

# Inpatient-Outpatient Shared Electronic Health Records: Telemedicine and Laboratory Follow-up After Hospital Discharge

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**F**or the growing number of patients with chronic conditions, care transitions, such as those after hospital discharge, require coordination among multiple clinicians practicing in different settings.<sup>1-3</sup> Health information exchange (HIE) that ensures that patient health information follows each patient as they move between care settings is important to providing well-coordinated care.<sup>4</sup> Still, developing widespread electronic health record (EHR) interoperability and HIE between settings remains challenging.<sup>5-8</sup> Emerging health care payment models, coordination, and consolidation efforts are likely increasing information sharing among providers at follow-up visits.<sup>9</sup> Still, there is limited evidence on the impact of sharing electronic patient information across settings on patient care transitions and outcomes, particularly on follow-up care and adverse events after a hospitalization.<sup>6,10,11</sup>

With limited electronic data sharing, deficiencies in information availability and communication among providers after hospital discharge are regularly reported by both clinicians and patients—including inconsistent awareness of the hospitalization itself and limited communication of medications, orders, and laboratory results, leading to medical errors and increases in readmission.<sup>12-19</sup> In the absence of broad clinical guidelines for optimal postdischarge follow-up interval or encounter type, differences in follow-up visit rates have been associated with mixed outcomes.<sup>9,20</sup> Shared seamless access to EHRs can offer clinicians direct access to fully view and document detailed patient clinical information across health care settings without requiring shifts across systems, modalities (like paper), or capabilities (like limited snapshots or fragmented documentation).<sup>21</sup> The timely exchange of patient information and communication is defined for this paper as data access to support clinical care at any time it is clinically needed, ideally in real time. Timely and seamless EHR access across providers can support patient transitions from hospital discharge to outpatient follow-up care, such as by facilitating coordination, risk stratification, and flexibility for telemedicine encounter types, with potential implications for clinical care quality and efficiency.<sup>18,20</sup> Early evidence from other settings and patient populations about impacts of HIE is mixed; however, findings of some studies have suggested that electronic

## ABSTRACT

**OBJECTIVES:** Continuity of patient information across settings can improve transitions after hospital discharge, but outpatient clinicians often have limited access to complete information from recent hospitalizations. We examined whether providers' timely access to clinical information through shared inpatient-outpatient electronic health records (EHRs) was associated with follow-up visits, return emergency department (ED) visits, or readmissions after hospital discharge in patients with diabetes.

**STUDY DESIGN:** Stepped-wedge observational study.

**METHODS:** As an integrated delivery system staggered implementation of a shared inpatient-outpatient EHR, we studied 241,510 hospital discharges in patients with diabetes (2005-2011), examining rates of outpatient follow-up office visits, telemedicine (phone visits and asynchronous secure messages), laboratory tests, and return ED visits or readmissions (as adverse events). We used multivariate logistic regression adjusting for time trends, patient characteristics, and medical center and accounting for patient clustering to calculate adjusted follow-up rates.

**RESULTS:** For patients with diabetes, provider use of a shared inpatient-outpatient EHR was associated with a statistically significant shift toward follow-up delivered through a combination of telemedicine and outpatient laboratory tests, without a traditional in-person visit (from 22.9% with an outpatient-only EHR to 27.0% with a shared inpatient-outpatient EHR;  $P < .05$ ). We found no statistically significant differences in 30-day return ED visits (odds ratio, 1.02; 95% CI, 0.96-1.09) or readmissions (odds ratio, 0.98; 95% CI, 0.91-1.06) with the shared EHR compared with the outpatient-only EHR.

**CONCLUSIONS:** Real-time clinical information availability during transitions between health care settings, along with robust telemedicine access, may shift the method of care delivery without adversely affecting patient health outcomes. Efforts to expand interoperability and information exchange may support follow-up care efficiency.

