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Electronic Health Record Usability and Post-Surgical Outcomes Among Older Adults with Dementia

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Abstract

Introduction: Electronic health record (EHR) usability, defined as the extent to which the system can be used to complete tasks, can influence patient outcomes. The aim of this study is to assess the relationship between EHR usability and post-surgical outcomes of older adults with dementia including 30-day readmission, 30-day mortality, and length of stay (LOS).

Methods: A cross-sectional analysis of linked American Hospital Association, Medicare claims data, and nurse survey data was conducted using logistic regression and negative binominal models.

Results: The dementia population who received care in hospitals with better EHR usability were less likely to die within 30 days of their admission following surgery compared to hospitals with poorer EHR usability (OR 0.79, 95% CI 0.68–0.91, $p = 0.001$). EHR usability was not associated with readmission or LOS.

Discussion: Better nurse reported EHR usability has the potential to reduce mortality rates among older adults with dementia in hospitals.

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The data has not been previously presented orally or by poster at scientific meetings.

Conflict of Interest Statement

The authors confirm that there are no relevant financial or non-financial competing interests to report.

Conflicts of Interest

The authors report no conflicts of interest.

Keywords

Dementia; electronic health records; patient outcomes

Introduction

In the United States (US), an estimated 6.5 million people age 65 and older have Alzheimer's Disease and Related Dementia [(ADRD); hereafter "dementia"].[1] This number is projected to grow due to the increasing population of adults age 65 and over.[2] Compared to the general population,[3] older adults with dementia have significantly greater health services utilization including hospitalizations.[2] In a recent study of Medicare beneficiaries, 32% of older adults with dementia had at least one hospitalization compared to 15% of beneficiaries without dementia.[2] As older adults with dementia have almost twice the likelihood of being hospitalized, it is essential to focus on the quality of care in the hospital setting for the dementia population.

Hospitalization is associated with poor outcomes among older adults with dementia, such as increased likelihood of readmission and mortality, and longer length of stay (LOS).[4,5] Among Medicare beneficiaries with dementia, over one in five (22%) hospital admissions are followed by a readmission within 30 days of discharge.[6] In another study of the dementia population, Beydoun and colleagues found that older adults with dementia were at 7% greater risk of death during a hospital stay compared to patients without dementia.[7] LOS has also been estimated to be extended by at least one day among older adults with dementia compared to persons without dementia.[4,7] Readmission and longer LOS have been associated with adverse outcomes such as delirium and higher healthcare expenditures.[8] The risk of these adverse outcomes is especially pronounced among older adults with dementia following surgery due to factors such as increased prevalence of delirium, and impaired communication.[2,9,10] In addition, older adults with dementia have greater comorbidity burden than the ones without dementia[11,12] that may be associated with increased rates of polypharmacy.[11] Finally, older adults with dementia often need care from a wide range of providers, including geriatricians and psychiatrists; however, care is frequently provided in a fragmented and uncoordinated manner.[13,14]

Electronic health record (EHR) systems have the potential to reduce medication errors and fragmented care and ultimately improve patient outcomes. In addition, EHR systems provide critical and essential patient information such as records of medications and clinical notes about the patients' cognitive status. This type of information is typically accessible to providers within a health system. Registered nurses constitute one of the largest groups of EHR users in hospitals. However, nurses often report that the EHR can be disruptive to their workflow.[15] More specifically, EHR usability, defined as the extent to which the system can be used effectively and efficiently to complete tasks,[16] has been linked to adverse events such as medication errors and delayed care delivery in the hospital setting.[17] Such adverse events can result in patient safety threats and poor outcomes, such as mortality.[18] Indeed, Kutney-Lee and colleagues found that poor EHR usability was associated with higher odds

of mortality among hospitalized adult surgical patients compared to those in hospitals with better EHR usability ratings.[18]

