LOVE IT? HATE IT? IT'S COMPLICATED
Electronic Medical Record User Experience

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Purpose and Overview:

The purpose of this session is to review the history and background of the coming of electronic medical record (EMR), the advantages as well as the unintended consequences of EMR implementation, and the UT Southwestern experience.

Objectives:

At the conclusion of this lecture, the listener should be able to:

1. Understand the evolution of EMR and its adoption.
2. Recognize the advantages of EMR
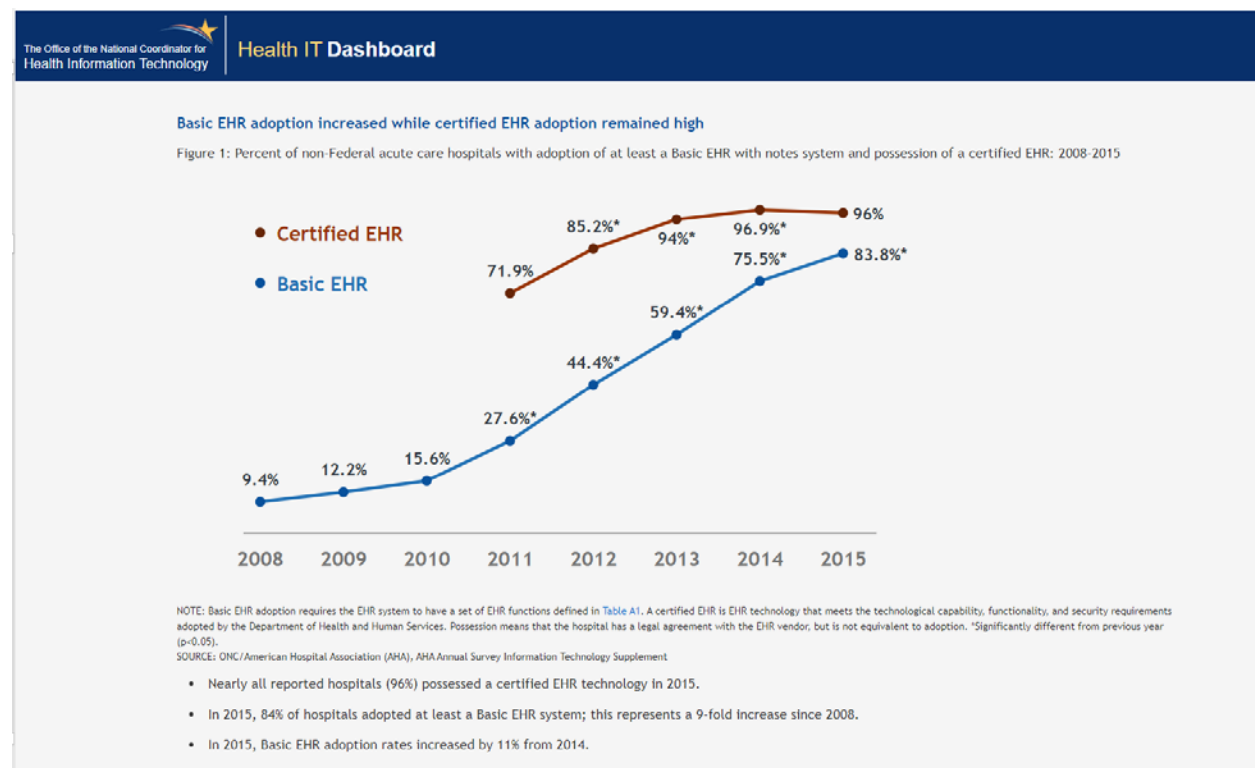3. Recognize some shortcomings and unintended consequences of EMR adoption

Background:

The Health Information Technology for Economic and Clinical Health (HITECH) Act is a part of an economic stimulus package introduced during the Obama administration: The American Recovery and Reinvestment Act of 2009 (ARRA).

The HITECH Act was created to encourage and expand the adoption of health information technology, especially, the use of electronic health records (EHRs) by healthcare providers.

The Health Insurance Portability and Accountability Act (HIPAA) of 1996 was created to require Health and Human Services (HHS) to adopt national standards for electronic health care transactions and code sets, unique health identifiers, and security. The HITECH Act of 2009 also expanded the scope of privacy and security protections available under HIPAA compliance by increasing the potential legal liability for non-compliance.

To ease the cost of transition to EHRs, the HITECH Act specifies that by the beginning of 2011, healthcare providers will be given monetary incentives for being able to demonstrate meaningful use of EHR. These monetary incentives will be offered until 2015, after which time penalties will be levied for failing to demonstrate such use.

Prior to the introduction of the HITECH Act in 2008, only 10% of hospitals had adopted EHRs. The Act increased the rate of adoption of EHRs from 3.2% in 2008 to 14.2% in 2015. By 2015, nearly all reported hospitals (96%) possessed a certified EHR technology in 2015[1].

