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Cover Page Footnote

The authors would like to acknowledge Dr. Cathleen O. Erwin and her contributions to earlier versions of this study. This article is associated with the Innovation & Technology lens of The Beryl Institute Experience Framework (<https://www.theberylinstitute.org/ExperienceFramework>). You can access other resources related to this lens including additional PXJ articles here: http://bit.ly/PX_InnovTech

Technology about me without me: An examination of the relationship between patient-facing technology and patient experience

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Abstract

To appreciate the role of electronic health records (EHRs) in achieving the goals of patient-centered care, scholars have focused primarily on the influence of EHR capabilities on clinical providers' behaviors. The objective of this study is to examine the degree to which patient-facing technology (*P-Tech*) in U.S. hospital EHRs are associated with patient evaluations of their care experience. A cross-sectional OLS regression is executed to examine the relationship between *P-Tech* and patient experience on a sample of U.S. hospitals ($n=1,168$) compiled via data from CMS, the American Hospital Association's (AHA) Annual Survey (2014), and the AHA Health Information Technology supplement (2014). Findings confirm a positive relationship between *P-Tech* and overall ratings of patient experience. In addition, the results find that *P-Tech* capabilities correspond to various communication pathways (Exchanging Information, Self-Management, and Administrative Actions) outlined by Street et al.¹ The findings show an association between hospitals offering patient-facing EHR technologies that enable exchange of information and better patient evaluations of their care experience. As care delivery continues to explore the advancement of telehealth and telecare services, highlighting patient perspectives and appreciating that patients perceive face-to-face interactions as a complement to digital interactions will be key to the digital transformation of healthcare.

Keywords

Patient experience, communication, telehealth, e-health, patient technology

Introduction

Electronic health records (EHRs) and other types of healthcare technology have altered the interaction between patients and providers.² Previous studies have examined the influence of EHR adoption on various aspects of care delivery and quality outcomes.³⁻⁵ From a care provider standpoint, the use of EHR offers potential for higher levels of efficiency and accessibility of health care services for the patient.⁶ From the patient perspective, the use of EHR may improve their care experiences but might also lead to concerns regarding privacy and their ability to effectively engage with available technologies. As a result, there exists a question as to how EHRs contribute to communication pathways between patients and providers and a need to understand the degree to which EHR capabilities might influence patient evaluations of their care.⁷

Previous examinations of the relationship between EHR capabilities and patient experience have focused on the adoption of EHRs on quality of care. These studies centered mainly on how the adoption EHRs changed care provider behaviors.⁷ Much less consideration has been given to whether EHR capabilities influence patient evaluations of their care. The purpose of this study is to

examine the influence of patient-facing technology (*P-Tech*) on patient experience in U.S. hospitals. *P-Tech* is defined as EHR capabilities that are accessible directly by patients and are intended to be utilized by patients in the absence of their care providers or hospital staff (e.g., patient portals).

By isolating the aspects of the EHR that patients interact with independently, we seek to conceptualize the manner in which patients interpret these capabilities based on Street et al.'s communication pathways and Rathert et al.'s explanation of patient communication.^{1,8} In this study, we test a hypothesis of a positive association between *P-Tech* availability and patient experience of care is tested on a nationally representative sample of U.S. hospitals ($n=1,168$). This study uses an OLS regression with robust standard errors on a unique dataset including data from CMS's *HospitalCompare* website, American Hospital Association's Annual Survey (2014), and Health Information Technology (2014) datasets. The findings of this study show that there is a significant positive association between *P-Tech* and patient experience. Sensitivity analyses find that the strongest associations exist between hospital's *P-Tech* capabilities and patient evaluations of care provider communication.

Background

In 2010, the Health Information Technology for Economic and Clinical Health (HITECH) Act was adopted. In 2015, Centers for Medicare & Medicaid Services (CMS) shifted from the Meaningful Use program to the Medicare Access, CHIP Reauthorization Act (MACRA), and in 2016 introduced the 21st Century Cures Act. The continued political action centering on the expansion, implementation, and use of EHRs suggests that stakeholders believe that EHRs have the power to aid organizations in providing high-quality care while also meeting their needs for efficiency. The need to examine the influence of EHRs on the quality of healthcare delivery is perhaps even more critical today than when the first act was proposed.⁹ Since the adoption of HITECH and the subsequent widespread adoption of EHRs, scholars, and practitioners have focused on the impact of both the adoption of the new organizational capabilities that health information technology brings and the impact of these capabilities on care provider attention and patient-reported quality outcomes.^{4,10} The results of which have been mixed.

