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Perspective

The impact of electronic health record–integrated patient-generated health data on clinician burnout

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ABSTRACT

Patient-generated health data (PGHD), such as patient-reported outcomes and mobile health data, have been increasingly used to improve health care delivery and outcomes. Integrating PGHD into electronic health records (EHRs) further expands the capacities to monitor patients' health status without requiring office visits or hospitalizations. By reviewing and discussing PGHD with patients remotely, clinicians could address the clinical issues efficiently outside of clinical settings. However, EHR-integrated PGHD may create a burden for clinicians, leading to burnout. This study aims to investigate how interactions with EHR-integrated PGHD may result in clinician burnout. We identify the potential contributing factors to clinician burnout using a modified FITT (Fit between Individuals, Task and Technology) framework. We found that technostress, time pressure, and workflow-related issues need to be addressed to accelerate the integration of PGHD into clinical care. The roles of artificial intelligence, algorithm-based clinical decision support, visualization format, human-computer interaction mechanism, workflow optimization, and financial reimbursement in reducing burnout are highlighted.

Key words: patient-generated health data, patient-reported outcomes, mobile health, clinician burnout, human-computer interaction, electronic health record

INTRODUCTION

In recent years, health-related data are increasingly collected by technologies such as portable devices with embedded sensors,[1,2] remote monitoring devices, wearable devices,[3] and smartphone apps.[4] These data can be collected continuously outside of the clinical settings and be shared with healthcare providers (HCPs). Health-related data that are generated, recorded, or gathered by patients outside of the clinical setting without the assistance of HCPs are termed patient-generated health data (PGHD).[5] Coupled with deployed electronic health records (EHRs), patient portals, and secure messaging, these new types of data enable patients to actively engage in the health care process, further improving the connection with their HCPs. In this way, the breadth, depth, and continuity of traditional health-related data are expanded, thus contributing to

improved treatment adherence, health outcomes,[6] healthcare quality, and patient safety.

This study examines how interactions with EHR-integrated PGHD may result in clinician burnout and identifies potential contributing factors, including technostress, time pressure, and workflow-related issues. Figure 1 demonstrates the relationship between EHR-integrated PGHD and contributors to clinician burnout.

PGHD AND EHR INTEGRATION

There are 2 main differences between PGHD and traditional health-related data generated within clinical settings[5]:

1. The data are gathered and recorded by patients outside the physicians' offices and no medical encounters are needed.
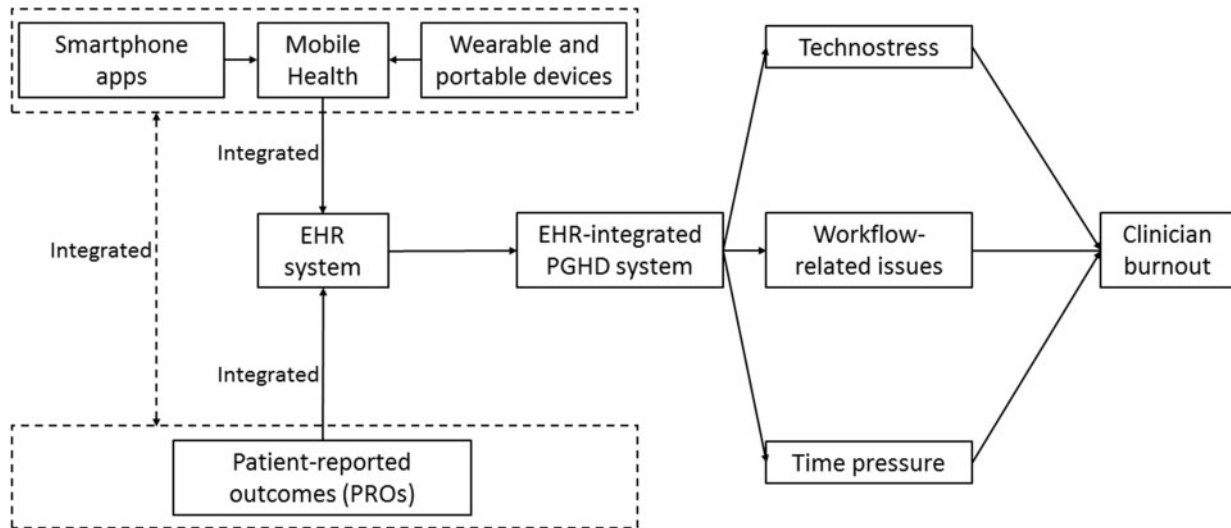
Figure 1. Conceptual model of the integration of electronic health record (EHR) and patient-generated health data (PGHD) with the impact on clinician burnout. PRO: patient-reported outcome.