*Am J Manag Care.* 2020;26(10):e327-e332. doi:10.37765/ajmc.2020.88506

TAKEAWAY POINTS

Continuity in access to patient information across providers in different settings can improve patient transitions. We examined whether timely access to complete clinical information through a shared inpatient-outpatient electronic health record (EHR) was associated with changes in rates of in-person follow-up visits after hospital discharge in patients with diabetes.

- ▶ Using the shared inpatient-outpatient EHR was associated with a shift toward 7-day follow-up delivered through a combination of telemedicine (telephone and patient-physician secure messages) and outpatient laboratory tests, without a traditional office visit.
- ▶ Patient outcomes, as measured by 30-day return emergency department visits or hospital readmission, were comparable when using the shared EHR.

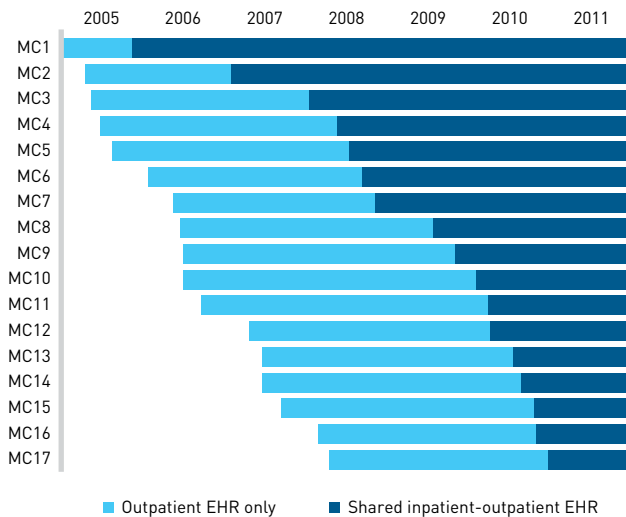
Timely availability of clinical information during health care transitions, in a setting with robust telemedicine access, can shift the method of care delivery without adversely affecting patient health outcomes.

inpatient-outpatient EHR and rates and types of outpatient follow-up, including office visits, telemedicine encounters (including asynchronous secure patient-physician messages and real-time telephone visits), and laboratory tests. We also examined the impact on adverse clinical events after hospital discharge, measured by emergency department (ED) visits and hospital readmissions.

MATERIALS AND METHODS

Study Design and Setting

FIGURE 1. Staggered EHR Implementation by MC: Quasi-Experimental Study With Concurrent Controls<sup>a</sup>



EHR, electronic health record; MC, medical center.

<sup>a</sup>This figure shows the schedule of staggered inpatient EHR implementation across all study MCs during the study period (2005-2011), which offered a natural experiment using a stepped wedge design. After implementation, the inpatient EHR completely replaced the paper medical chart. During the light blue time periods, there was only an outpatient EHR in use, but no inpatient EHR. During the dark blue time periods, there was an inpatient EHR in use, integrated with the outpatient EHR.

health information availability and exchange are associated with reductions in repeat tests or imaging, supporting the feasibility of telemedicine follow-up.<sup>11,21-25</sup>

Objectives

Building on previous findings of improved diabetes care and health outcomes after implementation of an outpatient-only EHR, we studied the subsequent implementation of a shared inpatient EHR that seamlessly integrates patient health information between hospital and outpatient providers.<sup>20,26</sup> In patients with diabetes, this study examined the association between provider use of the shared

This quasi-experimental study examined a historical natural experiment in which an integrated delivery system staggered implementation of an inpatient EHR, integrating it with an existing outpatient EHR, across 17 hospitalist-staffed hospitals (2006-2010). This created a stepped-wedge study design to study the impact of shared inpatient-outpatient EHR use (Figure 1). The implementation order was not associated with medical centers' health care quality or readmission rates.<sup>26</sup>

Prior to the study period, the outpatient EHR used by clinicians had already integrated all outpatient records, including primary and specialty care, laboratories, and pharmacy, but did not include complete clinical information from hospitalizations or ED visits. At baseline, providers also already had the capability to conduct scheduled real-time telephone telemedicine visits with patients and had access to a patient portal website that offered patient-provider asynchronous secure messaging tools. As such, our study examines a shift in provider-to-provider access to patient data across settings after implementation of the shared inpatient-outpatient EHR.

