proportion of burnout-positive respondents perceived increased EHR use as having a negative impact on efficiency of care.

The distribution of perceived impact increased EHR use has on cost of care did not differ significantly for any of the three clinician factors.

Discussion

Overall, approximately half of the respondents felt that the EHR had a negative impact on efficiency and around a third

Table 5 Frequency (percent) of perceived impact of EHR use on quality, cost, and efficiency by screened burnout status

Perceived EHR impact	Burnout screen		p-Value ^a
	Positive (n = 127)	Negative (n = 153)	
Quality			
Positive	39 (30.71%)	76 (50.00%)	0.0025 ^a
None	22 (17.32%)	21 (13.82%)	
Negative	57 (44.88%)	40 (26.32%)	
Don't know	9 (7.09%)	15 (9.87%)	
Cost			
Positive	10 (8.00%)	27 (17.65%)	0.0621
None	26 (20.80%)	38 (24.84%)	
Negative	51 (40.80%)	51 (33.33%)	
Don't know	38 (30.40%)	37 (24.18%)	
Efficiency			
Positive	23 (18.11%)	54 (35.29%)	0.0003 ^a
None	16 (12.60%)	18 (11.76%)	
Negative	82 (64.57%)	63 (41.18%)	
Don't know	6 (4.72%)	18 (11.76%)	

Abbreviation: EHR, electronic health record.

^ap-Value provided for chi-square test of independence significant at Bonferroni-corrected $\alpha = 0.0167$.

perceived the EHR as having a negative impact on quality and cost of care. Considering the significant financial investment and time commitment of implementing EHRs in the United States alone, these findings indicate many clinicians do not believe this investment is producing meaningful benefits.

Our study shows that positive clinician burnout status was associated with negative impressions of the EHR's impact on quality and efficiency, while lack of burnout was associated with more positive impressions. All other associations between clinician characteristics and health care system attributes did not reach statistical significance. Notably, our results suggest that seniority and gender are not associated with differing perceptions of the impact of EHRs on health care attributes of quality, efficiency, or cost of care. These results contest the idea that junior clinicians have less trouble with the technology compared with their more senior counterparts.

Clinician Years in Practice

Previous studies have shown that clinician age may affect perception of the EHR,³⁰ with age distribution correlating with years in practice. For example, Williams et al found older and attending-level physicians appeared more likely to report decreased satisfaction with the EHR, with perceived personal efficiency serving as a measure for overall satisfaction and impact on the patient,³¹ and Nguyen et al found that older age was associated with lower reported EHR usability.³² A clinician survey conducted by Emani et al in 2014

found that clinician demographics of age, race, and gender are not significantly associated with their responses on the benefits of Meaningful Use.³³ The one notable exception that was significant was where 33% of clinicians 55 years and over thought Meaningful Use would improve the quality of care, while only 22% of clinicians younger than 55 agreed. Our results indicate otherwise, as we found no significant difference in the perception of the efficiency, quality, or cost of EHR benefits between clinician groups with 10 or fewer years of practice and 11 or more years of practice. This might be explained by other factors the MS-Squared survey did not measure, such as teamwork or homogeneity of age distribution. For instance, Meyer showed in an analysis from 2011 that strong teamwork and a homogeneity of age distribution together fostered group adoption of new technology.²⁰

Our differing findings may also be due to other factors associated with the perception of EHR systems. One might assume that more junior clinicians have greater proficiency with information technology and therefore hold more positive views regarding the EHR compared with their older counterparts.³¹ Similarly, a senior clinician's lesser proficiency in technology may lead them to have more negative views on the functionality and efficiency of the EHR system. However, clinicians who worked prior to the advent of widespread EHR deployment may also more greatly appreciate its positive impact.²¹ Conversely, more junior clinicians may be less tolerant of inefficient technology, due to a comparative ease of use in other phone or computer applications in their daily lives, leading to a more negative perception of the EHR. Other factors related to EHR design, such as the accessibility of the EHR system at home, may be relevant as well. For instance, a recent longitudinal study showed that while resident physicians reduced their time spent on the EHR per patient over the course of a year, the proportion of time they spent in the EHR system after hours did not change.³⁴ Multiple factors may play into how the EHR is perceived, as our study demonstrates that years in practice alone is not associated with a significant difference in perceptions.

Clinician Gender

Our results showed that gender had no significant effect on clinician perceptions toward any of the three potential benefits of EHR. These findings challenge the existing literature, which generally supports that female physicians have different EHR use patterns (EHR use after hours, writing longer notes, documenting a greater number of encounters per day, face time with their patients) compared with their male counterparts.^{2,15,17,35} In another study, male physicians reported more frustrations with the EHR, noting lower levels of satisfaction with EHR usability, complexity, and cumbersome.³⁶ These gender-specific use factors may contribute to perceptions of EHR value. Overall, our analysis noted a slightly larger female population of responders and did not measure all the factors listed in these studies, which may explain why the MS-Squared study did not detect a significant difference between genders in the perceived value of EHRs.