Table 1. PROs and mHealth and their association with burnout

PGHD Domain	Definition	Association With Burnout
PROs	• PROs are assessments of patients' health conditions reported directly from patients in the form of question-naires.[7] • Health-related outcomes reported by patients have higher accuracy than clinical reports.[8] • Patient reporting can improve patient–provider communication, patient satisfaction, and symptom management.[9,10] • Widespread adoptions of PROs in performance evaluation cater to the growing interests in integrating PROs into EHR systems and patient portals.[11]	Main barriers to integrating PROs data into EHR: 1. Work overload. Clinicians are concerned that adding PROs will make their work burdensome[12]; 2. Lack of actionable guidance[13]; 3. Lack of validity of PRO scores to sufficiently support clinical decision-making; 4. Lack of financial incentives. Clinicians have no motivation to increase their job responsibilities without improved payment models[14]; 5. Low level of engagement of patients in completing PRO assessment. Providers have to spend extra time to explaining the purpose and assisting patients in completing the tasks.[13]
mHealth	• Mobile apps and wearable or portable devices that could be connected with smartphones have been increasingly harnessed to support health monitoring and management.[15] • Healthcare systems have been interdependent on EHR capacities due to the widespread adoption and legislation of meaningful use.[16] • Integration of data generated by various devices into EHR becomes a novel and critical capacity of hospital information systems.	Main barriers to integrating mHealth data into EHR: 1. Wearable device data are too noisy to be useful before compilation and interpretation by HCPs[17]; 2. HCPs may experience more alert fatigues in the clinical support systems[18]; 3. While some health systems and vendors have begun to develop user-centered design approaches to adapt workflows and collaborate with third-party wearable devices to improve the integration of PGHD and EHR, data interoperability and visualization still impede the connection between wearable PGHD and EHRs.[19]

EHR: electronic health record; mHealth: mobile health; PGHD: patient-generated health data; PRO: patient-reported outcome.

2. It is the patients who decide and take actions to share or distribute the data to HCPs or other stakeholders.

In this article, we focus on 2 main elements of PGHD: patient-reported outcomes (PROs) and mobile health (eg, mobile apps, wearable or portable devices). Table 1 illustrates the 2 elements and their association with burnout.

PGHD AND CLINICIAN BURNOUT

Clinician burnout is not only a syndrome of emotional exhaustion, but also a type of cynicism about job responsibilities.[20] With long-term demanding working paces, emotional intensity, and stressful environment, clinicians are becoming more and more likely to be exposed to burnout. Burnout is a reaction marked by lacking the sense of accomplishment, feeling emotionally exhausted, and experiencing depersonalization.

Burnout has a variety of negative consequences. For physical health, burnout may lead to type 2 diabetes,[21] arteriosclerotic disease,[22] cardiovascular diseases,[23] and coronary heart disease.[24] Clinicians who are often experiencing burnout may have more risks to develop musculoskeletal pain, which may even cause hospitalizations.[23] Moreover, respiratory issues and gastrointestinal prob-