The commercially available complete hospital EHR replaced the inpatient paper medical record and a patchwork of optional health information technology tools, creating a shared inpatient-outpatient EHR. Before implementing the inpatient EHR, HIE between inpatient and outpatient providers was not consistent and was provider dependent. After the inpatient EHR was implemented, both inpatient and outpatient EHRs were seamlessly integrated. The hospital EHR automatically integrates patient history and clinical information (eg, clinical notes, procedures, imaging, laboratory tests, medications) with the outpatient EHR used by primary care providers and specialists, including order-entry capability for outpatient follow-up, medication reconciliation before discharge, secure messaging between providers and with patients, and notifications to outpatient providers that their patient had been hospitalized.

Population

Between 2005 and 2011, we identified all hospitalizations among patients with diabetes (using the clinical diabetes registry) in medical centers where the outpatient EHR was already in use.

We examined patients with diabetes as an example of the impact of shared EHR use in a common chronic condition that has associated complications. We excluded from our study analytic data set patients who were not health plan members in the year prior to the hospitalization and for 30 days after discharge in order to ensure complete capture of comorbidities and follow-up outcomes. We also excluded hospitalizations of patients who were not discharged home in order to ensure eligibility for outpatient follow-up.

### Follow-up Encounters

Our data captured all outpatient office visits, telephone visits, secure electronic messages, and laboratory tests after hospital discharge. In the absence of broad evidence-based guidelines for any optimal postdischarge follow-up timing, we examined the encounters within 7 and 30 days after hospital discharge.<sup>9,20</sup> We also examined any 30-day clinical events as a measure of adverse health events or outcomes, including ED visits or readmissions, based on the 30-day Medicare readmission measures.

Among hospitalizations with follow-up, we examined the rates of follow-up through a combination of only telemedicine and laboratory tests.

### Analysis

We used multivariate logistic regression models for each type of follow-up encounter outcome with EHR status as the main predictor and adjustment for patient characteristics (age, gender, neighborhood socioeconomic status [SES], race/ethnicity, co-payment, comorbidity score), seasonality (calendar month, categorical variable), time trend (year 1 for 2005, year 2 for 2006, and so on, as a continuous variable), quadratic term of the time trend, comorbidity score (centered), interaction term of comorbidity score and time trend, medical center, and medical center-specific time trend (interaction term of medical center with time trend and quadratic term of time trend), with standard errors corrected for patient clustering (using Stata SE 10.1 [StataCorp LP]). We defined a patient as having a low SES neighborhood using 2000 US census block groups with 20% of residents having household incomes below the federal poverty level or 25% of residents 25 years or older having less than a high school education.<sup>27</sup> To adjust for comorbidity, we used the prospective diagnostic cost group score, which has been adopted by CMS for Medicare risk adjustment.<sup>28</sup>

We reported adjusted odds ratios from these multivariate models. For easier interpretation, we also calculated the adjusted rates of each outcome by applying the coefficients from the logistic regression to the entire cohort as if everyone were in pre-inpatient EHR and post-inpatient EHR periods, respectively, so that patients in pre-inpatient EHR and post-inpatient EHR periods shared the exact same characteristics (margins command in Stata).

In sensitivity analyses, we examined the subset of hospitalizations categorized as nonelective and findings were comparable (see [eAppendix](#) [available at [ajmc.com](#)]).

**TABLE 1.** All Hospitalizations Among Patients With Diabetes (2005-2011): Patient Characteristics

Patient characteristics	Total (N = 241,510)	Outpatient EHR only (n = 91,331)	Shared inpatient-outpatient EHR (n = 150,179)
Age in years			
< 18	0.35%	0.41%	0.31%
18-39	5.16%	5.01%	5.24%
40-64	39.42%	39.07%	39.64%
65-74	26.94%	26.90%	26.97%
≥ 75	28.13%	28.61%	27.84%
Gender			
Female	50.66%	49.06%	49.51%
Neighborhood SES			
Higher	68.52%	67.44%	69.17%
Lower	26.06%	26.93%	25.53%
Unknown	5.42%	5.62%	5.30%
Race/ethnicity			
White	52.04%	51.51%	52.36%
Black	12.60%	13.03%	12.34%
Hispanic	18.58%	19.07%	18.28%
Asian	14.92%	14.63%	15.09%
Other	1.87%	1.76%	1.93%

EHR, electronic health record; SES, socioeconomic status.