Given the high complexity of a surgical hospitalization for older adults with dementia due to cognitive impairment, it is plausible that EHR usability would play an important role in the care and outcomes of these patients, but these relationships have not been examined. We used the Systems Engineering Initiative for Patient Safety (SEIPS) model of Work System and Patient Safety to conceptualize these relationships.[19] The SEIPS model is adapted from the widely used Donabedian's structure-process-outcome model for health services research. The SEIPS model includes five distinct factors: person, tasks, technology, environment, and organization. In our study, the person (i.e., nurse) performs a range of nursing tasks (i.e., documentation) using technology (i.e., EHR). The nurse performs nursing tasks using EHR with various usability levels which are related to unique physical environments under certain organizational conditions that differ across hospitals. These five factors act together and influence the delivery of care processes, which ultimately can be associated with patient outcomes, 30-day readmission, 30-day mortality, and LOS. Thus, the purpose of this study was to assess the relationship between EHR usability and the postsurgical outcomes of older adults with dementia including 30-day readmission, 30-day mortality, and LOS.

Methods

Study Design and Data Sources

In this cross-sectional secondary data analysis, we linked data from 5 sources (1) the 2016 American Hospital Association (AHA) Annual Survey of Hospitals; (2) the 2016 AHA Healthcare Information Technology (IT) database; (3) the 2016 Medicare Provider Analysis and Review (MedPAR) files; (4) the 2016 Beneficiary Annual Summary File (BASF); and (5) RN4CAST-US, a large survey of registered nurses (RNs) collected from 4 states (California, Florida, New Jersey, and Pennsylvania) between 2015 and 2016. This study was reviewed by the University of Pennsylvania Institutional Review Board.

The AHA Annual Survey of Hospitals provided information about hospital characteristics (i.e., size, teaching status, and high-technology procedure capabilities), and the AHA Healthcare IT Database was used to obtain information about each hospital EHR system. MedPAR included data on readmission, mortality, and LOS, while the BASF provided Medicare beneficiary demographics. Lastly, the RN4CAST-US survey was used to obtain nurse reports of EHR usability – our main predictor variable. Surveys were mailed to the home address of ~231,000 RNs between January 2015 and December 2016 in the 4 states. Respondents had the option to complete the survey by mail or online. The survey included questions on a range of topics related to nursing practice and demographic information. The name of the primary employer was also obtained which allowed for merging with the AHA and patient data. The survey accomplished a response rate of 26% (n = 52,510).[20] While the survey response rate is low, it holds little weight in determining the sample's representativeness of our population of interest because our aim was to study hospitals, and the patients receiving care within those hospitals. In addition, the survey produced an average of 32 nurse responses per hospital, enough to produce reliable estimates of quality

and safety measures.[20] The survey has been widely used in previous studies.[18,21,22] Further details about the methodology are discussed elsewhere.[20,23]

Sample

We limited our analysis to nonfederal, acute care hospitals that 1) had at least 10 nurse survey respondents to provide reliable hospital-level measures, and 2) responded to the AHA Annual Survey of Hospitals and Health IT Survey. Our patient sample included Medicare beneficiaries aged 65 and older who underwent general, orthopedic, or vascular surgery and had been diagnosed with ADRD. Surgical patients were identified using a set of surgical diagnosis-related group (DRG) codes used in prior work.[18,24,25] The presence of ADRD was identified using the ADRD flag available in the Chronic Conditions Data Warehouse (CCW). This flag is generated by the Centers for Medicare & Medicaid Services based on an algorithm that searches for designated International Classification of Diseases (ICD-10) codes for the year of 2016 across inpatient and outpatient files. The CCW flag for ADRD is based on codes that identify Alzheimer's disease, vascular dementia, and frontotemporal dementias, as well as more generic diagnoses for dementias without a specified underlying disease process. The final sample included 36,473 Medicare beneficiaries cared for in 289 acute care hospitals across the 4 states. For more information about the study sample selection see Appendix A, Figure 1.