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Basic EHR adoption increased while certified EHR adoption remained high

Figure 1: Percent of non-Federal acute care hospitals with adoption of at least a Basic EHR with notes system and possession of a certified EHR: 2008-2015

- **Certified EHR**
- **Basic EHR**

NOTE: Basic EHR adoption requires the EHR system to have a set of EHR functions defined in Table A1. A certified EHR is EHR technology that meets the technological capability, functionality, and security requirements adopted by the Department of Health and Human Services. Possession means that the hospital has a legal agreement with the EHR vendor, but is not equivalent to adoption. *Significantly different from previous year (p<0.05).
SOURCE: ONC/American Hospital Association (AHA), AHA Annual Survey Information Technology Supplement

- Nearly all reported hospitals (96%) possessed a certified EHR technology in 2015.
- In 2015, 84% of hospitals adopted at least a Basic EHR system; this represents a 9-fold increase since 2008.
- In 2015, Basic EHR adoption rates increased by 11% from 2014.

By 2017, nearly 9 in 10 (86%) of office-based physicians had adopted any EHR[1] and nearly 4 in 5 (80%) had adopted a certified EHR[1]. Since 2008, office-based physician adoption of any EHRs has more than doubled, from 42% to 86%. ONC and the CDC began tracking adoption of certified EHRs by office-based physicians in 2014.

Table:

Percentage of Office-based Physicians with Electronic Health Record System
2004 - 2017

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2017
Any EHR	20.8%	23.9%	29.2%	34.8%	42%	48.3%	51%	57%	71.8%	78.4%	82.8%	86.9%	85.9%
Basic EHR	--	--	10.5%	11.8%	16.9%	21.8%	27.9%	33.9%	39.6%	48.1%	50.5%	53.9%	--
Certified EHR	--	--	--	--	--	--	--	--	--	--	74%	77.9%	79.7%

Advantages of EHR:

The initial goals of EHR was to advance healthcare by reducing errors, increase efficiency, improve quality of care and care coordination by easing the burden of information sharing between different covered entities.

One early study[2] conducted by Brigham and Women's Hospital in 1998 showed physician computer order entry (CPOE) decreased the rate of non-intercepted serious medication errors by 55%. Although this decrease was larger for potential adverse drug events (ADE) then for errors that actually resulted in an adverse drug event, this was one of the early studies that suggested CPOE can reduce costs and improve quality and that hospitals should consider adopting such systems. The CPOE application in the study functioned as part of an internally developed information system and included medications in the formulary with defaulted doses and a range of potential doses for each medication. These orders were legible including the signatures. Results of the study showed a decrease in preventable ADE by 17%. At an estimated annual costs of preventable ADEs of $2.8 million at that time, the annual savings would be $480,000. Other studies subsequently confirmed reduce medication errors. One recent study published in 2019 [3] showed the medication error rate was reduced from 50.2% to 28.2% (P<0.01). The number of medication errors related to dosage were reduced by 22% (P<0.01). Some studies suggested that serious medication errors can be reduced by as much as 83% when coupled with a clinical decision support system that generates alerts based on what the physician orders [4].

What about efficiency? A Canadian study conducted in 2016 [5] analyzed computerized order entry and showed errors reduction in electronic prescriptions and associated pharmacy calls to clarify. This was achieved by validation messages to ensure the prescriptions had all the required information, pharmacy and prescriber name, DEA information if required, patient sig and demographic information, and administration instructions. A total of 602 prescriptions were analyzed, 301 before implementation and 301 after. Of these prescriptions, 20.27% had errors before implementation and 12.96% had errors after. The decline in error rate was

statistically significant with p<0.05. The cost savings were estimated at $76 per 100 prescriptions for pharmacist and physician time-cost estimates combined.

EHR has shown to improve patient safety and subsequently, quality of care. In one 2016 study[6], optimization of an EHR-embedded clinical decision support (CDS) implementation of the Beers' Criteria for medication management and the Cockcroft-Gault formula showed that only 25% of alerts were acknowledged without change and about 15% elicited an evidence check implying clinicians were adjusting and therefore prescribing per evidence based guidelines. In another study, computerized physician reminders increased the use of influenza and pneumococcal vaccinations from 0% to 35% and 50% respectively, for hospitalized patients.[7] Other studies on vaccination rates found comparable results that reminders within EHR improve adherence to immunization guidelines.[8]

One study conducted from July 2009 through June 2010 found care sites with EHR were associated with higher achievement on eight of nine component standards in diabetic care. Those sites were also associated with greater improvement in care and outcomes. (a difference of 4.1% in annual improvement P0.02)[9]

Another benefit of EHR is care coordination by having patient information available electronically. Reduction of redundant or duplicate tests and speeding up the information exchange between clinicians by eliminating mail delivery of paper information and chart pulling facilities better care coordination among clinicians in the care of shared patients. One study by Nies et al[10] found that computerized reminders of previous blood tests reduced the steady increase of duplicate tests. In the study, the mean proportion of unnecessarily repeated HBs antigen tests increased by 0.4% per month (absolute increase, 95% CI 0.2% to 0.6%, p < 0.001). After the implementation of EHR enabled feature, a significant trend change occurred, with a monthly difference estimated at -0.4% (95% CI -0.7% to -0.1%, p = 0.02) resulting in a stable proportion of unnecessarily repeated HBs antigen tests. A study published in AMIA Annual Symposium Proceedings in 2009[11], showed according to 2 surveys, compared to clinicians without EHR, clinicians with 6+ months of EHR use more frequently reported timely access to complete information, and being in agreement on treatment goals with other involved clinicians.