## RESULTS

Among all 241,510 hospitalizations in 104,126 patients with diabetes from 2005 to 2011, 91,331 occurred before the shared inpatient EHR was implemented and 150,179 occurred after. **Table 1** shows patient characteristics.

After multivariate adjustment, the rate of any type of ambulatory follow-up encounter within 7 days of hospital discharge decreased from 72.8% to 69.2% after use of the shared EHR ( $P < .05$ ) (**Table 2**) and more modestly within 30 days after discharge, from 94.8% to 94.1% after use of the shared EHR ( $P < .05$ ). These patterns in care changes associated with shared EHR use were consistent when examining within the 30-day period after hospital discharge (eAppendix).

The type of follow-up care also changed after the shared EHR implementation. The proportion of 7-day follow-up delivered by a combination of telemedicine and laboratory tests and without an in-person office visit increased from 22.9% before use of the shared EHR to 27.0% after ( $P < .05$ ) (**Figure 2**). Specifically, follow-up with an in-person office visit within 7 days dropped from 55.9% to 50.5% ( $P < .05$ ), and use of any laboratory testing within 7 days after discharge dropped from 32.0% to 30.7% ( $P < .05$ ). No statistically significant changes occurred in the rates of telephone visits or secure messages ( $P > .05$ ).

As a measure of adverse health events or outcomes, there were no statistically significant differences in the rates of ED visits or readmission in the 30 days after hospital discharge associated with

**TABLE 2.** Association Between Use of Shared Inpatient-Outpatient EHR and 7-Day Follow-up Care and 30-Day Events After Discharge<sup>a</sup>

	Adjusted rates		Shared inpatient-outpatient EHR vs outpatient EHR only	
	Outpatient EHR only	Shared inpatient-outpatient EHR	Adjusted OR	95% CI
<b>Follow-up within 7 days after hospital discharge</b>				
Any follow-up*	72.83%	69.21%	0.84	0.80-0.87
In-person office visit*	55.91%	50.48%	0.80	0.77-0.84
Phone visit	9.04%	8.85%	0.98	0.90-1.06
Secure message	11.50%	11.74%	1.03	0.94-1.12
Laboratory test*	32.00%	30.70%	0.94	0.89-0.99
<b>Events 30 days after hospital discharge</b>				
ED visit	16.39%	16.69%	1.02	0.96-1.09
Hospital readmission	9.49%	9.35%	0.98	0.91-1.06

ED, emergency department; EHR, electronic health record; OR, odds ratio.

\**P* < .05.

<sup>a</sup>Logistic regression analyses adjusted for patient age, gender, neighborhood socioeconomic status, race/ethnicity, office co-payment, calendar month, time trend (year, continuous variable), quadratic term of time trend, medical center, interaction of medical center with time trend and quadratic term of time trend, comorbidity score (centered), and interaction of comorbidity score and time trend, with standard errors corrected by clustering at patient level. Adjusted rates are calculated by applying the coefficients from the logistic regression to the cohort as if everyone were in the pre-inpatient EHR period and in the post-inpatient EHR period, respectively.