Clinician Burnout

The significant association between burnout-positive clinicians and negative perceptions of EHR quality and efficiency may be explained partly by the nature of burnout itself. Burnout alone may lead to poor practice efficiency, and poor EHR design may only be one factor involved.³⁷ Our prior analysis demonstrated that EHR design factors accounted for only 6.8% of the variance in burnout. When other peri-EHR factors were included in our calculations, such as lack of workload control, lack of attention to work-life balance, chaotic work environments, and ineffective teamwork, the overall variance in burnout rose to 36.2%, still far short of 100%.⁴ Clearly, there are areas that contribute more significantly to burnout than merely the technology or other associated factors measured by this survey.³⁴

A recent systematic review found that negative perception of the EHR was one of the most common EHR-related factors associated with increased clinician burnout.³⁸ Previously studied variables encompassing clinician perceptions of the EHR included EHR-related frustration,^{2,39,40} usability,⁴¹ efficiency of communication,⁴⁰ and insufficient EHR support from the clinicians' organization.⁴² These variables were all found to be significantly associated with burnout. Given that burnout itself may be associated with poor clinician perceptions of EHR efficiency, it may be desirable to design EHR optimization programs that are specifically designed to not only address improved EHR efficiency but also target reduced clinician burnout.⁴³ This analysis further expands on the association between burnout and negative perceptions of the EHR by exploring clinician views regarding the EHR's impact on health care. Past research has demonstrated a correlation between burnout and decreased health care efficiency ratings among certain specialists, including adult congenital heart disease and mental health specialists.^{40,44} This study's results broaden these findings by including a wider range of specialties, with a primary care majority, and show a similar association between burnout and negative perceptions of the EHR. Clinician burnout is likely another important factor that must be considered when trying to optimize the design, deployment, and ongoing management of the EHR system.

Limitations

Our study sample was limited in number and scope, representing only 281 clinicians from 3 institutions. There was a slight female majority and was limited to a binary conception of gender. Our survey did not measure many clinician-level confounders such as the degree of prior experience or expertise clinicians had with technology overall, which may have influenced how comfortable they were with computers and the EHR in general.

We primarily looked at physicians in primary care and outpatient settings, excluding trainees such as residents or fellows new to the field. Furthermore, the workload and responsibilities may differ by role type (e.g., among nurse practitioners, physician assistants, DOs, and MDs) and thus perceptions of the EHR on quality, efficiency, and cost may

differ in this regard. Our survey was not powered to analyze and compare responses by role types. Our sample is not representative of the entire clinician workforce in general and may also represent opinions different from clinicians who work in more specialized or inpatient areas. Assessing how residents and fellows view the EHR may provide more insight into whether opinions on the EHR differ between junior and senior clinicians.

There was no analysis performed comparing survey respondents to nonrespondents. Thus, it is possible that those who responded to the survey are inherently different, with respect to burnout or additional study variables, than those who did not respond.

Conclusion

Our data showed that despite the EHR's many potential benefits, clinician burnout is associated with more negative clinician perceptions of these benefits. This study suggests that these perceptions are unlikely to be associated with years in practice or gender. Addressing clinician burnout may improve clinician perceptions of the value of EHRs.

Clinical Relevance Statement

EHRs have become integral components of a quality health care system and are key to the future of health care. Addressing clinician burnout may positively influence clinician's perceived value and acceptance of EHRs.

Multiple Choice Questions

1. According to the findings in this study, which of the following factors was/were associated with clinician perceptions of the value of EHRs?
 - a. The screened burnout status of the clinician.
 - b. The gender of the clinician.
 - c. The screened burnout status and the years in practice of the clinician.
 - d. The screened burnout status, years in practice, and the gender of the clinician.

Correct Answer: The correct answer is option a. Gender and years in practice were not significantly associated with the respondents' perceptions of the value of EHRs regarding quality, cost, and efficiency. Burnout status was significantly associated with respondent perceptions; those who screened positive for burnout were significantly more likely to rate EHR quality and efficiency negatively than those who screened burnout negative.
2. According to the findings in this study, which of the following factors was/were NOT associated with clinician perceptions of the value of EHRs?
 - a. The screened burnout status of the clinician.
 - b. The gender of the clinician.
 - c. The gender of the clinician and the years in practice of the clinician.

- d. The screened burnout status, years in practice, and the gender of the clinician.

Correct Answer: The correct answer is option c. Gender and years in practice were not significantly associated with the respondents' perceptions of the value of EHRs regarding quality, cost, and efficiency. Burnout status was significantly associated with respondent perceptions; those who screened positive for burnout were significantly more likely to rate EHR quality and efficiency negatively than those who screened burnout negative.