There is also a larger, societal benefits of EHR. Patient portal allows for another venue for recruitment in research studies for societal benefits. Furthermore, our study at UTSW suggests that patient portals may offer an additional advantage of minimizing bias and encourage broader, more inclusive participation in research.[12] With patient data stored electronically, data availability and accessibility is improved and allows for more quantitative analyses.[13][14]

Disadvantages of EHR:

Despite technological advances of EHR, physician burnout has become a significant issue. Reports of high rates of physician burnout and abnormally high rates of physician suicide gained

increasing attention. According to a 2018 Medscape report, physicians have the highest rate of suicide of any profession, more than twice that of the general population. [15]

Although burnout is complex and multifactorial, according to a 2019 national survey [16], EHR is among the top contributors to burnout ranking at number 4, behind "too many bureaucratic tasks, spending too many hours at work, and lack of respect from administrators, employers, colleagues or staff.

In a 2005 study [17] ,utilizing Physician Worklife Study instrument, 420 mostly primary care physicians were surveyed. The study showed 27% of physicians noted burnout symptoms and 31% said they were at least moderately likely to leave their jobs within 2 years. Fast forward to a 2018 study[18], where virtually every physician in the United States with an emailed address on record with the American Medical Association's Physician Master File were contacted, respondents surveyed show no improvement. In that study, of the 8,774 survey responses received, 62% were pessimistic about the future of Medicine, 55% describe their morale as somewhat or very negative and 78% said they sometimes, often or always experience feelings of burnout. Physicians indicated that patient relationships were their greatest source of professional satisfaction while EHR was their greatest source of professional dissatisfaction. In 2016, the same survey showed 59.8% respondents thought EHR distracted them from patient interaction and 32.9% said interaction was improved. However, in the subsequent 2018 survey, 65.7% thought EHR distracted them from interaction and only 9.9% thought there was improvement. Also of note was in 2016, 29.3% thought EHR reduced their efficiency but in 2018, 56% has said efficiency was reduced with EHR. Reduction of efficiency and patient interaction were the highest dissatisfying factors in EHR contributing to burnout.

A 2019 study has shown that documentation tasks took a toll on physicians' time and attention.[19] In ambulatory setting, where exam room computing has become a norm, an unintended consequence occurred where documentation tasks took up valuable face to face patient interaction time. In this study of five VA physicians, all asserted that the EHR competed for their attention and took time away from patients. In 2018, Olsen et al published a cross sectional survey of workplace stressors associated with physician burnout.[20] In this study, 475 physicians were included: academic faculty (372), hospital employed (52), and private practitioners (81). Prevalence of burnout was 56.6%. Predictors of burnout were poor control over workload, inefficient teamwork, insufficient documentation time (OR =5.83, 95% CI), hectic-chaotic work atmosphere, lack of value-alignment with leadership, and excessive electronic medical record time at home (OR = 1.99, 95% CI).

Insufficient documentation time was studied in 2018 by Gardner et al[21]. 4197 physicians in Rhode Island were surveyed for their EHR use. Of the 1792 respondents, physicians reporting poor/marginal time for documentation had 2.8 times the odds of burnout (95% CI; p<0.00001), compared to those reporting sufficient time. Physicians reporting moderately high/ excessive time on EHRs at home had 1.9 times the odds of burnout (95% CI; p<0.0001).   Female gender was associated with higher odds of burnout symptoms (AOR 1.41) compared to male in general as well as EHR related issues.

The term "pajama time" has been coined to notate time spent on EHR outside of work hours. In a 2016 publication[22], where 57 physicians from 16 practices in 4 states were observed in a time motion and self-report study, it was found that for every hour physicians provide direct clinical face time to patients, nearly 2 additional hours is spent on EHR and desk work within the clinic day. Outside office hours, physicians spent another 1 – 2 hours of personal time each night doing additional computer and other clerical work. During the office day, physicians spent 27% of total time on direct clinical face time with patients and 49.2% of time on EHR and desk work. In the exam rooms, 52.9% of time was spent in direct clinical face time and 37% on EHR and desk work. 21 physicians completed after-hours diaries reported 1 – 2 hours of after-hours work each night, devoted mostly to EHR tasks.

It's complicated
Usability is important:
Although EHR adoption has been ongoing for many years, user satisfaction has not improved from 2014 compared to 2015[23] or from 2016 to 2018[17].