On one hand, the addition of HIT has enabled practitioners and administrators to improve measurement and implementation of best practices, improving care outcomes, especially with regard to population health.¹¹ On the other hand, the size and scope of implementation of HIT and EHRs in hospitals and the attention required to train and adopt best practices can be detrimental to patient quality outcomes.¹² In addition, the influence of technology on care provider attention with regards to patient-provider interactions was also shown to have been negatively influenced by the widespread implementation of hospital EHRs.¹³

Several studies have examined the influence of EHRs on the patient experience of care in hospitals, and the results suggest some positive associations related to discharge instructions, overall ratings, and likelihood to recommend the hospital.^{3,14,15} One limitation of EHR adoption-oriented studies is that they examine the existence of an EHR only, not its specific capabilities. A reasonable justification of this is that most features of EHR are not patient-facing and are capabilities that would have little to no direct usage by the patient.¹⁶ These features may support patient-centered care but do so without any patient interaction (e.g., health information exchange to another facility). The notion that EHR capabilities might act as a mechanism for achieving the goals of patient-centered care and patient engagement with their care might require that patients actively engage with the EHR. Perhaps the examination of patient-facing technology (*P-Tech*) can aid in developing a deeper understanding of the relationship between EHRs and health care quality outcomes.

Hypothesis

A theoretical framework that aids the understanding of the relationship between patient-facing technology and patient experience is Street et al.'s framework for patient centered communication which articulates six essential communication pathways: fostering healing relationships, exchanging information, responding to emotions, managing uncertainty, making decisions, and enabling self-management that influence patient outcomes.¹ *Fostering healing relationships* is characterized by trust and rapport.¹ Everyone in a health care interaction should understand each other's roles in the healing process. Providers should take the lead in addressing issues that might prevent patients and families from being actively involved. According to Street et al., "A trusting relationship can both depend on and facilitate communication" (p.19).¹ *Exchanging information* regards the exchange of biomedical and psychosocial information that must be done for the purposes of causes, diagnosis, treatment, and prognosis.¹ Accurate information not only helps with medical issues, but it can also serve to reduce anxiety and increase hope. In *responding to emotions*, providers should recognize a patient's emotional state and respond appropriately.¹ Illness can invoke many negative emotions that are not only uncomfortable but also can affect treatment responses and pain experiences. In the function of *managing uncertainty*, communication serves to address the uncertainty that occurs when one's illness trajectory seems to be random, complex, or unpredictable.¹ Communication between providers and patients should seek to aid patients to diminish the level of uncertainty and, if possible, to eradicate it.

In addition to exchanging information and managing uncertainty, communication between patients and providers should also see to make decisions in a patient-centric manner. For the *making decisions* communication pathways, decisions should be based on patients' preferences, values, and understanding of the specifics of the illness.¹ Patients may vary in terms of how much they want to be involved in decision making. So, providers must present information to them in easily accessible manners so that even the decision to default to the providers decision making is one that the patient feels empowered to make. The communication pathway, *enabling self-management*, acknowledges that communication should seek to facilitate patient abilities to follow through with treatment plans, solve health problems, and behave in ways that improves their health.¹

Communication travels through pathways that can lead to better health, increased empowerment, and higher quality experiences.¹ Using Street et al.'s framework¹, previous research has aligned the communication pathways to understand the contribution of health care technology, such as electronic health records, to achieving patient centered communication.⁸ In this examination, Rathert et

al. find that electronic health records improved the capture of diagnosis related information, but seemed to interfere with the collection of psychosocial and emotional information.⁸ In terms of Street et al's pathways,¹ the findings suggest that EHRs aid in *exchange of information* and *enabling self-management*, but are not able to address *fostering healing relationships*, *responding to emotions*, *managing uncertainty*, and *making decisions* pathways.⁸ However, Rathert et al. also note that patient's ability to directly access the EHR and the ability to utilize messaging functions might improve communication, patient empowerment, engagement, and self-management.⁸ In this examination, we seek to examine solely the patient-accessible capabilities of EHRs, and we hypothesize that patient-facing capabilities of EHRs (*P-Tech*) will have a positive influence on the patient experience across a variety of communication pathways.