## DISCUSSION

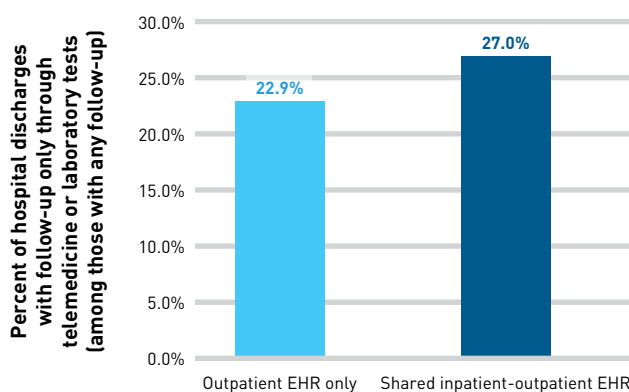
In this natural experiment involving the staggered implementation of a commercially available inpatient-outpatient shared EHR that shares patient data across providers in inpatient and ambulatory settings, we found that after hospital discharge, patients with diabetes had a higher likelihood of receiving follow-up care delivered only by a combination of telemedicine (telephone visits and asynchronous secure messages) and laboratory monitoring without a traditional in-person visit. We found slightly lower overall rates of follow-up office visits and outpatient laboratory tests. As a measure of clinical events, we found no statistically significant association between inpatient-outpatient EHR use and rates of return ED visits or hospital readmissions. Together, these findings suggest that the timely availability of complete clinical information from using a shared inpatient-outpatient EHR after a hospital discharge in a setting with strong telemedicine

access could shift the method of delivering follow-up care without adversely affecting patient health outcomes as measured by repeat ED visits or readmissions.

Although EHR interoperability and HIE functionality have been consistently promoted as policy priorities for improving the quality and efficiency of the American health care system, there is still limited research evidence to inform policy makers about the effects of continuity in provider access to patient information.<sup>6,8,29</sup> Our study builds this evidence as one of the largest rigorously designed studies to examine the impact of shared health information access across providers during patient transitions between health care settings. Our findings from patients with diabetes also complement findings of previous studies in the same integrated delivery system, in patients with diabetes and in general patient populations, in which both providers and patients reported that EHR use facilitated care coordination both by providing informational continuity among providers and by supporting direct communication between clinicians and medical staff through electronic messaging tools.<sup>30,31</sup> In a general patient population, primary care providers reported enhanced access to timely and complete patient information and better agreement on treatment goals and roles and responsibilities after the inpatient EHR was in use.

The optimal amount and timing of outpatient follow-up care after hospital discharge are not clear.<sup>9,20</sup> Although some studies have found that follow-up visits or telephone calls after hospital discharge were associated with better patient outcomes, others have found no effect or worse outcomes associated with more follow-up care, and the evidence continues to be mixed.<sup>29,32-39</sup> In the absence of broad evidence-based clinical guidelines for the optimal type or level of

**FIGURE 2.** Adjusted Rates of Follow-up Care Within 7 Days After Hospital Discharge Delivered Only Through Telemedicine or Laboratory Tests<sup>a</sup>



EHR, electronic health record.

<sup>a</sup>Adjusted rates are calculated by applying the coefficients from logistic regression analyses, which include inpatient EHR indicator, patient age, gender, neighborhood socioeconomic status, race/ethnicity, office co-payment, calendar month, time trend (year, continuous variable), quadratic term of time trend, medical center, interaction of medical center with time trend and quadratic term of time trend, comorbidity score (centered), and interaction of comorbidity score and time trend, to the cohort as if everyone were in the pre-inpatient EHR period and in the post-inpatient EHR period, respectively.

use of the integrated hospital EHR. After the integrated EHR was in use, 16.7% of hospital discharges were followed by an ED visit (vs 16.4% before; *P* > .05) and 9.4% were followed by another hospitalization within 30 days (vs 9.5% before; *P* > .05), as shown in Table 2.

after-discharge follow-up, our study aimed to examine whether use of a shared inpatient-outpatient EHR was associated with shifts in the type of follow-up care delivered after hospital discharge. Because we found that follow-up care was more likely to be delivered through only telemedicine and laboratory tests, without any evidence of adverse changes in downstream health events as measured by ED visits and rehospitalizations, these changes in follow-up care represent potential improvements in the efficiency of health care delivery without adversely affecting quality. Similarly, because the rate of outpatient laboratory tests in this study was lower after using the shared inpatient-outpatient EHR without measurable impact on ED visits or hospitalizations, it appears that EHR-enabled information availability may have decreased unnecessary testing. Our findings are consistent with early evidence from other settings and across patient populations, which have found that electronic health information availability and exchange are associated with reductions in repeat tests and imaging and improve the feasibility of telemedicine follow-up.<sup>20,23,24,40</sup>