Measures

Predictor Variable.—Consistent with previous research, EHR usability was measured using a 7-item scale on the RN4CAST-US survey.[18] The scale included the following statements: ability to access patient information quickly in the system, system interference with the provision of patient care, ease of use, trust in the system's patient assessment and medication data, the system's ability to assist in completing work efficiently, and the ability to easily share information with other health care team members. Using a 4-point Likert scale ranging from "strongly disagree" to "strongly agree," nurses reported their level of agreement with each statement. The scale has a Cronbach's alpha coefficient of 0.87 which indicated good internal consistency.[18] We created a hospital-level EHR usability score by calculating the mean of all 7 usability items for each individual nurse. Then, we averaged the nurse-level scores within each hospital. For all primary analyses, tertiles were used to categorize the EHR usability score for each hospital as: "poorer" (lowest tertile), "moderate" (middle tertile), and "better" (highest tertile) usability.

Outcome Variable.—Patient outcomes were obtained from the MedPAR database and included mortality within 30 days of admission in or outside of hospitals, readmission within 30 days for any cause, and LOS for the hospitalization. For beneficiaries who had more than one admission in one year, we used the first hospitalization for our analysis. Patients were excluded from the 30-day readmission and LOS measures if they died during the index admission.

Covariates.—In addition to evaluating the effects of EHR usability on the patient outcomes, we also accounted for the hospital's EHR adoption level. EHR adoption levels were defined by the established Office of the National Coordinator for Health Information

Technology guidance.[26] Information on hospital EHR adoption level was obtained from AHA IT Database and was classified as: (1) basic or less (with or without clinician notes); or (2) comprehensive. EHR adoption level was measured based on 4 components (e.g., electronic clinical information, computerized provider order entry, results management, and decision support). Research showed that adoption of comprehensive EHR systems with more complex functionalities (e.g., clinical decision support tools) may be essential to accomplish optimal quality and safety outcomes.[27] Hospitals with a basic EHR had each of the following components either fully implemented on at least 1 clinical unit or across all units: (1) electronic clinical information (e.g., documentation of demographics, problem lists, medication lists, clinician notes, and discharge summaries); (2) computerized provider order entry for lab report, medications etc.; and (3) results management (e.g., electronic laboratory, radiologic and diagnostic test reports). In addition to the 3 core components of basic EHR systems, hospitals with comprehensive EHR systems had the decision support component (e.g., clinical guidelines, drug allergy results etc.) that was implemented fully across all units.

In addition to the EHR adoption levels, several hospital and patient characteristics were also included in the analysis to account for potential confounding. Hospital characteristics obtained from the AHA Annual Survey included size (i.e., ≤100 beds, 101–250 beds, or >250 beds), teaching status (i.e., nonteaching, minor teaching, or major teaching), and high-technology procedure capability (i.e., ability to perform open heart surgeries and/or major organ transplants). Patient characteristics obtained from the MedPAR and BASF databases include age, sex, surgical type based on the DRG, and 27 comorbidities originally defined by Elixhauser.[28]

Data Analysis

Characteristics and outcomes of patients in the sample were examined using descriptive statistics. Distributions of the study hospital characteristics were examined for the overall sample and by EHR usability level. To identify significant differences among the hospital characteristics, we used chi-square tests for all variables, except for hospital size where the Fisher exact test was used. Before building the regression models, we assessed multicollinearity between independent variables and covariates by calculating variance inflation factors. We found no significant collinearity between variables. We used logistic regression models accounting for clustering effects of patients within hospitals to examine associations between hospital-level EHR usability and 30-day readmission and mortality. For LOS, we used a negative binomial model after omitting LOS that were less than one day. Unadjusted models examining the bivariate relationship between EHR usability and each outcome were examined first. We then estimated a set of models that adjusted for EHR adoption level and for patient characteristics including demographics and comorbidities. Finally, fully adjusted models that included EHR usability, EHR adoption level, and all measured covariates were examined. SAS 9.4 was used to conduct the analysis.