H1: There is a positive relationship between patient-facing technology (P-Tech) availability and patient experience of care.

In addition to examining the role of *P-Tech* in patient experience, it is also important to examine the relationship between the various communication pathways enabled by these capabilities. Determining the degree to which specific capabilities correspond to different communication pathways enables a richer understanding of how these various tech-enabled communication pathways function to influence the patient experience. Across the six pathways of communication described by Street et al.,¹ some align with *P-Tech* capabilities more than others. Specifically, the *exchanging of information* and *enabling of self-management* pathways capture most of functional capabilities enabled by *P-Tech*. *Exchanging information* regards biomedical and psychosocial information that must be exchanged for purposes of causes, diagnosis, treatment, and prognosis.¹ Examples of *Exchanging Information* enabled by *P-Tech* include the ability for patients to submit their own data to the EHR and having secure messaging with providers. While the accuracy of patient-generated data is questionable and may lead to potential errors, the agency this capability gives to patients can also serve to reduce anxiety and increase hope.⁸ It is also worth stating that data errors can occur due to human-error in every instance, and the ability for patients to input their own data offers patients the opportunity to correct any errors immediately as well. An *Exchanging Information* communication can be anything from entering patient data to developing a treatment plan for the patient. Information is exchanged to and from the patient as the patient eventually reaches a treatment outcome.

H1a: There is a positive association between exchanging of information communication via P-Tech and patient experience of care.

Enabling self-management communication should facilitate patient's abilities to follow through with treatment plans, solve health problems, and behave in ways that improves their health.¹ The fulfillment of health-related behaviors, such as completing a treatment plan, is an example of technology *enabling self-management*. Examples of this typically one-way communication pathway are patients viewing their health/medical information online, downloading information from a record, or requesting refills for prescriptions online. *P-Tech* can allow patients to review personal health data, receive notification of test results and information, secure direct messaging communication with a healthcare provider, and facilitate more engagement with health needs leading to greater outcomes.

H1b: There is a positive association between enabling self-management communication via P-Tech and patient experience of care.