It may be logical to assume, more EHR enhancement would lead to better user satisfaction and hence less stress. One study in 2014[24] showed that stress may rise with a moderate number of EHR functions compared to the low function EHR group. Compared to the low EHR cluster, physicians in the moderate EHR cluster reported more stress (p=0.03) and lower satisfaction (p=0.01). Time pressure was also associated with poor physician outcomes mainly in the high EHR cluster.
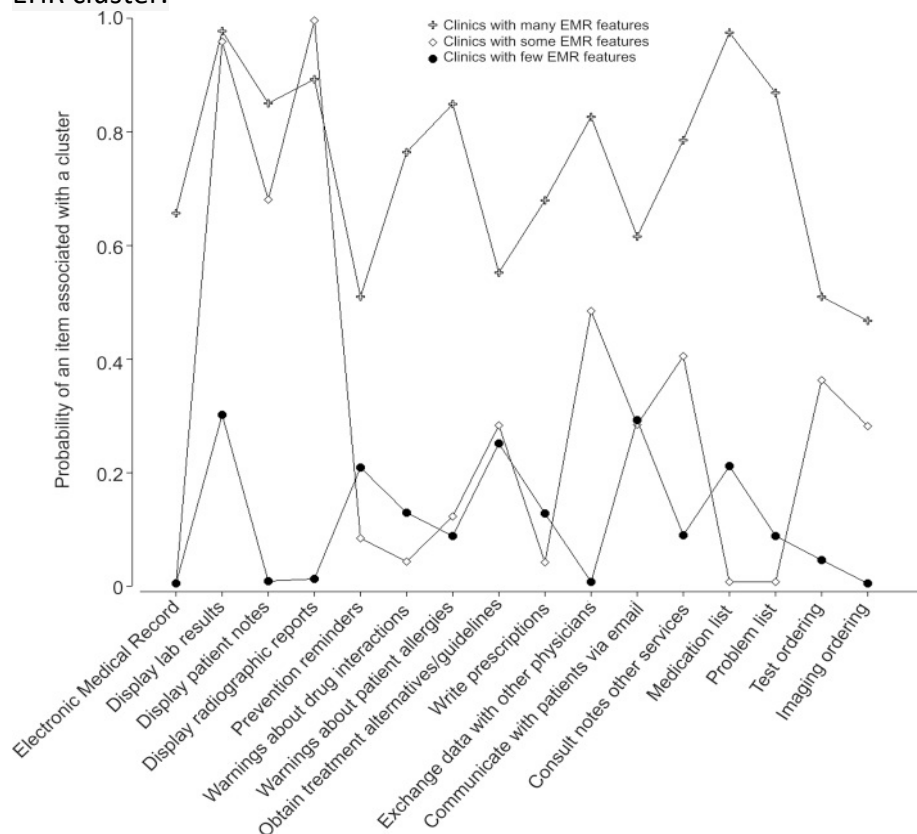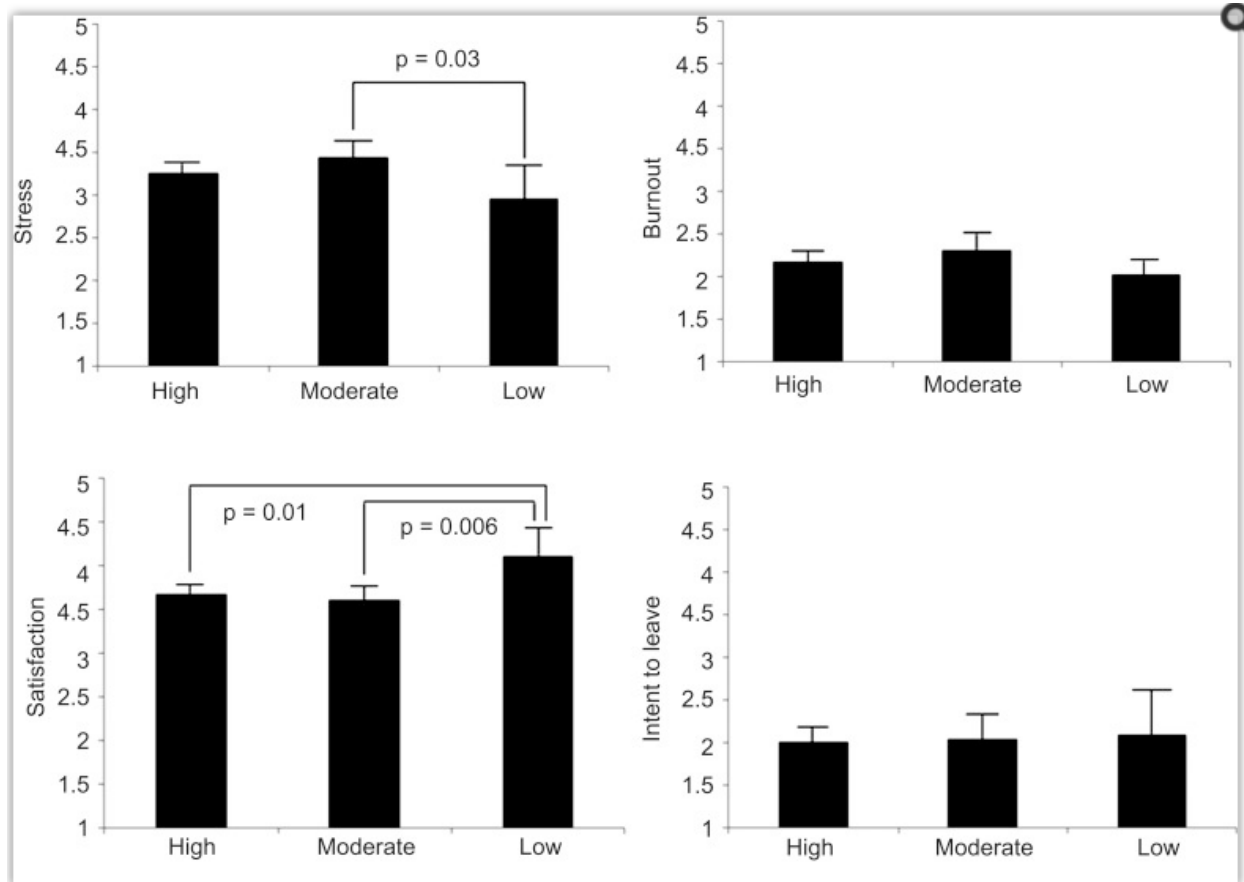
Stress scored on five-point scale, ≥3 defined as 'stressed'; Satisfaction scored on five-point scale, ≥3 defined as 'satisfied'; Burnout scored on five-point scale, ≥3 defined as 'burned out'; Intent to leave scored on five-point scale, ≥3 defined as 'likely to leave'.