Table 2. Technostress in EHR-integrated PGHD systems

Causes of Technostress	Conditions
Techno-complexity	EHR-integrated PGHD systems would add new elements and functions. For some physicians, these new functions add complexities to their jobs. More time and efforts are needed in understanding and practicing new skills. Owing to the unsolved standardization issues, various jargon and complicated operation steps make physicians more intimidated and stressed.
Techno-uncertainty	Physicians are not trained as engineers; they are not in favor of continuing technology upgrades and short life cycles of human-computer interaction systems. Taking care of patients is already overwhelming, and being pushed to update knowledge and relearn technical-related skills rapidly makes them unsettled.
Techno-overload	EHR-integrated PGHD systems incorporate more data than traditional EHRs. Physicians have to work harder and even faster because the time has not been extended.
Techno-insecurity	Owing to the different personal characteristics, some physicians who are experiencing technophobia[38] may dislike or fear technologies such as the PGHD system. Compared with young physicians or those who can better understand and handle new technologies, these physicians may lag behind and even lose their jobs.
Techno-invasion	With the implementation of EHR-integrated PGHD systems, patients may set higher expectations of their providers. Physicians are supposed to be reached whenever patients want to connect with them and respond to their PGHD-related queries or concerns. Sometimes, patients may even ask technical questions far beyond physicians' responsibilities. This makes physicians expand their regular roles and extend their work hours.

EHR: electronic health record; PGHD: patient-generated health data.

lems[25] as well as prolonged fatigues[26] have been proven to be significantly associated with burnout. For occupational health, burnout may lead to less job satisfaction[27] and reduced productivity,[28] thus reducing patient safety[29] and healthcare quality.[30] Healthcare workers who felt emotionally exhausted and depersonalized under the high demand of their responsibilities were affected by burnout.[31] Owing to the emotional pressure and syndrome subdimensions of cynicism, burnout could result in long-term sickness absence.[32] For mental health, as a prospective predictor of depressive symptoms,[33] burnout may lead to insomnia,[34] mental disorders, and other psychological diseases that may further cause hospitalizations.[23,35]

We identify 3 factors related to EHR-integrated PGHD that can contribute to clinician burnout.

Technostress

We categorize the causes of technostress with regard to EHR-integrated PGHD systems (Table 2). All of these factors might result in clinician burnout[36,37] and would be helpful to precisely identify or evaluate the extent to which technostress is introducing burnout to clinicians.

Time pressure

There are several mechanisms of health-related data sharing between patients and HCPs: patients directly report to HCPs, third party platforms perform health information exchange, EHR integration, etc.

Patient-directed mechanisms rely on the patients to manually send or show their data to the HCPs. This type of data sharing may be in-person or digital (eg, via email), which may cause a large burden on the HCPs, who are expected to interpret the data before or during the patient visit under strict time constraints. Linzer et al[39] created a formula to measure time pressure: time pressure ratio = (time needed to provide quality care—time allotted) / time allotted. If PGHD does not go through smoothly or as planned, additional time would be needed from HCPs to provide quality care, while the allotted time is always constant, so that the ratio would be increased. Time pressure is an important source of job dissatisfaction in many domains of healthcare settings.[39]

Workflow-related issues

Despite the merits of PGHD-EHR integration, it may also contribute to information overload. In some cases, the PGHD systems send the patient's data directly to a physician, likely through their mobile phones or electronic messaging systems. This mechanism, while efficient in urgent situations, may be burdensome to HCPs and can lead to fatigue if not all notifications are relevant.[40] Lack of interoperability is another concern. Third-party platforms may create new systems outside of the EHR or HCPs' working systems, leading to fragmented information sources that can be burdensome to the HCPs who have to check multiple sources of data before making a clinical decision. The interoperability issue may render the data unreadable by the HCP, which may also upset patients when their expectations are not fulfilled.

DISCUSSION

In this article, we have identified 3 factors that may contribute to clinician burnout related to PGHD-EHR integration: technostress, time pressure, and workflow-related issues. These factors can be mapped onto the modified FITT (fit between individuals, task and technology) framework (see Figure 2).[41] In this section, we propose several recommendations to resolve the barriers to PGHD-EHR integration so as to reduce clinician burnout.