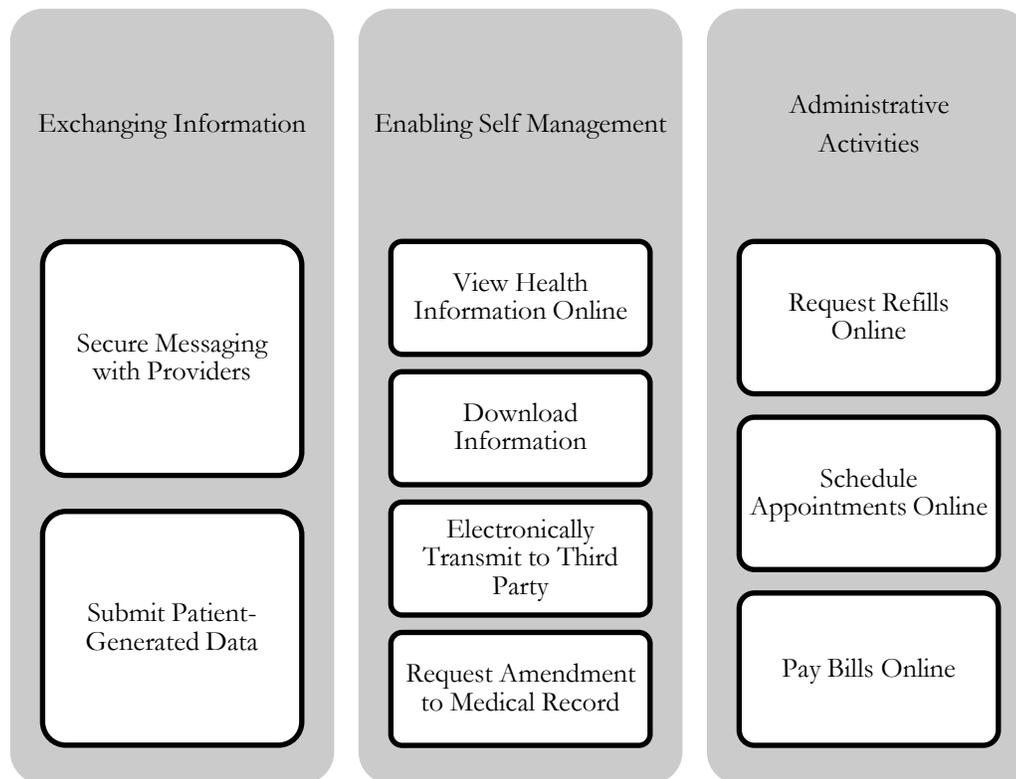
A few of the *P-Tech* capabilities available in hospital EHRs at the time of the study do not correspond with the communication channels outlined by Street et al,¹ but these communications may also be related to delivering a positive patient experiences. These activities include tasks such as the ability to pay bills online, schedule appointments, and similar functions that would typically be handled via administrative personnel in face-to-face interactions. These capabilities align with a form of communication that we have labeled *Administrative Activities*. The functions related to *Administrative Actions* are to be examined in an effort to appreciate the potential non-clinical communication pathways made accessible via *P-Tech*. These actions are seemingly similar to Street et al's *Managing Uncertainty* and *Making Decisions* communication pathways¹, however, as these functions do not align with provider-to-patient communication pathways, they require their own categorization beyond those outlined in Street et al. In-person interactions with front desk staff and other similar employees, for example, have the potential to effect patients' experience of their care though they are not explicitly included in patient experience surveys such as the *HCAHPS*.¹⁷ Similarly, the ability to complete necessary administrative functions via an EHR is likely to be positively associated with patient experiences of their care.

H1c: There is a positive association between patient access to administrative activities via P-Tech and patient experience of care.

Methods

The data come from two nationally representative sources. The patient experience data come from the publicly available Centers for Medicaid and Medicare Services (CMS) *HospitalCompare* website. Hospital characteristic data and IT capabilities come from the American Hospital Association (AHA) Annual Survey and the AHA Health

Figure 1: Communication Pathways and Corresponding P-Tech Capabilities



IT supplement database for 2014. The AHA database also includes organizational characteristics for more than 5,000 hospitals in the U.S. and was used to measure independent variables including hospital tax status (for-profit or not-for-profit), teaching status (membership in the Council of Teaching Hospitals), bed size (number setup and staffed), system membership (yes or no), hospital settings (urbanity), patient mix (percent Medicare and percent Medicaid), and the intensity of *P-Tech* [patient-facing EHR capabilities] (0 - 9). All data sets were merged, and a total of 1,645 hospitals (N=1,645) were included in all the databases. The analytic sample includes 1,168 hospitals (n=1,168) based on missing variables.

Key Variables of Interest

P-Tech

The Patient-Facing Technology variable (*P-Tech*) is created using the AHA IT survey (2014) responses to the Series 3 questions of the *Meaningful Use* section. These 9 questions each relate to patients’ ability to access various information or to contact personnel through the hospital’s EHR system. Each of the questions is dichotomous in nature (Yes =1). *P-Tech* values range from 0 to 9. The questions included in this series range from whether patients are able to view their medical information online to requesting prescriptions online to secure messaging with their providers and are thus qualitatively quite varied. Figure 1

includes a list of 9 *P-Tech* survey items as they align with the communication pathways. The *Exchanging Information* variable involved patient and healthcare provider interactions. The *Self-Management* variable captures when a patient engages and/or receives one-way communication. The *Administrative Actions* pathway captures any non-clinical communications.

Patient Experience

Patient experience ratings used in this study are based on each hospital’s overall *HCAHPS* star ratings (2014). Each of the star ratings has a range from 1 to 5. *HCAHPS* Star Ratings summarize the results for each *HCAHPS* measure and present it in a format familiar to consumers and are meant to ease quality comparisons across hospitals.¹⁹ The hypothesis is tested on a representative sample of U.S. hospitals through a series of OLS regressions with robust standard errors using data made available by CMS through their *Hospital Compare* website and the American Hospital Association’s Annual Survey and Health Information Technology datasets. First a model is run that examines the influence of the composite *P-Tech* measure. Then each of the three sub-categories of the composite measure are estimated individually. In the final model, the sub-components are all included in the model to show their relative influence on patient experience.