Seamless and timely electronic HIE is still limited across the US health care delivery system. Calls for increases in exchange capabilities at hospital discharge are growing, but few settings have measured the large-scale impact of EHR-based information integration across delivery settings.<sup>13,21,41-43</sup> Our study finds that movement toward more seamless health information access, even within an already integrated system, can affect the efficiency of follow-up care after hospital discharge without adversely affecting quality. These shifts may also potentially improve patient convenience through telemedicine follow-up without requiring the transportation and cost of making an in-person visit to health care providers. Although patient convenience and access are typically considered primary benefits of telemedicine, our finding of EHR-supported efficient posthospitalization follow-up through telemedicine may also be relevant as current crisis-based social distancing to protect patients and providers from infectious disease spread is rapidly shifting many medical office visits to telemedicine.

Although our study found modest average decreases in in-person visits, cumulative impacts of this magnitude may be substantial if replicated broadly across large numbers of annual hospitalizations in patient populations with chronic conditions. In addition, our finding of no statistically significant differences in clinical events can be interpreted as reassuring that negative impacts of care shifts were not detected. Further research is needed to explore patient follow-up care preferences and the clinical impacts of variations in follow-up care types in more detail.

### Limitations

There are several limitations to the interpretation and generalizability of our study design and setting. First, the natural experiment of shared inpatient-outpatient EHR implementation in this study is historical and may not fully generalize to current practice, which may vary across settings. Because the sharing of patient data across health care settings is still currently evolving, however, the study findings have potential relevance despite the historical study

period. Further, the study relevance is supported by examining a study setting with relatively mature telemedicine and a patient portal in which patients could access a portal website to schedule a telemedicine visit to communicate with physicians and to review visit details and laboratory results. The follow-up care patterns we identified would not be feasible without the ability to follow up with patients readily by phone or through secure messages. In other settings, in-person follow-up office visits may be needed to share paper discharge summaries or to notify providers of a recent hospitalization.<sup>13,43</sup> Also, the rates of follow-up care in our study at baseline were higher than previously reported in other settings, and the hospital readmission rates were somewhat lower; therefore, other settings with more limited follow-up patterns at baseline may experience different shifts with the availability of HIE across settings.<sup>12,14,32-36,44-46</sup> Our study examined patterns in follow-up care after implementing a systemwide EHR system, and we are not able to characterize the clinical appropriateness of any specific follow-up care regimen. Further study of the clinical significance of changes in follow-up care encounter types is needed. This study examined only patients with diabetes, and we cannot generalize directly to other patient populations. Shared EHRs and HIE are only tools to increase information availability; their impact is dependent on the clinical workflow and delivery system context in which they are used.

## CONCLUSIONS

Overall, in a setting that implemented a shared EHR with seamless HIE between inpatient and outpatient providers, patient follow-up care after hospital discharge was less likely to include an in-person office visit and instead was managed through exchange of asynchronous secure messages, telephone telemedicine, and outpatient laboratory tests. We found no statistically significant change in the rate of return ED visits or readmissions within 30 days after discharge, and we conclude that increased and timely information availability through the shared inpatient-outpatient EHR changed the pattern of follow-up care after discharge, enabling care delivery through non-office visit encounters without adversely affecting patient short-term outcomes. ■

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**Source of Funding:** National Institute of Diabetes and Digestive and Kidney Diseases (R01DK085070). The study sponsor had no role in the design and conduct of the study, including the collection, analysis, and interpretation of data and the writing of the article and the decision to submit it for publication.

