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A RAPID REVIEW OF PHYSICIAN BURDEN SECONDARY TO ELECTRONIC HEALTH RECORDS USE IN THE UNITED STATES FROM 2015 TO 2020

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By

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Abstract

Background: After the passing of the Health Information Technology for Economic and Clinical Health (HITECH) Act in 2009, there has been a tremendous increase in the number of hospitals and providers adopting and using Electronic Health Records (EHRs). While EHRs were a way of improving efficiency, quality, and safety of healthcare, there is emerging evidence that they are contributing to physician burden, which can take the form of increased workload, decreased satisfaction, negative attitudes, and burnout. For instance, Arndt et al. found that physicians spent half of their workday on the EHR during and after work, and Robertson et al. found that time spent on the EHR after hours was associated with burnout and decreased work-life balance.

Purpose: This capstone project is a rapid review of the research on physician burden and EHR use in the U.S. between January 2015 to February 2020. Its purpose is to assess recurring themes within recent literature focused on EHR-related physician burden.

Methods: Articles were found on PubMed using MeSH terms. Physician burden was defined by four MeSH terms: "burnout, psychological", "workload", "job satisfaction", and "attitude of health personnel." Articles were assessed based on inclusion and exclusion criteria. Inclusion criteria were 1) research articles, 2) sample populations in the US, 3) English language, 4) articles focused on physician burden and EHR use. Exclusion criteria were non-research articles, study populations outside of the US, not in English, and not focused on physicians, physician burden, or EHR use. The PubMed search resulted in 174 results and 21 articles were found from other sources. The articles were assessed based on their abstracts then their full text. After assessment, 28 articles met inclusion criteria. The 28 articles were then grouped based on quantitative vs qualitative methods, data types, and specific major themes.

Results: Twenty-eight articles were included in the rapid review. Twenty-seven articles used quantitative methods and 1 article used qualitative methods. Of the 27 quantitative articles, 16 used surveys, 6 used log data, 2 used direct observation and 3 used a mix of quantitative methods. The one qualitative study used interviews. Major themes were burnout, workload, satisfaction, attitudes, and time tracking. The number of respondents with burnout ranged from 24.1% to over 60%. Six out of nine articles found burnout associated with not enough time on documentation, high total amount to EHR use, EHR use after work, low EHR usability, and higher number of in-box messages. For satisfaction, 4/8 studies found a negative association between satisfaction and EHR use, while the other 4 articles found either positive satisfaction with EHR use or no association between EHR use and overall job satisfaction. Workload increased with EHR use in the form of increased effort processing in-box messages, generating after visit summaries, increased administrative time, increased time on documentation and chart review. Negative attitudes included inaccurate information and decreased meaningful patient-provider interaction. Positive attitudes included faster lab results and better provider communication. Around half of clinic time is spent on the EHR and after work EHR use ranged from 21 minutes to 2.5 hours.

Conclusion and Implications: Physician burden is a growing issue in the U.S. and EHR use is an unintended contributor to physician burden in the form of increased burnout and workload. Improving EHR use among physicians is an important part of reducing physician burden in the US, which can be done by using scribes, improving EHR training, improving EHR usability, and reducing documentation and billing requirements for providers.

Keywords: Electronic health records, physicians, physician burden, burnout, job satisfaction, workload, and attitude of health personnel

Table of Contents

Acronyms and Abbreviations

HITECH….Health Information Technology for Economic and Clinical Health Act

EHR……..electronic health records

HIT…….health information technology

AHRQ…..….Agency for Health Research and Quality

AMA……..American Medical Association

ACGME…..…Accreditation Council for Graduate Medical Education

NLM……....National Library of Medicine

MBI……..Maslach Burnout Inventory

PGY……Postgraduate year

SUS…….System Usability Scale

CPOE…….....computerized provider order entry

AVS…….after visit summary

NASA-TLX……National Aeronautics Space Administration- Task Load Index

QUIS……..Questionnaire for User Interaction Satisfaction

HHS……The U.S. Department of Health and Human Services

MACRA……Medicare Access and CHIP Reauthorization Act of 2015

MIPS…….Merit-based Incentive Payment System

APMS……..Alternative Payment Models

Introduction

After the passing of the Health Information Technology for Economic and Clinical Health (HITECH) Act on February 17, 2009, the adoption and use of electronic health records (EHRs) has grown exponentially over the course of the decade. In 2008, prior to the passage of the HITECH act, only 13.4% of U.S. non-federal acute care hospitals and 42% of physicians used EHRs in the office setting (ONC 2017, ONC 2019). As of 2017, EHR adoption is at 96% for non-federal acute care hospitals, and at 86% of U.S. Office-based Physicians based on ONC/American Hospital Association and CDC/NCHD data (ONC 2017, ONC 2019).

The purpose of the HITECH Act was to improve healthcare quality, efficiency, and safety by promoting adoption and "meaningful use" of certified EHR technology (Wager 2017). To fulfill that purpose, the HITECH Act contained multiple components to incentivize and support EHR adoption throughout the United States. It created the Medicare and Medicaid Incentive programs, where eligible hospitals and providers received incentive payments for adopting, implementing, or upgrading to a certified EHR. In addition, a year after adoption, the eligible hospitals and providers had to demonstrate meaningful use of the EHR based on the meaningful use standard (Wager 2017). The meaningful use standard evolved over time and was split into three stages: Stage 1 focused on electronic capture of clinical information, Stage 2 focused on advancing clinical processes, continuous quality improvement through the EHR, and information exchange in a structured format, and Stage 3 focused on improving health outcomes (Wager 2017, CDC 2017).