Table 1. Summary Statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
PE	2,437	71.00	8.21	37	100
P-Tech	2,187	5.67	2.54	0	9
Self-management	2,370	2.89	1.15	0	4
Exchanging Info	2,356	1.65	1.05	0	3
Admin Action	2,521	1.12	0.79	0	2
Size	2,642	3.93	2.00	1	8
Profit Status	2,049	0.17	0.38	0	1
System	1,626	0.90	0.30	0	1
Micro (ref. Rural)	2,642	0.17	0.37	0	1
Metro (ref. Rural)	2,642	0.22	0.42	0	1
Medicare %	2,642	0.51	0.15	0	2.32
Medicaid %	2,642	0.18	0.12	0	2.33
Teaching	2,642	0.07	0.26	0	1

Results

Descriptive statistics and correlation of all variables are available in Table 1 and Table 2, respectively. Results from our main analysis are presented in Table 3. The results of the model testing hypothesis H₁ on the relationship between the components as a single composite *P-Tech* are presented in column (i). This analysis finds a positive association between the patient-facing technology composite measure (*P-Tech*) and patient experience (0.29, $p \leq .01$). The results of the model testing hypothesis H1b on the relationship between *Self-Management* capabilities and patient experience are presented in column (ii) and show that *Self-Management* is positively associated with

patient experience (0.38, $p \leq .05$). Column (iii) presents the results of the test for hypothesis H1a relationship between *Exchanging Information* EHR components and patient experience and finds a positive association (0.78, $p \leq .01$). The results of the relationship between *Administrative Actions* and patient experience (regarding hypothesis H1c) is presented in column (iv), and shows a positive association (0.71, $p \leq .01$). Each of the three EHR components are included independently in the final model is presented in column (v) to test the relative strength of each component. In this model, *Exchanging Information* maintains a significant and positive association to patient experience (0.95, $p \leq .01$), and the other components fail to reach significance.

Table 2. Correlation of Variables

Variables	Overall	P-Tech	Self- mgmt	Ex. Info	Admin	Size	Profit	System	Micro	Metro	M'care	M'caid	Teach
PE	1.00												
P-Tech	0.14	1.00											
Self-mgmt	0.11	0.89	1.00										
Ex. Info	0.16	0.90	0.70	1.00									
Admin	0.08	0.76	0.50	0.57	1.00								
Size	-0.14	0.08	0.07	0.04	0.11	1.00							
Profit	-0.27	-0.13	-0.18	-0.14	0.02	0.01	1.00						
System	0.04	0.03	-0.02	0.05	0.06	0.08	0.02	1.00					
Micro	-0.01	-0.04	-0.02	-0.02	-0.08	-0.27	-0.03	-0.01	1.00				
Metro	0.06	-0.01	-0.01	0.02	-0.05	-0.40	-0.09	0.01	-0.13	1.00			
M'care %	0.08	-0.04	-0.02	-0.02	-0.07	-0.37	-0.08	-0.03	0.05	0.33	1.00		
M'caid %	-0.30	-0.03	-0.05	-0.02	0.00	0.25	0.06	0.02	0.06	-0.16	-0.45	1.00	
Teach	0.02	0.07	0.08	0.06	0.04	0.47	-0.12	0.03	-0.12	-0.11	-0.20	0.14	1.00

Table 3. The Influence of Patient Facing Technology (*P-Tech*) Composite and Communication Pathways on Patient Experience in U.S. Hospitals