Protection of Human and Animal Subjects

This study was determined to be exempt research by the Western Michigan University Homer Stryker M.D. School of Medicine Institutional Review Board.

Funding

This project was supported in part by grant number R18HS022065 from the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services.

Conflict of Interest

None declared.

Acknowledgments

We would like to thank Duncan Vos, MS (Western Michigan University Homer Stryker M.D. School of Medicine), who assisted with biostatistics of this project. We also thank the members of the MS-Squared research team Mark Linzer, MD (Hennepin County Medical Center), Sharry Verres (University of Arizona), and Nancy Morioka-Douglas (Stanford University).

References

- 1 Shanafelt TD, West CP, Sinsky C, et al. Changes in burnout and satisfaction with work-life integration in physicians and the general us working population between 2011 and 2020. *Mayo Clin Proc* 2022;97(03):491–506
- 2 Gardner RL, Cooper E, Haskell J, et al. Physician stress and burnout: the impact of health information technology. *J Am Med Inform Assoc* 2019;26(02):106–114
- 3 Grow HM, McPhillips HA, Batra M. Understanding physician burnout. *Curr Probl Pediatr Adolesc Health Care* 2019;49(11):100656–100610
- 4 Kroth PJ, Morioka-Douglas N, Veres S, et al. Association of electronic health record design and use factors with clinician stress and burnout. *JAMA Netw Open* 2019;2(08):e199609
- 5 Menachemi N, Collum TH. Benefits and drawbacks of electronic health record systems. *Risk Manag Healthc Policy* 2011;4:47–55
- 6 Adane K, Gizachew M, Kendie S. The role of medical data in efficient patient care delivery: a review. *Risk Manag Healthc Policy* 2019;12:67–73
- 7 Khairat S, Burke G, Archambault H, Schwartz T, Larson J, Ratwani RM. Perceived burden of ehrs on physicians at different stages of their career. *Appl Clin Inform* 2018;9(02):336–347
- 8 Wu DTY, Xu C, Kim A, Bindhu S, Mah KE, Eckman MH. A scoping review of health information technology in clinician burnout. *Appl Clin Inform* 2021;12(03):597–620
- 9 Sinha A, Shanafelt TD, Trockel M, Wang H, Sharp C. Novel nonproprietary measures of ambulatory electronic health record