The HITECH Act funded 62 Regional Extension Centers (RECs) throughout the U.S. to assist providers with EHR adoption and meaningful use. It also funded training programs for Health Information Technology (HIT) professionals to create a workforce that would provide

support and maintain the EHR systems. In addition, the U.S. federal government promoted innovation and exemplary EHR use by funding 17 Beacon communities and Strategic Health IT Advanced Research Projects (SHARP) that demonstrate innovative ways of addressing specific health problems in the community through HIT (Wager 2017).

The Office of the National Coordinator for Health IT (ONC), the office tasked to provide leadership and oversight for the nation-wide adoption of EHRs and health information exchanges (HIE), promoted EHR adoption through its website, which lists multiple benefits and advantages of EHR use. For instance, EHRs provide complete, up-to-date patient information that is legible and accurate (ONC 2017). EHRs also improve care coordination by increasing accessibility and secure sharing of information with patients and other providers (ONC 2017, Wager 2017). The ONC also states that EHRs allow for safer and reliable prescribing, improved productivity, efficiency and work-life balance, and reduced costs (ONC 2017). These findings were based on scientific evidence, such as the 2006 systematic review by Chaudhry et al. that looked at 257 studies and showed that EHR use improved adherence to guideline-based care, enhanced surveillance, and decreased medication errors. While studies have shown the benefits of EHRs, the Agency for Healthcare Research and Quality found through their 2001-2005 MEMO (Minimizing Error, Maximizing Outcome) study that the implementation of an EHR system can contribute to physician burden.

Negative Effects of Physician Burden

Physician burden takes the form of increased workload, decreased satisfaction, negative attitudes, and especially burnout which is a growing concern within the United States. Burnout is a syndrome characterized by emotional exhaustion, depersonalization, and a lack of sense of personal accomplishment due to chronic stress (AHRQ 2017). A recent study showed that

physician burnout was associated with a 96% increased odds of patient safety incidents, over two times increased odds of poorer quality of care, and an over two times increased odds of reduced patient satisfaction (Panagioti 2018). Burnout also leads to decreased work effort (Shanafelt 2016), higher rates of job turnover (Williams 2010), and higher suicide rates with 40% higher suicide rates in male physicians and 130% higher suicide rates in female physicians in comparison to the general population (Center 2003). Due to this issue, the Accreditation Council for Graduate Medical Education (ACGME), the National Library of Medicine (NLM), the American Medical Association (AMA), and many other organizations have made efforts to reduce physician burden and burnout. ACGME changed the Common Program Requirements to include directly addressing resident and fellow well-being (2017), AMA provided educational modules on preventing physician burnout (2019), and researchers, such as Bird et al., are developing resiliency training curriculums for residents (2016).

The Role of EHR in Physician Burden – Emerging Evidence

Despite the benefits of EHRs described earlier, several studies have reported EHR use as a major contributor to physician burden. In a 2017 study, the researchers observed that family medicine physicians in Southern Wisconsin from 2013-2016 spent half of their workday (5.9 hours) interacting with the EHR during and after clinic (Arndt 2017). Robertson et al. surveyed residents and faculty at 19 primary care programs and 75% of respondents with burnout attributed burnout to the EHR (Robertson 2017). Robertson also found that time spent after-hours on the EHR was associated with burnout and decreased work-life balance. In addition, a 2018 study by Gardner et al. determined there was a 2.8 increase in the odds for burnout among physicians that reported poor/marginal time for documentation, 1.9 odds of burnout among

physicians reporting moderately high/excessive EHR time at home, and 2.4 odds of burnout among those who agreed EHRs add to daily frustrations (Gardner 2019).

The literature on physician burden and EHR use is highly variable with no standardized methodology or metrics, and while there are many studies on the topic, there isn't a review of the most recent literature. This capstone project entails a rapid review of the research on physician burden and EHR use in the U.S. between January 2015 to February 2020, and assesses recurring themes and potential interventions that could mitigate the negative impact of EHR use on physicians in the U.S.

Methodology

A rapid review is a form of evidence synthesis that uses streamlined systematic review methods to provide information in a timely fashion for policy decisions (Temple, Hartling). Rapid reviews are best used for new or emerging research topics and critical topics (Temple). Given that fact that physician burden due to EHR use is a new and critical research topic, a rapid review was the method chosen for this capstone project.

Journal articles included in this rapid review were focused on physician burden due to electronic health records use. Article searches were performed in PubMed. During the PubMed search, MeSH terms were used to make subsequent searches reproducible. MeSH, or Medical Subject Headings, is a vocabulary thesaurus for indexing articles in PubMed. Physician burden was not a MeSH term, so it was defined broadly and MeSH terms "burnout, psychological", "workload", "job satisfaction", and "Attitude of Health Personnel" were used to cover physician burden. MeSH terms "electronic health records" for EHR and "physicians" for physicians were also used. The search results were then filtered for full text, English language, articles within the last 5 years, and journal articles.

After the PubMed search was completed, the search results were manually sorted based on inclusion and exclusion criteria. Inclusion criteria were: 1) research articles, 2) sample population within the US, 3) English language, 4) articles focused on physician burden, which could be burnout, workload, satisfaction, and attitudes with EHR use. Exclusion criteria were results that were not research articles, had study populations outside of the US, not in English language, articles not focused on physicians, physician burden, and EHR use.

The PubMed searches resulted in 174 articles. Additionally, twenty-one articles were found from other sources, including articles found in the references of relevant articles from the PubMed search results. After reviewing the abstracts of the 195 articles based on the inclusion and exclusion criteria, the remaining 47 articles were reviewed again based on their full text. After performing a thorough review of the 47 full text articles, 28 articles were included in the rapid review. Figure 1 visually demonstrates the search algorithm used in this Capstone project.