A more recent study in 2019[25], however, found that relatively simple EHR enhancement decrease cognitive workload. In this study of 38 participants, researchers studied 2 groups of EHR users, a group with baseline function where all patients with abnormal or critical test results were placed in a general folder and provided no decision support instructions for next steps was compared to the study group where EHR was enhanced with dedicated folder previously identified critical test results for patients who did not appear for a scheduled follow up evaluation and provided policy-based decision support instructions. Cognitive burden was quantified subjectively using NASA-Task Load Index and physiologically using blink rates. Performance was quantified according to the percentage of appropriately managed abnormal test results. The 18 participants in the enhanced EHR demonstrated statistically significant

lower cognitive workload. These studies suggested that there is an optimal level of EHR enhancement that leads to better user satisfaction and that the next generation systems should strip away non-value added EHR interactions.

What then, is the optimal level of EHR enhancement? How does one add enhancement without sacrificing usability. First, usability has to be measured. System Usability Scale (SUS) was developed by John Broke in 1986. It allows manufacturers to evaluate a variety of products and services, including software, hardware, mobile devices and websites. It is a 10-item questionnaire with 5 response options for respondents, from strongly agree to strongly disagree.   In this scale, users rated Google search as number one with a SUS score of 93, giving it an "A" grade. Amazon has a score of 82, receiving a B grade. In comparison, EHR received a score of 45, putting it in the "F" category.[26] This study in 2019 attempted to shed some light on the correction of EHR usability and burnout. This cross-sectional survey of US physicians received 5197 responses (17.1% response rate). Surveys were sent out to 30,456 physicians using the AMA Physician Masterfile. EHR usability was scored using SUS scale. Burnout was measured using the Maslach Burnout Inventory. Physician-rated EHR usability was independently associated with the odds of burnout with each 1 point more favorable SUS score associated with a 3% lower odds of burnout (OR 0.97; 95% CI, p,0.001). The authors concluded that EHR received a grade of F by physician users evaluated using a standardized metric of technology usability. They also concluded that there is a strong dose-response relationship between EHR usability and the odds of burnout.

A

B

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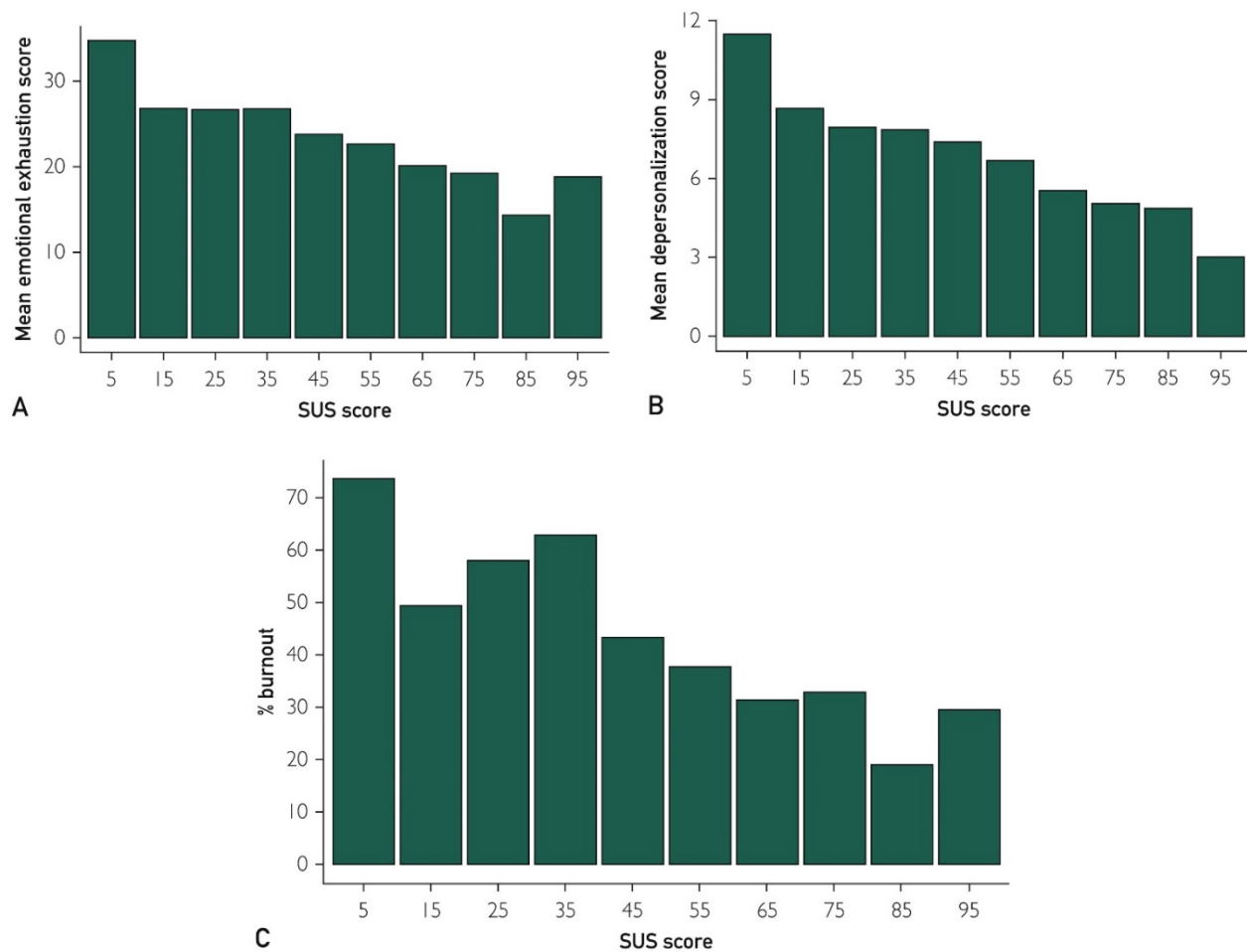
Additional observation from that study included while SUS scores varied widely by practice location, those who worked in an academic medical center rating their HER less favorabliy (p=0.002)   Older physicians were more likely to rate their HER as less usable (for each 1 year older, coefficient, -0.19; 95% CI, p =0.007). In this study, there was no gender relationship observed. SUS score was the highest among Anesthesiologists and lowest among General Surgeons.