Results

Patient and Hospital Characteristics

Characteristics and outcomes of older adults with dementia who underwent surgery (n = 36,473) are shown in Table 1. The mean age of patients in our sample was 82 years old. Most of the patients were female (63.4%) and belonged to the non-Hispanic white race/ethnicity group (87.4%). Older adults with dementia in our sample also had high rates of comorbidities such as uncomplicated hypertension (57.4%), hypothyroidism (23.2%), and chronic pulmonary disease (21.5%). Most patients were admitted for orthopedic (64.2%) surgery, followed by general (23.4%) then vascular (12.4%) surgeries. On average, older adults with dementia in our sample had a LOS of nearly 7 days (mean = 6.6, SD = 6.28). Lastly, about 6% of patients died and 15% were readmitted within 30 days of admission.

Characteristics of study hospitals overall and by degree of EHR usability are described in Table 2. More than half of the hospitals had adopted a comprehensive EHR (65.4%), had more than 250 beds (56.8%), and had high technology status (62.9%). About 34% of hospitals that had comprehensive EHR systems were classified as having better EHR usability compared to 30.0% of hospitals with a basic EHR system ($p = .024$). More than half (55.2%) of major teaching hospitals were in the highest EHR usability category compared to 24.8% and 34.5% of minor and non-teaching hospitals, respectively ($p = .013$). Of the four states, California had the highest proportion of hospitals classified as having better EHR usability (46.4%).

Associations of EHR Usability on Surgical Patient Outcomes

Table 3 displays findings from our unadjusted and adjusted regression models examining the relationship between EHR usability and the surgical outcomes of older adults with dementia. In the unadjusted model, we found that older adults with dementia who received care in hospitals with better EHR usability were less likely to die within 30 days of admission following surgery compared to those treated in hospitals with poorer EHR usability (odds ratio [OR] 0.80, 95% confidence interval [CI] 0.70–0.92, $p = .002$). This finding remained consistent following adjustment for EHR adoption level (OR 0.81, 95% CI 0.80–0.94, $p = .002$), for patient characteristics (OR 0.77, 95% CI 0.66–0.89, $p = <.001$), and in our fully adjusted model (OR 0.79, 95% CI 0.68–0.91, $p = .001$). We found no statistically significant results when we assessed the relationship between EHR usability and other patient outcomes (i.e., 30-day readmission and LOS). In other words, EHR usability was not associated with 30-day readmission and LOS of postsurgical older adults with dementia. The results of the full regression models are presented in Appendix A, Table 1

Discussion

In this cross-sectional study, we assessed the relationship between EHR usability and the postsurgical outcomes of older adults with dementia including 30-day readmission, 30-day mortality, and LOS. To our knowledge, this study is among the first to explore the relationship between EHR usability and the outcomes of older adults with dementia in hospital setting. We found that postsurgical older adults with dementia receiving care in

hospitals with better EHR usability were 21% less likely to die in the hospital following their procedure compared with older adults with dementia in hospitals with poorer usability. We found no statistically significant associations between EHR usability and 30-day readmission and LOS. Our findings are partially consistent with prior research. Using a sample of 343 hospitals, Kutney-Lee and colleagues analyzed the relationship between EHR usability and the outcomes of adult surgical patients, including readmission and 30-day mortality.[18] In this study, the researchers discovered that patients undergoing surgery in a hospital with poorer EHR usability had odds of mortality and readmission that were 21% and 6% higher respectively, compared to patients in hospitals with better usability.