The relevant articles were then separated based on qualitative vs quantitative methods, then types of data used to assess physician burden and EHR use, and finally into smaller, more specific themes. Data types used by included studies were survey, log data, direct observation, and interview. Log data is data within the EHR system that tracks user activity, including clinical tasks performed in the EHR, such as documentation, orders, or chart review. The specific themes found were burnout, satisfaction, workload, attitudes, and time-tracking. Table 1 groups the 28 articles based on data types and major themes.

Results

Of the 28 articles that met the inclusion criteria for this rapid review, 27 articles were quantitative studies and 1 study was a qualitative study. Of the quantitative studies, 16 used

surveys, 6 used log data, 2 used direct observation, 2 used survey and direct observation, and 1 used survey and log data to assess physician burden secondary to EHR use. The qualitative study interviewed physicians and analyzed major themes.

Sample sizes varied greatly between studies, ranging from 5 Vascular Surgery residents to 155,500 physicians based on log data from Cerner's Light on Network across the US. Fifteen studies included physicians from all specialties and 13 studies focused on specific specialties, such as ophthalmologists, adult congenital cardiac specialists, pediatricians, or family medicine. Study locations were also highly variable; 8 studies were throughout the US, 15 studies took place in academic centers, hospitals, residency programs, or practices, 3 looked at physicians from a specific state, and 2 were across four states.

Quantitative Studies

1. Surveys

There were 16 quantitative studies that used surveys to assess physician burden and EHR use: 14 studies used a cross-sectional survey design, and 2 were longitudinal survey studies. The main themes were physician burnout, satisfaction, and workload with overlap of themes within some of the articles.

a. Burnout

Eight survey-based studies focused on physician burnout with EHR use with 7 of the articles being cross-sectional survey studies and 1 being a longitudinal survey study. Burnout was primarily assessed using the Maslach Burnout inventory (n = 5) or the Mini-Z (n =2). The Maslach Burnout Inventory, or MBI, is a validated 22-item questionnaire used to assess occupational burnout. The mini-z is another burnout questionnaire that consisted of only 10

items. The five studies that used the MBI were Marckini, Sinsky, Shanafelt, Domaney, and Melnick, and they found that the percent of physicians with at least one burnout symptom ranged from 24.1% to 63.5% (Sinsky 2017, Domaney 2018). The 2 studies that used the mini-z questionnaire had the percent of physicians with at least one burnout symptom ranging from 25.9% to 53.5% (Gardner 2019, Hauer 2018). In addition, Hauer et al. found that the number of burned out physicians was increasing (Hauer 2018); from 2014 to 2017, the percent of burnout increased from 46.9% to 53.5% among practicing Wisconsin physicians of all specialties (Hauer 2018).

Three studies found an association between burnout and EHR use, in the form of excessive time on the EHR after work (Hauer 2018, Gardner 2019, and Robertson 2017). Hauer traced burnout to 3 categories: clinical leader alignment, EHR/documentation time, and workload control. Hauer et al. found that frustration was directly correlated with number of hours spent on the EHR outside of work; the percentage of physicians reporting frustration with the EHR was 2 times higher among those that spent 8 or more hours on the EHR at home in comparison to the physicians that spent 0-2 hours on the EHR at home (85.1% vs 42%) (Hauer 2018). A cross-sectional study that surveyed 4197 physicians of all specialties in Rhode Island noticed a difference in the percent of burnout among EHR users and non-EHR users, with 27.2% of EHR using physicians had burnout, in comparison to 13.6% of physicians without an EHR (Gardner 2019). The study also found that 69.8% of respondents reported HIT-related stress, which was defined as 3 measures: frustration, excessive time on EHR at home, and insufficient time for documentation (Gardner 2019). Using adjusted models, Gardner found an association between burnout and the 3 HIT-stress measures (frustration AOR = 2.44, excess EHR time at home AOR = 1.93, insufficient documentation time AOR = 2.81) (Gardner 2019). Another

cross-sectional study that surveyed 585 residents and faculty physicians from Virginia, North Carolina, South Carolina, and Florida, reported that 37% of respondents had burnout and 75% of respondents attributed burnout to EHR use (Robertson 2017). In addition, respondents that spent more than 6 hours of EHR use after work were more likely to report burnout (OR = 2.9) and attribute it to the EHR (OR = 3.9) (Robertson 2017).

Domaney et al. assessed the relationship between EHR use and the separate components of burnout (emotional exhaustion, depersonalization, and personal accomplishment) among Psychiatry residents (n =40), ranging from postgraduate year 1 (PGY-1) to postgraduate year 4 (PGY-1), and faculty (n = 12) (2018). The study found that 60% of PGY1s, 87% of PGY2s, 50% of PGY3s, 40% of PGY4s, and 67% of faculty had at least one symptom of burnout (Domaney 2018). When aggregated together, 63.5% of respondents had burnout. Emotional exhaustion was positively correlated with EHR use outside of work (r = 0.54), hours reviewing EHR notes (r = 0.52) and total EHR time (r = 0.45). Personal accomplishment was negatively correlated with total EHR time (r = -0.48) and hours writing EHR notes (r = -0.50) (Domaney 2018). Faculty had similar results to residents, except there was a positive correlation between total EHR time and personal accomplishment (Domaney 2018).