Suggestions for solving the impact of technostress on clinician burnout

To perform PGHD-EHR integration, HCPs need to have clear role assignments. That is, when they should respond to PGHD, when to interfere and take over care, what to do, and how to interfere. Best practices and protocols are needed to guide HCPs. The development and application of the FHIR (Fast Healthcare Interoperability Resources) data standard have offered opportunities to improve PGHD presentation and visualization.[42]

Improving the usability and usefulness of the EHR-integrated PGHD systems can help to reduce technostress. Physicians always feel frustrated and anxious about the unfamiliar interfaces and insufficient instructions. If physicians find it easy and comfortable to
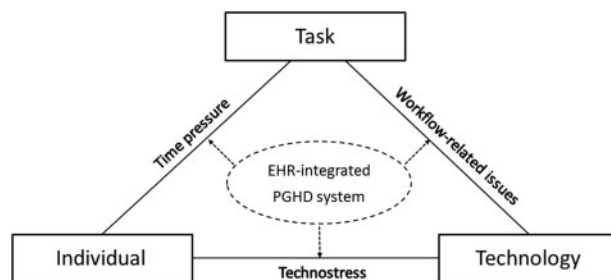
Figure 2. Modified FITT (Fit between Individuals, Task and Technology) framework of electronic health record (EHR)–integrated patient-generated health data (PGHD) and factors associated with clinician burnout.

review and interpret PGHD, then burnouts will decrease. PGHD visualizations, such as text results alongside numeric scores, pictographs, trending lines, flag signs, and data visualized in chronological order, are useful approaches.[43] HCPs and researchers should work together with other stakeholders such as health information technology vendors, wearable device and mobile health vendors, data visualization designers, cognitive scientists, and data scientists to develop and improve the frictionless user experience and usability for optimal uptake.[44] For example, PGHD should be visualized as an aggregated and descriptive manner so that visualizations and any correlations could be seen at once. HCPs can recognize patterns and extrapolate meaningful findings without jumping to different screens or clicking different functional buttons or logging into other interfaces. A customized dashboard with real-time health data visualization may be helpful for HCPs to find the patients they need to care for and the most relevant information (eg, medical history from PROs).

To avoid unrealistic expectations, patients and HCPs should be mutually aware of each other's needs; this bidirectional relationship can be achieved by adding some communication mechanisms in the integrated system. Meanwhile, other relevant stakeholders such as technology vendors, hospital leaders, and reimbursing agencies need to reconcile differences in the expectations of using PGHD with appropriate policies and regulations.[19] Keeping ownership of PGHD with patients may be another approach that may change the current landscape. Patients have discretion over whether, when, or how to share these data; this patient-driven empowerment may help to adjust the expectation of HCPs and their engagement. Meanwhile, HCPs have the privilege to set some parameters in the integrated system. For example, clinicians can adjust the frequency at which they want to receive PGHD, and patients cannot transmit any data to clinicians without an explicit order.

Technostress could also be reduced by education and training, which could be incorporated into medical boards and continuing education. Trainees include medical assistants, nurses, physicians, practice professionals, and even a broader range of participants. Training should include using PGHD to support shared decision making, patient-provider communication, etc.[45]

Suggestions for solving the impact of time pressure on clinician burnout

To reduce the time pressure, the EHR systems could develop standardized templates and data types for PGHD integration, so that providers can check the standardized summaries without spending time sifting through PGHD.

Financial reimbursement is important to relieve time pressure. Reimbursement models should align with the use of PGHD.[46]

Assigning current procedural terminology codes and the development of quality measurements associated with PGHD may facilitate reimbursement for reviewing it.[47] To build a supportive infrastructure and proper incentives, it would be critical to measure the extra time spent on PGHD-related care management, home visit, or clinical consultation.[45] Health systems can conduct retrospective analyses of the operationalization of work demands and resources of HCPs, which could provide more insights for the tasks that are particularly demanding or poorly designed for PGHD. The shift-work systems may be optimized to meet the personal preferences and ergonomic criteria of the HCPs, such as rescheduling of the working programs, redesigning workplace and resource allocation for PGHD, providing technical education and support, etc.[48]