A

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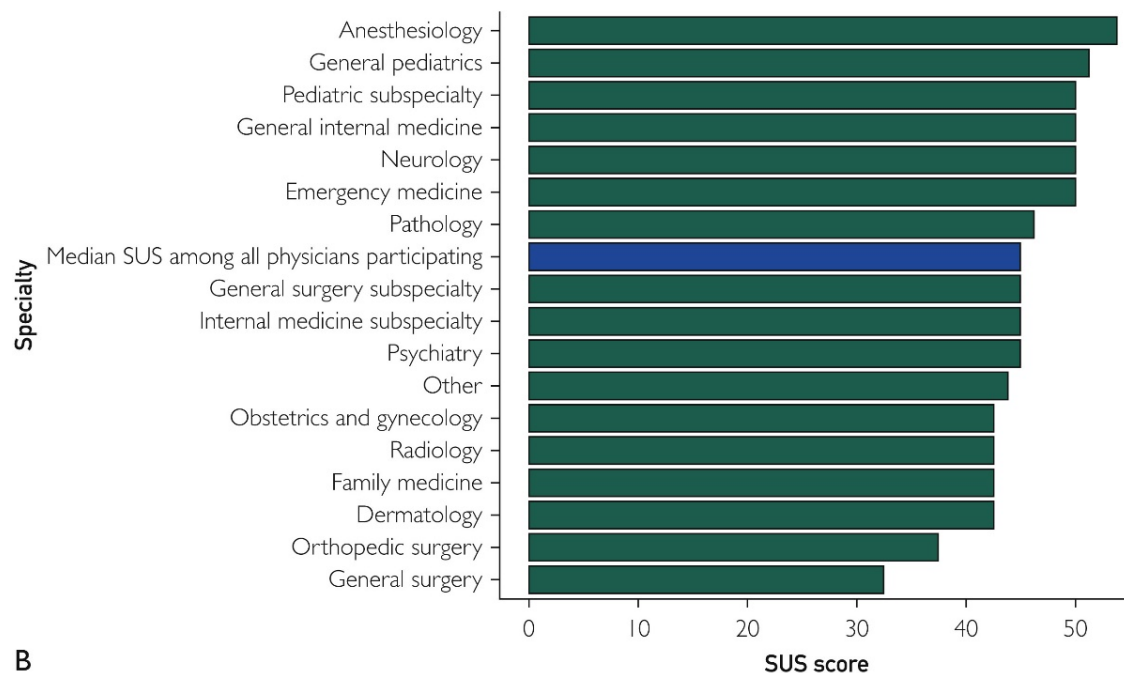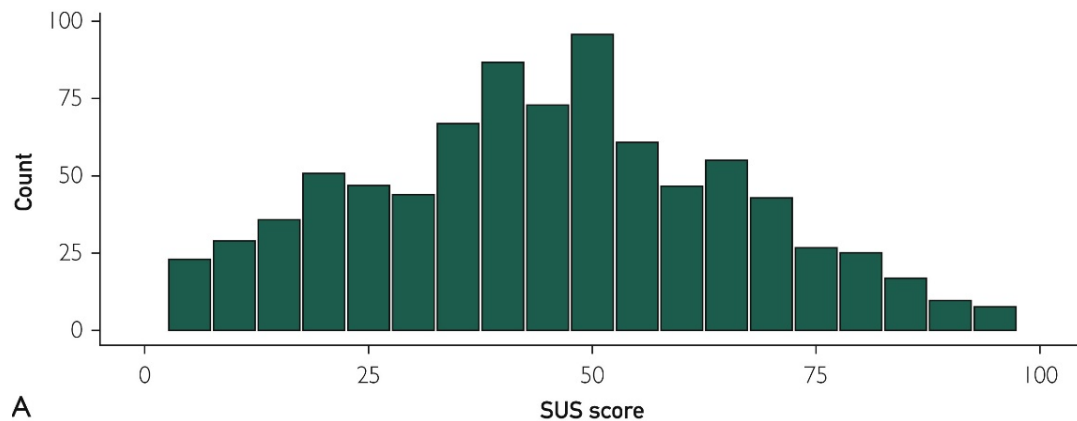
It's complicated
There are other factors at play:
While it is understandable that the design and usability of EHR would influence provider satisfaction, could one further infer that high EHR satisfaction would lead to low burnout? One study published in 2019 showed that although EHR design and use factors are associated with clinician stress and burnout, other challenges, such as chaotic clinic atmospheres and workload control deserved same attention.[27]