One study looked at the association between burnout and the usability of the EHR. Melnick et al assessed burnout among 870 US physicians of all specialties using MBI and EHR usability measured by the System Usability Scale (SUS) (Melnick 2020). The SUS is an industry standard used to measure technology usability consisting of a 10-item questionnaire with a score ranging from 0 to 100 (Melnick 2020). Higher SUS scores represent higher usability and 68 is the average score across industries (Melnick 2020). The study found that 45.9% of their responders had at least one symptom of burnout and the mean SUS score was 45.9 (SD = 21.9),

which is the bottom 9% of usability scores across other industries and is categorized as “not acceptable”, or a grade F (Melnick 2020). On multivariate analysis, burnout was independently associated with SUS score, with 1-point increase of the SUS score associated with a 3% decrease of burnout (OR 0.97 (0.97-0.98) (Melnick 2020).

Instead of assessing the EHR’s impact on burnout, Marckini et al. assessed the impact of burnout on satisfaction with the EHR. A survey of 110 adult congenital heart disease physicians in the US found that those with burnout were more dissatisfied with clerical burden, EHR efficiency, and disagreed that the patient portal improved patient care (Marckini 2019).

One study’s results contradicted the association between burnout and EHR use (Shanafelt 2016). The study by Shanafelt et al. in 2016 surveyed physicians from the AMA Physician Masterfile and found that users of EHRs and Computerized Provider Order Entry (CPOE) had higher rates of burnout. However, after performing a multivariate analysis, only CPOE, and not EHR use, was associated with higher risk of burnout after adjusting for age, sex, specialty, practice setting, and hours worked per week (Shanafelt 2016).

b. Physician satisfaction

Seven articles focused on physician satisfaction with EHR use, including the previously mentioned articles by Sinsky and Shanafelt.

Three studies assessed satisfaction with specific functions of an EHR system: CPOE, patient portals, after visit summary (AVS), and discharge communication (Shanafelt 2016, Emani 2015, Sheu 2015). Shanafelt et al. found that among those who used EHRs, 36% were satisfied with the EHR, while 43.7% were dissatisfied, and only 23% believed the EHR improved efficiency, in comparison to the 62.5% that disagreed (2016). For respondents that used CPOE, 38.1% were

satisfied with their CPOE and 41.9% were dissatisfied with it (Shanafelt 2016). For patient portals, only 21.9% believed it improved efficiency, while 51% disagreed (Shanafelt 2016). The researchers also mentioned that physicians who used EHRs, CPOE, and patient portals had lower satisfaction with clerical burden related to patient care (Shanafelt 2016).

Emani et al. looked at physician satisfaction with the AVS among 853 physicians and, even though 80% of respondents reported that generating the AVS was easy, Emani found that many physicians had low satisfaction (66.2%) with the AVS (2015). In contrast, a study by Sheu found that slightly more than half (54%) of the 124 physician residents and attendings in the Division of General Internal Medicine at UCSF were satisfied with communication at patient discharge. However, while 71% receiving automated discharge notifications, only 39% felt the automated notifications with the discharge summaries were adequate for safe transition of care (2015).

One study focused on satisfaction was a longitudinal survey study. Ehrlich et al surveyed 56 to 62 ophthalmologists (varied at each time point) in the University of Michigan on satisfaction with their EHR after transition from paper charts measured 1 month before implementation, 3,7, 13, and 24 months after implementation, and analyzed curve shapes to assess for change (Ehrlich 2016). They differentiated the curve shapes into four types: J-curve, L-curve, U-curve, and flat line (Ehrlich 2016). In relation to the baseline, a J-curve represented an increase, a L-curve represented a decrease, a U-curve represented a decrease with subsequent return to baseline, and a flat line represented no change (Ehrlich 2016). Ehrlich found there was a decrease in job satisfaction; one month prior to EHR implementation, only 15.6% reported the health record system had a negative impact on job satisfaction, but, 24 months post-EHR implementation, that increased to 59% (flat line, $p = 0.01$) (Ehrlich 2016). However, there was no statistically significant change in overall job satisfaction (flat line, $p = 0.69$) (Ehrlich 2016).

One study looked at the effect of satisfaction with the EHR on work hours and physician retention. In Sinsky's study, the multivariate analysis showed respondents who were dissatisfied with their EHR were more likely to reduce work hours in 12 months (OR = 1.44) and leave current practice in 24 months (OR = 1.57) (Sinsky 2017).

In contrast, two studies found that most respondents were satisfied with their EHR. Raglan et al. evaluated factors affecting EHR adoption, strengths, and barriers of adopting an EHR, and physician satisfaction with EHR use among 689 surveyed Obstetrics-Gynecology physicians across the US (Raglan 2017). Among the 59.7% of surveyed physicians using an EHR, 63.2% reported they were satisfied with their EHR system vs 30.8% that reported they were unsatisfied with it (Raglan 2017). Williams assessed provider satisfaction among 111 physicians of all specialties at the Medical University of South Carolina. Responses were based on a continuous scale from 0 to 100 (0 representing "extremely negatively" and 100 representing "extremely positively", neutral response anchored at 50) and found that physicians were generally satisfied with the EHR (mean 58 (SD 22)) and physician perceived efficiency was correlated with overall provider satisfaction with the EHR($r = 0.68$) (Williams 2019).

c. Workload

Three survey studies assessed physician workload with EHR use. Emani's study that assessed physicians' satisfaction with the AVS also found that 76.1% of surveyed physicians believed generating the AVS increased physician workload and 81% of respondents reported generating and providing the AVS negatively impacted workflow (Emani 2015). On further analysis, the effect of AVS on workload was significantly associated with the number of hours worked per week (mean effect: >20 hrs -1.0, ≤ 20 hrs – 0.80, $p = 0.04$) (Emani 2015).