There are several potential explanations for a link between better EHR usability and lower odds of mortality among surgical patients with dementia. Nurses use EHR systems for various reasons such as monitoring patients' conditions and as part of their surveillance of patients throughout the hospital stay.[29] While cognitive impairment complicates the provision of nursing care,[2,30] EHR systems with better usability have the potential to improve nurses' ability to assess conditions of older adults with dementia by effectively and efficiently providing access to patient medical records and communicating with other clinicians. Furthermore, one of EHR's capabilities is medication management; by providing a record of patients' medications or allergies, EHRs can automatically flag problems for clinicians whenever a new medication is prescribed. Medication management is a significant need when caring for older adults with dementia, as older adults with dementia are more likely to have chronic conditions and require many prescribed medications than patients without dementia.[11,31] In addition, a usable system that allows clinicians to effectively communicate about discharge planning may also be another reason behind our findings. In other words, an EHR system that functions efficiently and effectively may serve to support nurses and other clinicians in addressing the unique care needs of older adults with dementia throughout the surgical care continuum, thus reducing post-surgical mortality.

A possible explanation for our null finding related to 30-day readmission is that upon postsurgical discharge, older adults with dementia often face difficulties reporting symptoms, adhering to medications, reporting medication side effects, and complying with treatment and follow-up recommendations in the community.[31,32] Because of deficits in memory, language, and judgment, older adults with dementia may not receive timely and continuous primary care following discharge.[33] Therefore, it is plausible that these factors may be more important predictors of 30-day readmissions following surgery among older adults with dementia than EHR usability during the surgical admission. As a consequence, older adults with dementia can be more susceptible to 30-day readmission following surgery. Our findings also showed that LOS was not associated with EHR usability. While the literature on the factors that influence LOS among older adults with dementia is not consistent,[7,34,35] our findings should not be interpreted as negative because longer LOS in some circumstances is unavoidable and may in fact be beneficial toward a safe recovery.[4]

Our findings have implications for hospital leadership and EHR vendors. The results underscore the significance of having better EHR usability to reduce post-surgical mortality in hospital settings among older adults with dementia. In addition, as nurses play a critical role in monitoring patients' conditions during their hospital stay,[36] it is crucial for EHR

vendors to include nurses' inputs in the development and implementations of EHR systems. Nurses should also be consulted by hospitals and EHR vendors about the additional resources they may need to provide high quality care to older adults with dementia to improve other post-surgical outcomes.

More research is needed to have a better understating of how the EHR can be used and tailored to support care delivery for the dementia population. For instance, there is a general need of more research on the relationship between EHR usability and patient outcomes among the dementia population as our paper is the first to explore this topic. Additionally, future studies should look at the EHR and assess whether clinicians' notes include information about the cognitive status of the patients and match these results with CCW flag for ADRD. This way we will have a better understanding about if the providers were aware of dementia diagnosis of the patients and if their awareness made a difference in the patients' outcomes.

Limitation

This study has some limitations. First, the study has a cross-sectional design; therefore, we were not able to test for causality. Second, due to our sampling of hospitals, nurses, and patients in 4 US states, the generalizability of our study results may be limited and may be only applicable to the 4 states. We also explored differences between the respondents to the main survey and respondents to the survey of non-responders (which included monetary incentives) in terms of nurse demographics (i.e. sex, age, race, ethnicity, education, years of experience), as well as nurse-assessed organizational measures including the work environment, patient care quality, safety, and staffing levels. While some nurse demographics differed between the two samples, virtually no significant differences were observed in nurse-assessed organizational measures. Third, the survey used to assess EHR usability was conducted of registered nurses; therefore, we cannot draw conclusions about the perspectives of other end-users in our study hospitals. Multiple studies, however, have documented that EHR usability is a major safety concern that is shared by other clinicians, including physicians.[37,38] Fourth, since not all hospitals that participated in the AHA Annual Survey responded to the AHA IT survey, our sample size was reduced. However, our sample size was sufficient for our analysis. We also looked at the hospital characteristics between AHA IT survey responders and non-responders' hospitals. Majority of hospital characteristics between the two groups were not statistically different. Fifth, we also acknowledge that EHR measure used in the hospitals was not specifically designed for the dementia population. Absent the more specific measure, we felt that the hospital-level measure was a suitable proxy. Sixth, other factors might have impacted the outcome of this study. More specifically, ADRD which is a progressive neurodegenerative disease, has different severity stages that we were not able to assess because Medicare claims data do not have this information. Thus, we were not able to evaluate how each stage is associated with our findings. Lastly, due to challenges involved with the diagnosis of the disease, some older adults with dementia might not have been identified in the Medicare data.