In this study, 282 ambulatory primary care and subspecialty clinicians from 3 institutions were surveyed on stress and burnout, opinions on EHR design and use factors, and coping strategies. Most participants noted stressful work conditions: 74.5 % reported time pressure for documentation, 60.2% spent moderately high or excessive time on the EHR at home,. Overall, 50.4% felt they had insufficient personal time, 47.5% reported having minimal coverage for their EHR inboxes when needed. 76.2% of respondents said that productivity was overemphasized, 49.6% reported marginal or poor control over workload and 50.7% judged their office atmospheres as chaotic or tending toward chaotic. Almost half

described symptoms of burnout in this study. The authors found the most prevalent concerns about EHR design was information overload, slow system response times, excessive data entry, inability to navigate the system quickly, note bloat , fear of missing something, interference with the patient-clinician relationship, and notes geared toward billing. Overall, EHR design and use factors accounted for 12.5% of variance in measures of stress and 6.8% of variance in measures of burnout. In contrast, work conditions including chaos, physical symptoms from computer use accounted for 36.2% of variance in burnout.   The authors concluded that while EHR use contributes to burnout, other factors like office atmospheres, control of workload deserves equal attention.

Documentation needs, time pressure to complete chart and excessive "pajama time" are factors contributing to EHR burnout that are often cited. One article from 2018 discussed the fact that while many blame vendors for physician dissatisfaction with EHRs and the associated increase in burnout, it was the US government and ultimately hospitals and health systems that should share the blame.[28] According to Epic Systems unpublished data, US clinical notes have doubled in length after HITECH was enacted. Although the Merit-based Incentive Payment System (MIPS) and other incentive programs are focused on moving the US system from a fee-for-service toward a value-based model, they have documentation requirements that clinicians found increasingly taxing. The authors suggested that the EHR vendors that benefited from HITECH have disproportionately focused on developing robust financial and compliance features at the demands of hospitals and health systems. While adequate documentation secure financial return, it may be at a cost of usability. Compared to other Epic customers overseas, US clinical notes were nearly 4 times longer on average. Physicians abroad were more likely to report satisfaction with EHR use and cite it as an efficiency tool.
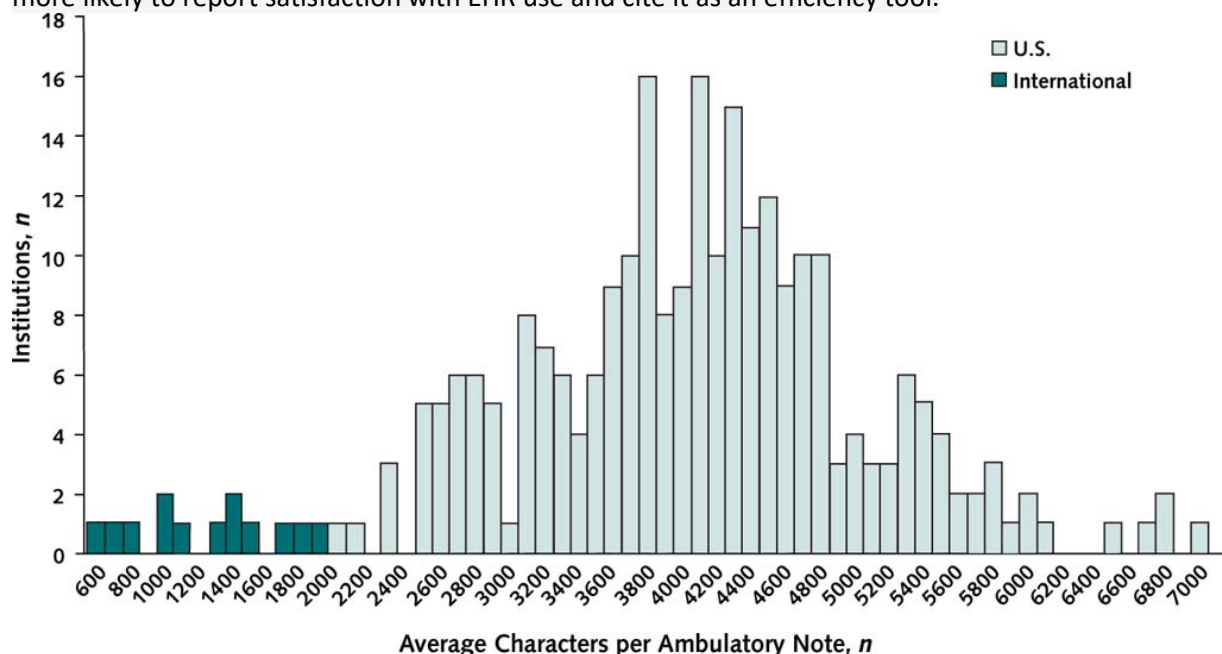
They were also more likely to have briefer note, containing only essential clinical information and omits much of the compliance and reimbursement documentation that commonly bloats the American clinical note.