Coleman et al. compared the responses of surveyed Wisconsin physicians of all specialties in 2009 and 2014 (2015). The researchers found that 68% of Wisconsin physicians reported EHRs made their overall workload much or moderately worse and three-fourths of respondents felt that had no to only some control on the amount of time they spend completing EHR work (Coleman 2015). When looking at weekly EHR use after work in 2014, Coleman found that 30% of respondents spent 0-2 hours, 22.5% spent 2-3 hours, 18% spent 4-6 hours, 13.6% spent 6-8 hours, and 12% spent more than 8 hours per week. Hauer also looked at surveyed Wisconsin physicians, but from 2009, 2014, and 2017, and found that 64.2% of Wisconsin physicians in 2017 reported the EHR added frustration to their day and that increased number of hours spent on EHR after work was correlated with increased level of frustration (Hauer 2018). The researchers found that, from 2014 to 2017, there was a decrease in the number of physicians spending time on the EHR at home, except in the 4-6 hour and greater than 8 hour ranges, which increased by 0.9% and 5.7%, respectively (Hauer 2018).

d. Attitudes

Four survey studies focused on attitudes toward EHRs and EHR use. Doberne et al. assessed the attitudes of 808 US pediatricians toward EHR use when seeing new patients and found that there was a moderate to severe barrier in obtaining information from the EHR in the form of information inaccuracies, information overload, information poorly displayed, unable to find information, needed information not in EHR, and other providers don't record information consistently in EHR (2017). The 2017 Ehrlich study found that ophthalmologists believed that the EHR decreased their ability to create high quality documentation (ability to create high quality documents with system– 90.6% 1 month pre-implementation vs 37.9% to 55.0% post-implementation, L-curve, $p < 0.01$) and meaningful interactions with patients (system supported

meaningful interaction – 93.8% pre-implementation vs 12.8% 24-months post-implementation, L-curve, $p<0.01$), but there was no change in perceptions of patient safety (flat line, $p=0.43$) or efficiency/workflow ($p=0.97$). Jamoom et al. looked at the positive and negative EHR-related administration impacts among 1471 US physicians of all specialties (2016). The researchers found that a positive impact of EHR use was receiving faster lab results due to EHR (69%), while negative impacts were increased time spent reviewing patient information (70%), increased time spent on documentation (84%), and disrupted interactions with patients (60%) (Jamoom 2016). However, 60% of respondents also reported the benefits outweighed the costs of EHR use (Jamoom 2016). Raglan et al.'s study found that, among the 334 OB-GYN physicians using EHR, 50.3% reported it decreased time spent on pharmacy calls and time to receive and review lab results, but 66.8% of respondents stated it increased time spent planning, reviewing, ordering, and documenting care (2017).

Coleman et al. identified factors contributing to physician satisfaction and dissatisfaction, which included EHR use (Coleman 2015). The researchers found that 56% reported that using an EHR worsened patient-provider interaction and 50% reported there was not enough time to complete work in the EHR during the workday (Coleman 2015). However, there were some EHR factors that had a positive impact on physician satisfaction; half of respondents reported the EHR improved their ability to provide highest quality of care, 50% reported improved ability to communicate with other physicians based on the quality of chart notes, and 70% reported the availability of chart notes through the EHR has also improved communication between physicians (Coleman 2015).

2. Log Data

Of the 26 quantitative studies, 6 used log data to assess physician burden and EHR use. Five studies were descriptive studies and one was a retrospective cohort study. The main themes of these studies were time-tracking and workload.

a. Time-tracking

Five articles that used EHR log data focused on time-tracking. Three studies found that approximately half of the time spent in clinic is on the EHR, which ranged from 3.17 hours to 4.5 hours on the EHR per day (Arndt 2017, Tai Seale 2017, Overhage 2020). Physicians also spent a considerable amount of time on the EHR during after-hours with one study finding that physicians spent 1.4 hours per day on the EHR outside of clinical hours (Arndt 2017). Another study assessed vascular surgery residents' time spent on the EHR over the course of 6 months and found that residents spent 21.1% (on weekdays) to 22.0% (on weekends) of total EHR time after work (Aziz 2019). A study looking at time spent on documentation among trauma surgeons found that they spent 1,760 hours, or the equivalent of 73.3 24-hour days, completing 26,455 notes within 1 year (Golob 2016).

b. Workload

Only one study focused on workload, specifically EHR inbox notifications. Murphy et al. evaluated the inboxes of 92 physicians in 3 large practices in Texas and found that the mean total notifications/day for PCPs was 76.9 with 20.2% related to test results and, for specialists, it was 29.1 with 10.4 related to test results (2016). Based on the results of a previous study, which found that PCPs within the VA system spent a mean time of 49 minutes for 56.4 notifications a

day, Murphy was able to extrapolate that clinicians within this study spent 66.8 minutes/day processing notifications (Murphy 2012, Murphy 2016).

3. Direct Observation

    a. Time tracking

Two articles used direct observation to track time of EHR use during work hours. A 2016 study by Sinsky et al. used direct observation and an after-hours diary to assess time spent on the EHR during the working hours and after-work hours among 57 physicians from Family Medicine, Internal Medicine, Cardiology, and Orthopedics in 16 practices in 4 states (Sinsky 2016). The study found that 49.2% of the total time in the workday was spent on the EHR and desk work. While in the exam room, physicians spent 37% of their time on the EHR (Sinsky 2016). Twenty-one of the physicians reported with a mean of 1.5 hours per day on work after hours with 59% spent on the EHR (Sinsky 2016).