Variables	P-Tech Composite (i)	Self-Management (ii)	Info Ex. (iii)	Admin Action (iv)	Components (v)
Obs.	n= 1,168				
Size	-0.66*** (0.14)	-0.69** (0.14)	-0.66*** (0.14)	-0.76*** (0.13)	-0.65*** (0.14)
Profit Status	-4.55*** (0.50)	-4.41*** (0.47)	-4.43*** (0.49)	-4.52*** (0.47)	-4.65*** (0.51)
System	1.55* (0.91)	1.74* (0.92)	1.45 (0.88)	1.14 (0.89)	1.35 (0.91)
Micro (ref. Rural)	-0.79 (0.66)	-0.97 (0.63)	-0.99 (0.63)	-1.14* (0.61)	-0.78 (0.66)
Metro (ref. Rural)	-0.99 (0.82)	-1.08 (0.77)	-0.93 (0.81)	-0.72 (0.77)	-1.04 (0.82)
Medicare %	-5.45** (2.13)	-6.30*** (2.07)	-6.17*** (2.08)	-6.13*** (2.04)	-5.50*** (2.14)
Medicaid %	-21.17*** (2.71)	-21.54*** (2.59)	-22.49*** (2.61)	-22.28*** (2.50)	-21.48*** (2.69)
Teaching	2.00*** (0.68)	2.20*** (0.66)	1.91** (0.66)	2.47** (0.65)	2.04** (0.68)
P-Tech	0.29*** (0.08)				
Self-management		0.38** (0.18)			-0.42 (0.26)
Exchanging Info			0.78*** (0.20)		0.95*** (0.29)
Admin Action				0.71*** (0.26)	0.41 (0.35)
Constant	78.13*** (1.97)	79.19*** (1.95)	79.33*** (1.85)	80.36*** (1.85)	79.12*** (1.99)
R-squared	0.19***	0.18***	0.19***	0.19***	0.19***

A specificity analysis reveals that this relationship is driven by an association between these EHR capabilities and the communication of their providers. To determine the degree to which patients are associating their care with different aspects of the care delivery, a supplementary analysis was executed to examine the degree to which *P-Tech* is associated with each of the *HCHAPS* composite scores (Communication with Nurses, Communication with Doctors, Staff Responsiveness, Pain Management, Communication about Medicines, Discharge Instructions, Understood, Cleanliness, and Quietness). The results of the specificity analyses are presented in Table 4 and find a significant positive association between *P-Tech* and nurse communication (i) (0.13, $p \leq .05$), responsiveness (iii) (0.23, $p \leq .08$), communication about medicines (v) (0.12, $p \leq .06$), discharge (vi) (0.09, $p \leq .04$), understood (vii) (0.20, $p \leq .07$), and cleanliness (viii) (0.16, $p \leq .07$).

Discussion

The results of this study’s analysis find significant support for the positive association between patient-facing technological capabilities (*P-Tech*) and patient experience. Each of the specific communication pathways tested show a positive association with patient experience supporting hypotheses 1a, 1b, and 1c. The results are mixed, however, in the final model testing hypothesis 1, as only the *P-Tech* capabilities that communicates via the *Exchanging Information* pathway show a significant independent positive influence on patient experience relative to the other capabilities. Of note, the full analytic model shows that the influence of *Self-Management* communication pathways changes direction from a positive to a negative influence on patient experience, however, this fails to reach significance. This finding helps to explain why the composite score (*P-Tech*) supports the hypothesis of a