Conclusion

Clinicians depend upon EHR systems to support patient care tasks such as clinical decision making, care planning, medication ordering and administration, and communication with other members of the healthcare team. Better usability of EHR systems can improve patient outcomes and safety and may be even more important to high-risk groups, such as older adults with dementia. Our study showed that better EHR usability was associated with lower odds of 30-day post-surgical mortality among older adults with dementia. Other outcomes such as 30-day readmission and LOS were not associated with EHR usability. Therefore, better nurse reported EHR usability has the potential to reduce mortality rates among older adults with dementia in hospitals, however more research is needed to better understand how to improve other outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

1. What is the primary question addressed by this study?

   How is EHR usability associated with post-surgical outcomes including 30-day readmission, 30-day mortality, and length of stay among older adults with dementia?

2. What is the main finding of this study?

   Older adults with dementia who received care in hospitals with better EHR usability were less likely to die within 30 days of their admission following surgery compared to hospitals with poorer EHR usability (OR 0.79, 95% CI 0.68–0.91, $p = 0.001$). However, there was no relationship between EHR usability and readmission or LOS.

3. What is the meaning of the finding?

   Our findings suggested that better EHR usability is associated with reduced 30-day mortality among older adults with dementia. Therefore, improving EHR usability may be beneficial for reducing the likelihood of post-surgical mortality for older adults with dementia.

Table 1

Characteristics and Outcomes of Older Adults with Dementia

Surgical Older Adults with Dementia (n = 36,473)	
Age, mean (SD)	82.25 (8.0)
Sex n (%)	
Male	13345 (36.6)
Female	23128 (63.4)
Race/ ethnicity, n (%)	
Non-Hispanic White	31886 (87.4)
Non-Hispanic Black	2007 (5.5)
Hispanic	1110 (3.0)
Asian	734 (2.0)
Other (i.e., North American Native, unknown, and other)	736 (2.0)
Elixhauser comorbidities	
Hypertension, uncomplicated	20944 (57.4)
Hypothyroidism	8456 (23.2)
Hypertension, complicated	7843 (21.5)
Chronic pulmonary disease	7858 (21.5)
Deficiency anemias	7780 (21.3)
Depression	6373 (17.5)
Heart failure	6254 (17.2)
Diabetes without chronic complications	6285 (17.2)
Renal failure, moderate	5900 (16.2)
Valvular disease	4788 (13.1)
Peripheral vascular disease	4234 (11.6)
Diabetes with chronic complications	4069 (11.2)
Weight loss	3069 (8.4)
Obesity	3018 (8.3)
Surgical procedure, n (%)	
General	8536 (23.4)
Orthopedic	23408 (64.2)
Vascular	4529 (12.4)
Patient outcomes, n (%)	
30-day mortality	2287 (6.3)
30-day readmission	5511 (15.1)
Length of stay, mean (SD)	6.61 (6.3)

Abbreviations. EHR: electronic health record, *SD*: standard deviation.