A 2015 study by Carayan found that the time spent on documentation and clinical review increased by 18-31% for residents and 14-27% for attendings after EHR implementation in 3 ICUs at a rural, tertiary hospital in the eastern United States (2015). Attendings also had a significant increase of time spent on order management (0.37-3%) (Carayan 2015). The average number of activities per hour also significantly changed for residents and attendings; residents had an increase of 31% of activities per hour (117 to 154), while attending saw a 23% decrease in their activities per hour (138 to 106) after EHR implementation (Carayan 2015).

4. Mixed Quantitative Methods

Three studies used a mix of survey and another quantitative method (direct observation or log data). Each study focused on different themes: burnout, time-tracking, and workload and attitudes.

a. Burnout

Tai-Seale et al in a 2019 study used log data and surveys to assess in-basket messages, burnout, and intended change in clinical work hours. Thirty-six percent of respondents reported having burnout symptoms. Researchers found that physicians had an average of 243 in-basket messages per week. Forty-five percent of physicians with burnout symptoms believed they had greater than average number of weekly system-generated in-basket messages, in comparison to 29% that believed they had average to less than average number of messages (Tai-Seale 2019). There also was higher odds of burnout and intention to reduce clinical work hours with the perception of above-average number of messages (Tai-Seale 2019).

b. Workload and Attitudes

Khairat et al. looked at workload using a sample of 14 Emergency Medicine attendings (n=8) and residents (n=6) who completed 6 Emergency Medicine scenarios within 1 hour and assessed time to complete, workload with the National Aeronautics Space Administration -Task Load Index (NASA-TLX), and satisfaction with the EHR's user interface with the Questionnaire for User Interaction Satisfaction (QUIS) (2018). The NASA-TLX is a workload assessment tool that measures perceived workload levels based on 6 dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration (Khairat 2018). The QUIS assesses satisfaction with specific aspects of a human-computer interface and measures overall

satisfaction based on 5 subscales: overall reaction, screen factors, terminology, and system feedback, learning factors, and system capabilities (Khairat 2018). The researchers found an association between EHR screen design and effort to find information, temporal demand levels, and overall perceived workload (Khairat 2018). In addition, when assessing frustration, attendings complained about warnings and error messages, such as alerts, due to their frequency and the rationale behind them, and residents complained about number of mouse clicks per task, orders being difficult to change after placement, alert fatigue, and information overload while reviewing patients' charts (Khairat 2018).

c. Time-tracking

Young et al. assessed time spent on the EHR using direct observation in clinic and a survey question to estimate time spent on the EHR at home. Similar results were found in comparison to studies that used log data, around half of clinical time is spent on the EHR and deskwork (54%) (Young 2018). This result was based on the total estimated EHR time per visit of 18.6 minutes and the average visit length of 35.8 minutes per patient (Young 2018).

Qualitative Study

a. Workload and Attitudes

Only one article was a qualitative study and it focused on EHR-related physician workload and attitudes. A 2016 study by Meigs et al performed a multiple case study among physicians in 13 family practice and 3 pediatrics office-based practices in San Antonio, Texas, and grouped by EHR adoption status (8 adopters, 4 partial adopters, and 4 non-adopters). Meigs utilized semi-structured interviews, field notes, and observation notes to assess workload and physicians' attitudes toward EHR use. The researchers found that while 75% believed the EHR

improved availability and access to records, 92% of respondents believed efficiency decreased due to increased administrative workload, workflow disruption, and the need to create workarounds (Meigs 2016). In addition, EHRs added significant time to the workday and increased workload with significant increase in administrative time, doubled in comparison to no EHR use (Meigs 2016).

Discussion

Studies have found that EHR use is associated with physician burden, in the form of increased burnout, increased workload, and increased length of time on the EHR. However, physician satisfaction, including job satisfaction, and attitudes toward the EHR system were mixed.

The number of physicians with at least one symptom of burnout varied between 24.1 to over 63.5% of surveyed physicians. In 6 out of 9 articles that focused on burnout and EHR use, burnout was associated with not enough time for documentation, high total amount of EHR use, EHR use after work hours, low EHR usability, and higher number of in-box messages (Gardner 2019, Robertson 2017, Hauer 2018, Domaney 2018, Melnick 2020, Tai-Seale 2019). Burnout was also associated with higher odds of intention to reduce clinical work in 12 months and leave current practice in 24 months (Sinsky 2017).

Five articles that focused on workload found that there was an increase in physician workload associated with EHR use. This was seen by increased effort processing in-box messages, generating the AVS for patients, increased administrative time, and increased time on documentation and chart review (Emani 2015, Murphy 2016, Meigs 2016, Coleman 2015, Hauer 2018). Workload was also impacted by the EHR interface, such as the screen design, which was associated with increased effort to find information, temporal demand levels, and perceived

workload (Khairat 2018). For studies that evaluated time of EHR use during and after clinical hours using log data and direct observation, they found that around half of clinical time is spent on the EHR, varying from 45% by Arndt et al. to 54% by Young et al. (Arndt 2017, Young 2018, Sinsky 2016, Tai-Seale 2017). Four articles noted that substantial time was spent outside of work hours on the EHR, varying from 21.7 minutes to 1.5 hours per workday (Young 2018, Arndt 2017, Sinsky 2016, Overhage 2020).

Unlike physician burnout and workload, physician satisfaction with EHR use was mixed; 5 out of 8 studies found a negative association between satisfaction and EHR use (Sinsky 2017, Shanafelt 2016, Emani 2015, Williams 2019), and 3 studies found a positive or no significant impact of EHR use on satisfaction (Ehrlich 2016, Sheu 2015, Raglan 2017). For instance, physicians who used an EHR were less likely to be satisfied with their clerical burden related to patient care (Shanafelt 2016). In addition, like burnout, EHR dissatisfaction was associated with higher odds of reducing clinical work or leaving current practice (Sinsky 2017). However, in another study, while 59% of surveyed ophthalmologists reported a negative impact of the EHR on job satisfaction 24 months post-EHR implementation vs 15.6% pre-EHR implementation ($p=0.01$, flat line), there was no statistically significant change in overall job satisfaction ($p = 0.69$, flat line) (Ehrlich 2017). Three other studies noted that most physicians were satisfied with their EHR or patient discharge communication (Raglan 2017, Sheu 2015, Williams 2019).