Table 4. Specificity of Patient Facing Technology (P-Tech) on HCAHPS Composites

Variables	Nurse Comm (i)	Doctor Comm (ii)	Responsive (iii)	Pain (iv)	Comm about Medicines (v)	Discharge (vi)	Understood (vii)	Cleanliness (viii)	Quiet (ix)
Obs.	n= 1,168	n=1,168	n= 1,168						
P-Tech	0.13*** (0.05)	0.04 (0.05)	0.23** (0.08)	0.03 (0.05)	0.12* (0.06)	0.09** (0.04)	0.20** (0.07)	0.16** (0.07)	0.16* (0.09)
Size	-0.57*** (0.09)	-0.61*** (0.08)	-1.50*** (0.14)	-0.49*** (0.10)	-0.86*** (0.10)	-0.33*** (0.07)	-0.63*** (0.11)	-1.31*** (0.12)	-1.33*** (0.17)
Profit Status	-3.08*** (0.32)	-1.44*** (0.28)	-3.53*** (0.46)	-1.99*** (0.29)	-2.44*** (0.35)	-1.40*** (0.24)	-3.98*** (0.41)	-3.39*** (0.39)	1.84*** (0.55)
System	0.36 (0.54)	0.26 (0.44)	0.76 (0.79)	0.35 (0.50)	0.04 (0.56)	0.62 (0.39)	0.97 (0.71)	0.57 (0.71)	-0.83 (0.93)
Micro (ref. Rural)	0.83** (0.38)	1.33*** (0.42)	2.34*** (0.59)	0.43 (0.43)	1.31** (0.48)	0.59* (0.33)	-0.06 (0.53)	1.58** (0.51)	1.12 (0.72)
Metro (ref. Rural)	1.15** (0.49)	2.99*** (0.53)	3.36*** (0.70)	0.73 (0.61)	1.81** (0.71)	-0.98** (0.45)	-0.94 (0.70)	1.63** (0.67)	4.57** (0.86)
Medicare %	3.22*** (1.25)	-0.43 (1.17)	3.10 (1.88)	1.18 (1.24)	1.19 (1.62)	0.43 (1.07)	-3.23* (1.91)	3.20* (1.64)	-7.32** (2.48)
Medicaid %	-8.00*** (1.59)	-7.82*** (1.29)	-9.93*** (2.03)	-7.61*** (1.53)	-7.78*** (1.66)	-5.06*** (1.21)	-16.07*** (2.21)	-8.07*** (1.85)	-11.43*** (2.81)
Teaching	1.89*** (0.40)	1.48*** (0.35)	2.20*** (0.63)	1.03** (0.41)	2.00*** (0.44)	0.40 (0.35)	2.23*** (0.53)	1.14* (0.58)	-0.28 (0.80)
Constant	80.19*** (1.26)	84.23*** (0.95)	70.85*** (1.93)	73.13*** (1.12)	67.64*** (1.37)	87.91*** (0.85)	57.59*** (1.75)	76.76*** (1.53)	70.40*** (2.24)
R-squared	0.27***	0.25***	0.36***	0.19***	0.22***	0.10***	0.21***	0.32***	0.19***

positive relationship but with less magnitude than any of the specific communication pathways.

The findings of this study reveal that patient assessment of various patient-facing EHR capabilities statistically and conceptually load onto Street's three communication pathways (*Self Management, Exchanging Information, and Administrative Action*). The EHR capabilities that contribute to patients ability to exchange information with their providers (*Exchanging Information*) have a significant positive relationship to patient experience. The results of this analysis address several important questions germane to healthcare practice and policy. The findings show support that patient ratings of their care experience are associated with the specific technological capabilities of hospital EHR systems that they are able to interact with directly and independently. The results show that interactions with *P-Tech* correspond to specific patient-centric communication pathways, and that each of these pathways are related to patients' ratings of their care experience. Also, the results of the specificity analyses suggest that patients may be conflating patient-facing EHR capabilities with communication with their providers. Thus, it may be that patients are associating their personal interactions with care providers in concert with technological interactions via the hospital system's EHR.

Another takeaway from these findings is that, for patients, EHRs are an extension of the care experience. Thus, capabilities that center on their preferences and needs and empower them are going to be most aligned with patient's desired outcomes. Specifically, this study demonstrates the need to evaluate EHRs based on how patients will interact with EHRs in addition to how care providers and administrators will in appreciation that each of these stakeholders have different needs from the EHR. The findings suggest that patient ability to self-manage, for example, is not related to their assessments of the care experience. This suggests that patients may be perceiving some elements of their experiences of EHRs as an extension of interactions with their care providers, but not all. As such, with some elements of *P-Tech*, patients may be perceiving their interactions with EHRs as a means for deeper engagement with care providers. It is possible that these technology tools are yielding patient empowerment.¹⁹ Technology may be enabling patient empowerment allowing for a higher degree of patient-centered care and patient engagements with that care. Incorporating more of the patient's needs and perspectives is increasingly important as patients become more active in the care process.²⁰