Incorporating artificial intelligence (AI) and algorithm-based approaches[49,50] into the EHR-integrated system would enable intelligent filters and customizable alerts for clinicians, providing critical and digestible information rather than large volumes of data. This automated decision support system may assist in cleaning meaningless data and generating feasible action items for clinicians. Clinical symptoms or diseases may be identified automatically by algorithms using PGHD, and the integrated system then could provide guidelines to suggest self-management strategies for patients or tailored treatment strategies for HCPs.[51] All the information should be displayed on a single screen without the need for reviewing multiple windows. Incorporated with advanced clinical decision support, the integrated system can algorithmically identify which patients need attention based on the validated and robust prediction models. In addition, machine learning or deep learning algorithms are helpful to support decision making for patients such as when to interact with the clinician.[52] That being said, these benefits of AI have not been validated thoroughly, and more research is needed to implement and evaluate the AI-assisted EHR-integrated PGHD system.

Suggestions for solving the impact of workflow-related issues on clinician burnout

Making workflows automatic eases the clinical operations and decreases clinicians' workload. For example, the algorithm-embedded EHR-integrated PGHD can display a patient's medical records with understandable visualizations and send reminders to clinicians for upcoming patient-provider interaction in advance. Specifically, clinicians may want the PROs to be presented as fixed and structured templates implemented in the existing EHRs so that the review process could be streamlined; they just need to click on a few buttons, and all the necessary results would pop up. The operational process needs clear instruction. Some key elements in the workflow should be considered, including (1) entities that could be responsible for reviewing PGHD and make necessary

responses—depending on the severity, they could be provider, practice, or hospital-level representatives; (2) optimal time frame and frequency of reviewing PGHD and responding; (3) modalities that HCPs can use (eg, secure message, phone call, telehealth); and (4) types of PGHD that are most valuable for self-monitoring and clinical decision support.[53]

Health systems should regularly evaluate the impact of the EHR-integrated PGHD on clinicians, eliminate redundancies, and simplify the workflows. Examples include building systems that allow for inter-professional sharing of relevant work, using organization-level rapid-cycle improvement approaches to do outcomes-driven workflow redesign, streamlining the process of the integration and application of PGHD and EHR, etc. The implementation, evaluation, and upgrade of EHR-integrated PGHD systems should incorporate the perspectives of the frontline end users, including clinicians and patients, for human-centered design.

Participating in quality improvement programs that focus on optimizing the workflow of EHR-integrated PGHD is also an effective way to reduce clinician burnout, especially for primary care clinics.[54] Through taking advantage of resources and strategies that quality improvement programs provide, health systems can redesign the workflow by conducting system-level optimization and maintain sustainable improvement. Meanwhile, the process may also enhance the level of value alignment with leadership and alleviated cynicism, which in turn may help reduce clinician burnout.

In EHR-integrated PGHD, quality control is an important task. The AI-integrated system can automatically identify and remind the clinicians of defective diagnosis and treatment items and specific reasons for the recommendation. If a certain drug is not prescribed or the dosage is insufficient, the system can remind HCPs to click the quality control prompt to complete the corresponding treatment. The AI-integrated system can also send timely feedback on the healthcare quality control report to the hospital stakeholders. There are clinical texts in the EHR, and some health systems may have patient-to-provider electronic messages or unstructured biomedical data. All those data are useful information for the AI-integrated and algorithm-enabled system. Also, social media messages could be treated as one type of PGHD, which may have a critical impact on patients' mental health.[55] Using natural language processing technology and a series of diagnosis and treatment algorithms to fully understand the details and logical relationships of the data not only can enable better integration, but also can improve the comprehensiveness and rationality of clinical decision support, which may further help to reduce clinician burnout.

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AUTHOR CONTRIBUTIONS

JY was responsible for the study design, data analysis, and interpretation of results for the work, and wrote the manuscript.

DATA AVAILABILITY

The data underlying this article are available in the article.

CONFLICT OF INTEREST STATEMENT

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