Physician attitudes toward their EHR systems were also mixed. Some of the negative aspects that physicians reported were information inaccuracies, decreased quality of documentation, decreased meaningful interaction with patients, and increased frustration due to the EHR (Doberne 2017, Ehrlich 2016, Hauer 2018, Jamoom 2016, Meigs 2016). Positive aspects mentioned were receiving laboratory results faster through the EHR system and better

care delivery (Hauer 2018). The EHR design played a role in increasing frustration with the system, with physicians complaining of frequency and rationale for warnings and error messages, number of mouse clicks per task, alert fatigue, and information overload while reviewing patient charts (Khairat 2018).

Implications

While EHRs were thought to be the solution for better quality of care, patient outcomes, care coordination, and accessibility to patient information, there has been an increase in physician burden due to EHR use (HealthIT). In this rapid review, EHR use was associated with increased burnout, increased workload, decreased satisfaction, and negative attitudes toward the EHR among physicians. In this world with quickly advancing technologies, EHR systems are an important part of US healthcare. Improving the EHR through better usability, reducing required documentation, reducing after-hours EHR use, and increasing direct patient care are important factors that should be considered when designing, updating, or changing an EHR system.

Recommendations to reduce physician burden related to EHR use

There have been many suggested solutions to decrease physician burden secondary to EHR use, including the use of scribes, better EHR training, improved usability of the EHR interface, and decreased documentation requirements for reimbursement. The use of scribes has been proposed as a solution to decrease physician burnout and improve efficiency by decreasing documentation burden for physicians. Gidwani et al. performed a study assessing physician satisfaction while working with scribes among 4 physicians and 2 scribes, and found that physicians had a high adjusted odds of expressing satisfaction with their clinic (10.75), having enough face-time with patients (3.71), and amount of time spent on documentation (86.09).

Improving EHR training has also been proposed as a potential way of decreasing physician burden by improving the physician's proficiency with their EHR system. The study by Robinson et al. looked at the use of an enhance EHR training program, which taught physicians ways to optimize their EHR, and found that, among the 3500 physicians that completed the training from 2014 to 2016, 78% reported time saving of 4-5 minutes or more per hour on EHR documentation. This translates into 40-60 minutes a day of less documentation time for physicians.

Improving the usability of EHR systems is another potential solution to reduce physician burden by reducing cognitive workload, click and pop-up burden, alert fatigue, and documentation time (Muzar 2019, Guo 2017). Muzar et al. looked at physicians' ability to locate abnormal laboratory results and follow evidence-based protocols for those results in the baseline EHR and an enhanced EHR that separated abnormal lab results in a separate folder and provided policy-based decision support for next steps (2019). Muzar found that the enhanced EHR reduced cognitive workload based on blink rate. The concept is that blink rate decreases with visual task demands requiring more attention and working memory load. The enhanced EHR had a higher blink rate of 24, while the baseline EHR participants had a lower blink rate of 16.

Guo et al.'s case study focused on physician-driven changes in New York-Presbyterian Brooklyn Methodist Hospital to enhance usability of the EHR among physicians (Guo 2017). A change mentioned by Guo et al. was the creation of an instant mobile documentation application that allowed physicians to review charts, dictate notes, places orders, and submit billing statements on a portable device like a tablet or smart phone (Guo 2017). Other EHR changes were the use of auto-population of abnormal lab results with color-coding, incorporating decision support with "soft stops" and "hard stops", and color coded EHR dashboards (Guo 2017). These

changes were beneficial because the mobile documentation application reduced documentation time, auto-population and color-coding of abnormal lab results reduced click burden and increased quick identification of abnormal lab results, decision support reduced click burden and ordering of inappropriate tests, and the dashboards reduced need for pop-ups, alert fatigue, and click burden (Guo 2017).

Another solution for reducing physician burden secondary to EHR use was reducing documentation and billing requirements for reimbursement. Downing et al. compared the US healthcare system and healthcare systems in other countries and found that US physicians spend 4 times as much time on documentation (2018). He also notes that the HITECH Act and the initiation of Meaningful Use incentives unintentionally increased the amount of documentation, doubling the length of physician notes (Downing 2018).

Fortunately, the US Congress has recognized the importance of reducing administrative and regulatory burden associated with EHR use in the 21st Century Cures Act, passed in 2016. The 21st Century Cures Act directed HHS to create goals, a strategy, and recommendations to reduce provider burden due to EHR use. The HHS created three goals: reduce the effort and time to record health information, reduce effort and time to meet regulatory reporting requirements, and improve functionality and ease of use of EHRs. On February 2020, HHS released a report titled "Strategy on Reducing Regulatory and Administrative Burden Relating to the Use of Health IT and EHRs" that contains strategies and recommendations to reduce EHR-related provider burden.

Limitations

There are three major limitations with this paper: 1) most of the studies that met inclusion criteria had a cross-sectional/observational study design, which impacts the ability to assess causality due to the lack of temporality. 2) a majority of studies were survey-based, which can be affected by response bias, where respondents and non-respondents might differ substantially leading to a skewed perspective of physician burden and EHR use. 3) the generalizability of study findings is also another limitation as most studies were focused on a sample population within a hospital/healthcare system, a state, or a specialty. However, three out of 4 studies that were nation-wide and included all physician specialties found similar results to studies focused on specific locations or specialties.