The specificity analyses findings show that *P-Tech* is most strongly associated with patient's ratings of *Staff Responsiveness, Understood, Cleanliness, Quietness, Nurse Communication, Communication about Medicines, and Discharge Instructions*. Taken together, these results suggest that the relationship between *P-Tech* and patient reported experience is potentially driven by an association between *P-Tech* and nursing-related activities. Each of the *HCAHPS* composites that are associated with *P-Tech* directly addresses nurse communication and activities. The association of *P-Tech* with ratings of nurse communication and nursing activities is not altogether surprising as previous studies have shown that patient evaluations of their care experiences are driven by nurses.^{21,22}

What is novel, however, is that these relationships exist despite how remote some of the *P-Tech* capabilities are from nursing professionals. Some of the capabilities included in *P-Tech*, for example the ability to order refills for prescription medications or to schedule an appointment, are strongly associated with patient evaluations of nursing activities despite having no corresponding operations done by nurses. It could be that, rather than having a disassociated evaluation of the various aspects of their care wherein the technological aspects of their care experience and the interpersonal aspects of their care experience are isolated and distinct from each other, patients are evaluating all aspects as comprehensive components of their care experience. An example of this from the financial industry is the multiple manners in which a customer can initiate a transfer of funds. A customer can walk into a brick-and-mortar bank location and speak with a teller, they can walk up to an automated teller machine, they might use a telephone to call into the bank, they may also go online to the bank's website, or they might use an app on a smartphone device to do so. When the customers evaluate their bank, they are prone to do so based on the quality of the various modalities that they have utilized in concert, not as isolated interactions. In other words, the relationship found in this study may not be suggesting an increase in the number of *P-Tech* capabilities necessarily. Instead, emphasizes that each of these technological communication pathways is evaluated by patients as a complement to the interpersonal interactions of their care experience.

While emphasis has been given to the improvement of interpersonal interactions in the patient experience and patient-centered care literatures, a key takeaway of this study is that *P-Tech* is not distinct from bedside manner in the view of patients. The positive association between *P-Tech* and patient experience suggests instead that these interactions are linked and each aspect is important in the formation of the care experience. The evidence provided in this study shows that patients do not experience the face-to-face interactions and technological interactions as distinct from each other. Specifically, patients view the

availability of *P-Tech* capabilities that enable *Exchanging Information* as having the strongest relationship to care provider communication. Healthcare administrators would be wise to consider this notion, evidenced by this study, as each of these types of interactions are significant components of the patient experience which aligns with The Beryl Institute's definition of patient experience as the sum of all interactions.²³ A practical implication of this study's findings is that patients may view the availability of *P-Tech* as a gross indicator of an organization's dedication to service quality.

Conclusion

As this examination is cross-sectional in nature, it is not able to approach a causal understanding of the relationship between *P-Tech* and patient experience. In addition, the collection period of the study data is limiting as it measures these relationships prior to the COVID-19 pandemic, a time in which many of the communication pathways were forced to occur via *P-Tech*.²⁴ However, given the principal implication of this study that there is a positive association between the availability of *P-Tech* and patient experience in a nationally-representative sample in which the communication pathways statistically and conceptually load onto specific pathways, the likelihood that these communication pathways have been altered significantly is unlikely. What may have changed however is the degree to which the technological pathways and face-to-face pathways are linked. For this reason, further exploration of these concepts is encouraged to determine the validity of this relationship with more recent data.

As MACRA emphasizes patient engagement through technology and as telehealth is likely to be a more robust delivery model following the COVID-19 pandemic, this study's findings are timely and relevant to the present and future patient experience landscape. In addition, in the advent of telehealth and expansion of telehealth and telemonitoring capabilities in the aftermath of the COVID-19 pandemic,²⁴ it is critically important for practitioners to understand the manners in which patients are conceptualizing their experiences with hospital-related technology. While this study does not include data from the time of the pandemic, the results of this study suggest that technological communication capabilities are positively associated with patient's overall evaluation of their care experience. Many health systems and patients have seen the benefits of telehealth visits, which were deployed by hospitals to enable patient visits, telehealth enabled patients to receive care despite various government shutdowns to reduce the spread of the virus,²⁵ and plan to increasingly utilize these technological services.²⁶ As these initiatives are built and deployed, it will be important to consider not only the impact of these services on the healthcare workforce but also on patients' experiences of care as well.

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