What then, can be done?
Optimization and Training

Documentation requirement and its billing / coding focus has drawn physician criticism of EHR use. However, could it be possible that lengthy note actually equates to a quality note? According to Edwards et al [29], subjective assessment of note quality did not correlate with clinical quality scores. The implication is that even if a lengthier note equates to a higher quality note, it has no correlation to quality of care. Using a 9 item Physician Documentation Quality Instrument (PDQI-9), 239 notes written by primary care physicians, cardiologists and endocrinologists were assessed. Reason for visit was absent in 10% of notes, significant copy/pasted material was present in 10.5% of notes. Clinical quality scores for diabetes and coronary artery disease showed no significant association with subjective note quality.

Optimizing EHR documentation tools may help ease the burden. A study published in 2018 showed note template may help.[30] Interns from 4 academic hospitals on inpatient service were given lectures on note writing and suggestion of using best-practice note templates. Note quality was rated using PDQI-9. Reviewers documented number of lines per note and time signed. Of the 199 post intervention notes reviewed, significant improvements were seen in the general impression score, all domains of the PDQI-9 and multiple competency items. Documentation of only relevant data was found. Notes were concise and complete with 25% fewer lines and were signed on average 1.3 hours earlier in the day.

Part of optimization is getting rid of unnecessary items and clicks. Our study in 2019[31] showed that EHR can be leveraged to identify and remove features that add to the EHR burden without adding value to care delivery. In our first initiative, review of EHR usage data in our ambulatory clinicians revealed that General Internal Medicine (GIM) physicians were receiving 3 times as many "CC Chart" messages in their inbox as specialists in the same organization. This amount of CC charts was a result of a programming point that automatically sends a copy of each non-PCP clinic note to the PCP on file when the encounter is closed. Consensus was reached among physician leadership and the practicing clinicians to abandon this practice and use only intentional CC Chart routing. The result was cutting pre-intervention volume of 9,500 CC chart to under 5,000 messages per month. In our second initiative, we eliminated the requirement of second password entry in the order workflow, saving 692,465 password entries among our 1,917 ordering clinicians over a 7.5 month period in our outpatient setting.

Another study in July 2019[32] found that in a multispecialty practice, inbasket messages generated by the EHR system accounted for almost half of the weekly in-basket messages received per physician, on average, exceeding the numbers received from their colleagues and patients. Furthermore, receiving more than the average number of system-generated inbasket messages was associated with 40% higher probability of burnout and 38% higher probability of intending to reduce clinical work time.   The authors concluded that meaningful redesign of EHR inbasket workflow and a wellness-enhancing work environment are necessary to effectively improve physicians' well-being.

One study published in Mayo Clinic Proceedings in 2019[33] showed that a clinic-focused Sprint process (an intensive team-based intervention) can optimized EHR efficiency and improved satisfaction. In that study, an 11-,e,ber team including 1 project manager, 1 physician

informaticist, 1 nurse informaticist, 4 EHR analysts and 4 trainers worked in conjunction with clinic leaders to conduct on-site HER and workflow optimization for 2 weeks using an Agile project management approach. The Sprint team trained clinicians and staff, built specialty-specific EHR tools and redesign teamwork. They reported that with the use of the Net Promoter Score, clinician satisfaction with the EHR increased from -15 to +12. Using a modified version of the Maslach Burnout Inventory, the authors found that before the Sprint, 39% of clinicians reported feeling burnout; after the Sprint, the percentage was 34%. This however, did not reach statistical significance (p=0.434).

Looking ahead:

Increasing artificial intelligence employment may ease EHR burden. AI powered virtual assistants may further improve EHR usability. Vendors are increasing aware of usability and the importance of user satisfaction. Features like "Hey Epic", which mimics "Hey Siri" or "Alexa" in EHR may further gain acceptance within medical communities.

Legislation is also increasingly aware of clinician EHR burden. Centers for Medicare and Medicaid Services (CMS) is implementing the Documentation Requirements Simplification (DRS) Initiative. As of January 1, 2018 a teaching physician does not have to re-document a medical student's notes of an E&M visit, but can verify them. The effort is ongoing. If you are interested, send your feedback and suggestions to ReducingProviderBurden@cms.hhs.gov.

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