**Author Disclosures:** Dr Hsu serves as a consultant for Cambridge Health Alliance, Columbia University, Community Servings, Delta Health Alliance, Robert Wood Johnson Foundation, and University of Southern California. The remaining authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

**Authorship Information:** Concept and design (MR, JHu, RB, IG, MGJ, BF, JHs); acquisition of data (MR, JHu); analysis and interpretation of data (MR, JHu, RB, IG,

MGJ, DB, RN, BF, JHs); drafting of the manuscript (MR, JHu, DB); critical revision of the manuscript for important intellectual content (MR, JHu, RB, IG, MGJ, DB, RN, BF, JHs); statistical analysis (JHu, RB, RN); obtaining funding (MR); administrative, technical, or logistic support (MR); and supervision (MR).

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REFERENCES

1. Anderson GF. *Chronic Care: Making the Case for Ongoing Care*. Robert Wood Johnson Foundation; 2010.
2. Health, United States, 2013: *With Special Feature on Prescription Drugs*. National Center for Health Statistics; 2014.
3. Thorpe KE, Ogden LL, Galactonova K. Chronic conditions account for rise in Medicare spending from 1987 to 2006. *Health Aff (Millwood)*. 2010;29(4):718-724. doi:10.1377/hlthaff.2009.0474
4. Health information exchange: executive summary. Agency for Healthcare Research and Quality. December 2015. Accessed September 15, 2020. [https://effectivehealthcare.ahrq.gov/sites/default/files/related\\_files/health-information-exchange\\_executive.pdf](https://effectivehealthcare.ahrq.gov/sites/default/files/related_files/health-information-exchange_executive.pdf)
5. O'Malley AS, Grossman JM, Cohen GR, Kemper NM, Pham HH. Are electronic medical records helpful for care coordination? experiences of physician practices. *J Gen Intern Med*. 2010;25(3):177-185. doi:10.1007/s11606-009-1195-2
6. Rudin RS, Motala A, Goldzweig CL, Shekelle PG. Usage and effect of health information exchange: a systematic review. *Ann Intern Med*. 2014;161(11):803-811. doi:10.7326/M14-0877
7. Report on health information blocking. Office of the National Coordinator for Health Information Technology. April 2015. Accessed September 15, 2020. [https://www.healthit.gov/sites/default/files/reports/info\\_blocking\\_040915.pdf](https://www.healthit.gov/sites/default/files/reports/info_blocking_040915.pdf)
8. CMS, HHS. Medicare and Medicaid programs: electronic health record incentive program. final rule. *Fed Regist*. 2010;75(144):44313-44588.
9. Ganguli I, Wasfy JH, Ferris TG. What is the right number of clinic appointments?: visit frequency and the accountable care organization. *JAMA*. 2015;313(19):1905-1906. doi:10.1001/jama.2015.3356
10. Callen J, Georgiou A, Li J, Westbrook J. The safety implications of missed test results for hospitalised patients: a systematic review. *BMJ Qual Saf*. 2011;20(2):194-199. doi:10.1136/bmjqs.2010.044339
11. Rahurkar S, Vest JR, Menachemi N. Despite the spread of health information exchange, there is little evidence of its impact on cost, use, and quality of care. *Health Aff (Millwood)*. 2015;34(3):477-483. doi:10.1377/hlthaff.2014.0729
12. Moore C, Wisnivesky J, Williams S, McGinn T. Medical errors related to discontinuity of care from an inpatient to an outpatient setting. *J Gen Intern Med*. 2003;18(8):646-651. doi:10.1046/j.1525-1497.2003.20722.x
13. Kripalani S, LeFevre F, Phillips CO, Williams MV, Basaviah P, Baker DW. Deficits in communication and information transfer between hospital-based and primary care physicians: implications for patient safety and continuity of care. *JAMA*. 2007;297(8):831-841. doi:10.1001/jama.297.8.831
14. Bell CM, Schnipper JL, Auerbach AD, et al. Association of communication between hospital-based physicians and primary care providers with patient outcomes. *J Gen Intern Med*. 2009;24(3):381-386. doi:10.1007/s11606-008-0882-8
15. Roy CL, Poon EG, Karson AS, et al. Patient safety concerns arising from test results that return after hospital discharge. *Ann Intern Med*. 2005;143(2):121-128. doi:10.7326/0003-4819-143-2-200507190-00011
16. Jha A, ed. *Summary of the Evidence on Patient Safety: Implications for Research*. World Health Organization; 2008.
17. van Walraven C, Mamdani M, Fang J, Austin PC. Continuity of care and patient outcomes after hospital discharge. *J Gen Intern Med*. 2004;19(6):624-631. doi:10.1111/j.1525-1497.2004.30082.x
18. Jones J, Nowels CT, Sudore R, Ahluwalia S, Bekelman DB. The future as a series of transitions: qualitative study of heart failure patients and their informal caregivers. *J Gen Intern Med*. 2015;30(2):176-182. doi:10.1007/s11606-014-3085-5
19. Robelia PM, Kashiwagi DT, Jenkins SM, Newman JS, Sorita A. Information transfer and the hospital discharge summary: national primary care provider perspectives of challenges and opportunities. *J Am Board Fam Med*. 2017;30(6):758-765. doi:10.3122/jabfm.2017.06.170194
19. Javorsky E, Robinson A, Boer Kimball A. Evidence-based guidelines to determine follow-up intervals: a call for action. *Am J Manag Care*. 2014;20(1):17-19.
20. Reed M, Huang J, Brand R, et al. Implementation of an outpatient electronic health record and emergency department visits, hospitalizations, and office visits among patients with diabetes. *JAMA*. 2013;310(10):1060-1065. doi:10.1001/jama.2013.276733
21. Hwa K, Wren SM. Telehealth follow-up in lieu of postoperative clinic visit for ambulatory surgery: results of a pilot program. *JAMA Surg*. 2013;148(9):823-827. doi:10.1001/jamasurg.2013.2672
22. Rudin RS, Salzberg CA, Szolovits P, Volk LA, Simon SR, Bates DW. Care transitions as opportunities for clinicians to use data exchange services: how often do they occur? *J Am Med Inform Assoc*. 2011;18(6):853-858. doi:10.1136/amiajnl-2010-000072