- use associated with physician work exhaustion. *Appl Clin Inform* 2021;12(03):637–646
- 10 Gregory ME, Russo E, Singh H. Electronic health record alert-related workload as a predictor of burnout in primary care providers. *Appl Clin Inform* 2017;8(03):686–697
 - 11 Gardner DRL, Cooper E, Haskell J, et al. Response to “Impact of HIT on burnout remains unknown - for now”. *J Am Med Inform Assoc* 2019;26(11):1421
 - 12 Robertson SL, Robinson MD, Reid A. Electronic health record effects on work-life balance and burnout within the i(3) population collaborative. *J Grad Med Educ* 2017;9(04):479–484
 - 13 Marmor RA, Clay B, Millen M, Savides TJ, Longhurst CA. The impact of physician EHR usage on patient satisfaction. *Appl Clin Inform* 2018;9(01):11–14
 - 14 Frintner MP, Kaelber DC, Kirkendall ES, Lourie EM, Somberg CA, Lehmann CU. The effect of electronic health record burden on pediatricians' work-life balance and career satisfaction. *Appl Clin Inform* 2021;12(03):697–707
 - 15 Chesak SS, Cutshall S, Anderson A, Pulos B, Moeschler S, Bhagra A. Burnout among women physicians: a call to action. *Curr Cardiol Rep* 2020;22(07):45
 - 16 McPeck-Hinz E, Boazak M, Sexton JB, et al. Clinician burnout associated with sex, clinician type, work culture, and use of electronic health records. *JAMA Netw Open* 2021;4(04):e215686
 - 17 Rittenberg E, Liebman JB, Rexrode KM. Primary care physician gender and electronic health record workload. *J Gen Intern Med* 2022. Doi: 10.1007/s11606-021-07298-z
 - 18 Khairat S, Xi L, Liu S, Shrestha S, Austin C. Understanding the association between electronic health record satisfaction and the well-being of nurses: survey study. *JMIR Nurs* 2020;3(01):e13996
 - 19 Nakagawa K, Yellowlees P. Inter-generational effects of technology: why millennial physicians may be less at risk for burnout than baby boomers. *Curr Psychiatry Rep* 2020;22(09):45
 - 20 Meyer J. Workforce age and technology adoption in small and medium-sized service firms. *Small Bus Econ* 2011;37(03):305–324
 - 21 Morris MG, Venkatesh V. Age differences in technology adoption decisions: implications for a changing work force. *Person Psychol* 2000;53(02):375–403
 - 22 de Koning J, Gelderblom A. ICT and older workers: no unwrinkled relationship. *Int J Manpow* 2006;27:467–490
 - 23 Jamoom EW, Heisey-Grove D, Yang N, Scanlon P. Physician opinions about ehr use by ehr experience and by whether the practice had optimized its ehr use. *J Health Med Inform* 2016;7(04):1000240
 - 24 Kroth PJ, Morioka-Douglas N, Veres S, et al. MS-squared survey instrument v 2.0. 2019. Accessed March 4, 2022 at: <https://digitalrepository.unm.edu/ms2/3/>
 - 25 Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42(02):377–381
 - 26 Harris PA, Taylor R, Minor BL, et al; REDCap Consortium. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform* 2019;95:103208
 - 27 Linzer M, Gerrity M, Douglas JA, et al. Physician stress: results from the physician worklife study. *Stress Health* 2002;18(01):37–42
 - 28 Rohland BM, Kruse GR, Rohrer JE. Validation of a single-item measure of burnout against the maslach burnout inventory among physicians. *Stress Health* 2004;20:75–79
 - 29 Office of the National Coordinator for Health Information Technology. Office-based physician electronic health record adoption. *Health IT Quick-Stat #50*. 2021. Accessed March 4, 2022 at: <https://www.healthit.gov/data/quickstats/office-based-physician-electronic-health-record-adoption>
 - 30 Seu M, Cho BH, Pigott R, et al. Trends and perceptions of electronic health record usage among plastic surgeons. *Plast Reconstr Surg Glob Open* 2020;8(04):e2709
 - 31 Williams DC, Warren RW, Ebeling M, Andrews AL, Teufel li RJ. Physician use of electronic health records: survey study assessing factors associated with provider reported satisfaction and perceived patient impact. *JMIR Med Inform* 2019;7(02):e10949
 - 32 Nguyen OT, Jenkins NJ, Khanna N, et al. A systematic review of contributing factors of and solutions to electronic health record-related impacts on physician well-being. *J Am Med Inform Assoc* 2021;28(05):974–984
 - 33 Emani S, Ting DY, Healey M, et al. Physician beliefs about the impact of meaningful use of the EHR: a cross-sectional study. *Appl Clin Inform* 2014;5(03):789–801
 - 34 Holmgren AJ, Lindeman B, Ford EW. Resident physician experience and duration of electronic health record use. *Appl Clin Inform* 2021;12(04):721–728
 - 35 Ganguli I, Sheridan B, Gray J, Chernew M, Rosenthal MB, Neprash H. Physician work hours and the gender pay gap - evidence from primary care. *N Engl J Med* 2020;383(14):1349–1357
 - 36 Khairat S, Coleman C, Ottmar P, Bice T, Koppel R, Carson SS. Physicians' gender and their use of electronic health records: findings from a mixed-methods usability study. *J Am Med Inform Assoc* 2019;26(12):1505–1514
 - 37 Lou SS, Liu H, Warner BC, Harford D, Lu C, Kannampallil T. Predicting physician burnout using clinical activity logs: model performance and lessons learned. *J Biomed Inform* 2022;127:104015
 - 38 Yan Q, Jiang Z, Harbin Z, Tolbert PH, Davies MG. Exploring the relationship between electronic health records and provider burnout: a systematic review. *J Am Med Inform Assoc* 2021;28(05):1009–1021
 - 39 Harris DA, Haskell J, Cooper E, Crouse N, Gardner R. Estimating the association between burnout and electronic health record-related stress among advanced practice registered nurses. *Appl Nurs Res* 2018;43:36–41
 - 40 Tajirian T, Stergiopoulos V, Strudwick G, et al. The influence of electronic health record use on physician burnout: cross-sectional survey. *J Med Internet Res* 2020;22(07):e19274
 - 41 Melnick ER, Dyrbye LN, Sinsky CA, et al. The association between perceived electronic health record usability and professional burnout among us physicians. *Mayo Clin Proc* 2020;95(03):476–487
 - 42 Eschenroeder HC, Manzione LC, Adler-Milstein J, et al. Associations of physician burnout with organizational electronic health record support and after-hours charting. *J Am Med Inform Assoc* 2021;28(05):960–966
 - 43 English EF, Holmstrom H, Kwan BW, et al. Virtual sprint outpatient electronic health record training and optimization effect on provider burnout. *Appl Clin Inform* 2022;13(01):10–18
 - 44 Marckini DN, Samuel BP, Parker JL, Cook SC. Electronic health record associated stress: a survey study of adult congenital heart disease specialists. *Congenit Heart Dis* 2019;14(03):356–361