Conclusion

Physician burden secondary to EHR use is a major concern in the US, especially as the rate of burnout increases among US physicians (Shanafelt 2019). Over the last five years, there has been many studies focused on this topic, and the number of these studies are likely to increase in the future. A potential area of study is physician burden and the impact of the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA), which created the Quality Payment Program tracks, the value-based payment system called the Merit-based Incentive Payment System (MIPS) and Advanced Alternative Payment Models (APMs). This is an area worth exploring because it changed EHR reporting measures from the ones created by the Meaningful Use Incentive programs. Another area of future study is the HHS's strategies and recommendations to reduce EHR-related provider burden.

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Table and Figures

Figure 1. The literature search algorithm for the rapid review.

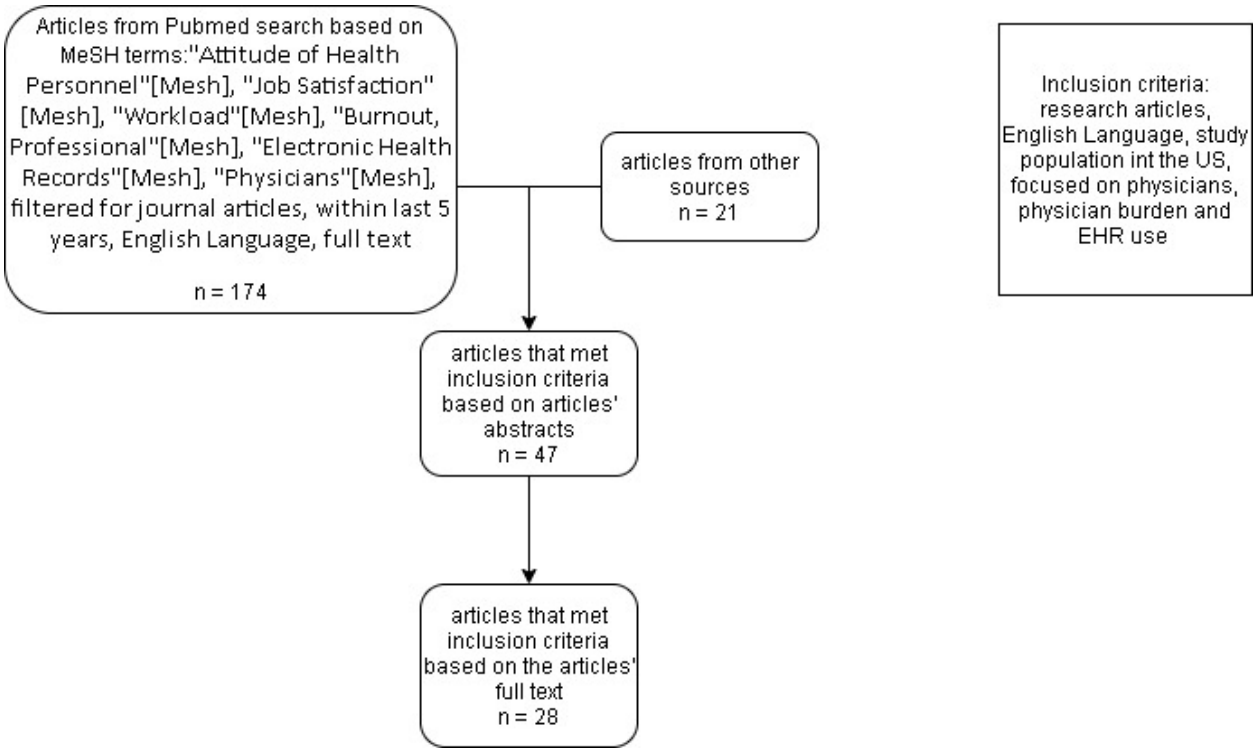

Table 1. The 28 studies that met inclusion criteria grouped by major themes, some studies covered multiple themes and are mentioned more than once.

Themes	Quantitative (n =27)				Qualitative (n =1)	Total
	Survey (n= 16)	**Log Data (n=6)**	**Direct Observation (n=2)**	**Mixed (n=3)**	**Interview (n=1)**	
Burnout	Marckini 2019 Sinsky 2017 Shanafelt 2016 Domaney 2018 Melnick 2020 Gardner 2019 Hauer 2018 Robertson 2017 (n=8)			Tai-Seale 2019 (n=1)		**9**
Satisfaction	Sinsky 2017 Shanafelt 2016 Raglan 2017 Emani 2015 Sheu 2015 Ehrlich 2016 Coleman 2015 Williams 2019 (n=8)					**8**
Workload	Emani 2015 Coleman 2015 Hauer 2018 (n=3)	Murphy 2016 (n=1)		Khairat 2018 (n=1)	Meigs 2016 (n=1)	**6**
Attitudes	Doberne 2017 Jamoom 2016 Raglan 2017 (n=3)			Khairat 2018 (n=1)	Meigs 2016 (n=1)	**5**
Time-tracking		Tai-Seale 2017 Overhage 2020 Arndt 2017 Aziz 2019 Golob 2016 (n=5)	Sinsky 2016 Carayan 2015 (n=2)	Young 2018 (n=1)		**8**

Biographical Sketch

Dr. Lori Wong is finishing her Master of Public Health degree with a concentration in Population Health Policy and Management at the University of Kentucky. She is also a General Preventive Medicine resident at the University of Kentucky and plans on pursuing a career in Clinical Informatics.