Table 2

Characteristics of Study Hospitals by Degree of EHR Usability in Hospitals Providing care to Older Adults with Dementia

Hospital characteristics					
	Total (n = 289)	**Poorer EHR Usability (n = 98)**	**Moderate EHR Usability (n = 97)**	**Better EHR Usability (n = 94)**	**P**
EHR Adoption Level, n (%)					0.024
Basic EHR or less	100 (34.6)	44 (44.0)	26 (26.0)	30 (30.0)	
Comprehensive EHR	189 (65.4)	54 (28.6)	71 (37.6)	64 (33.9)	
Hospital size, n (%)					0.139
<= 100 beds	10 (3.5)	5 (50.0)	4 (40.0)	1 (10.0)	
101–250 beds	115 (39.8)	46 (40.0)	32 (27.8)	37 (32.2)	
>250 beds	164 (56.8)	47 (28.7)	61 (37.2)	56 (34.2)	
Teaching status, n (%)					0.013
Nonteaching	139 (48.1)	41 (29.5)	50 (36.0)	48 (34.5)	
Minor teaching	121 (41.9)	51 (42.2)	40 (33.1)	30 (24.8)	
Major teaching	29 (10.0)	6 (20.7)	7 (24.1)	16 (55.2)	
Technology status, n (%)					0.158
Low	106 (37.1)	41 (38.7)	28 (26.4)	37 (34.9)	
High (performs open heart surgery and/or organ transplant)	180 (62.9)	56 (31.1)	67 (37.2)	57 (31.7)	
State, n (%)					0.017
CA	97 (33.6)	26 (26.8)	26 (26.8)	45 (46.4)	
FL	98 (33.9)	33 (33.7)	35 (35.7)	30 (30.6)	
NJ	31 (10.7)	13 (41.9)	11 (35.5)	7 (22.6)	
PA	63 (21.8)	26 (41.3)	25 (39.7)	12 (19.0)	

Abbreviations., EHR: electronic health record, CA: California, FL: Florida, NJ: New Jersey, PA: Pennsylvania.

Note. P-values were generated from chi-square tests for categorical variables.

Table 3

Effects of EHR Usability on Surgical Patient Outcomes among Older Adults with Dementia

	Coefficient	Unadjusted		Adjusted for EHR adoption level		Adjusted for patient characteristics		Fully adjusted	
30-day mortality									
EHR usability (reference: poorer)	OR (95% CI)		P		P		P		P
Better		0.80 (0.70–0.92)	0.002	0.81 (0.80–0.94)	0.002	0.77 (0.66–0.89)	<.001	0.79 (0.68–0.91)	0.001
Moderate		0.93 (0.82–1.06)	0.287	0.93 (0.82, 1.05)	0.236	0.91 (0.79–1.03)	0.156	0.93 (0.81–1.07)	0.325
Comprehensive EHR (reference: basic EHR or less)		—		1.03 (0.91–1.1)	0.604	—		1.03 (0.91–1.17)	0.645
30-day readmission									
EHR usability (reference: poorer)	OR (95% CI)		P		P		P		P
Better		0.98 (0.88–1.8)	0.653	0.98 (0.88–1.08)	0.642	0.94 (0.84–1.04)	0.210	0.93 (0.84–1.03)	0.174
Moderate		0.98 (0.88–1.08)	0.636	0.97 (0.88–1.07)	0.539	0.95 (0.86–1.05)	0.377	0.94 (0.85–1.03)	0.183
Comprehensive EHR (reference: basic EHR or less)		—		1.04 (0.96–1.13)	0.347	—		1.05 (0.96–1.14)	0.259
Length of stay									
EHR usability (reference: poorer)	IRR (95% CI)		P		P		P		P
Better		1.03 (0.97–1.09)	0.356	1.03 (0.97–1.09)	0.364	0.99 (0.95–1.04)	0.695	0.98 (0.94–1.03)	0.453
Moderate		1.02 (0.97–1.07)	0.424	1.01 (0.96–1.06)	0.611	1.01 (0.97–1.05)	0.685	1.00 (0.96–1.04)	0.991
Comprehensive EHR (reference: basic EHR or less)		—		1.05 (1.00–1.09)	0.047	—		1.04 (1.00–1.08)	0.070

Abbreviations. EHR: electronic health record, *OR:* odds ratio, *IRR:* incidence rate ratio, *CI:* confidence interval.