23. Rudin RS, Bates DW. Let the left hand know what the right is doing: a vision for care coordination and electronic health records. *J Am Med Inform Assoc*. 2014;21(1):13-16. doi:10.1136/amiajnl-2013-001737
24. Kummerow Broman K, Roumie CL, Stewart MK, et al. Implementation of a telephone postoperative clinic in an integrated health system. *J Am Coll Surg*. 2016;223(4):644-651. doi:10.1016/j.jamcollsurg.2016.07.010
25. Soegaard Ballester JM, Scott MF, Owei L, Neylan C, Hanson CW, Morris JB. Patient preference for time-saving telehealth postoperative visits after routine surgery in an urban setting. *Surgery*. 2018;163(4):672-679. doi:10.1016/j.surg.2017.08.015
26. Reed M, Huang J, Graetz I, et al. Outpatient electronic health records and the clinical care and outcomes of patients with diabetes mellitus. *Ann Intern Med*. 2012;157(7):482-489. doi:10.7326/0003-4819-157-7-201210020-00004
27. Krieger N, Gordon D. Re: "Use of census-based aggregate variables to proxy for socioeconomic group: evidence from national samples." *Am J Epidemiol*. 1999;150(8):892-896. doi:10.1093/oxfordjournals.aje.a010095
28. Zhao Y, Ellis RP, Ash AS, et al. Measuring population health risks using inpatient diagnoses and outpatient pharmacy data. *Health Serv Res*. 2001;36(6, pt 2):180-193.
29. Overhage JM. Health information exchange: 'lex parsimoniae'. *Health Aff (Millwood)*. 2007;26(5):w595-w597. doi:10.1377/hlthaff.26.5.w595
30. MacPhail LH, Neuwirth EB, Bellows J. Coordination of diabetes care in four delivery models using an electronic health record. *Med Care*. 2009;47(9):993-999. doi:10.1097/MLR.0b013e31819e1ffe
31. Graetz I, Reed M, Shortell SM, Rundall TG, Bellows J, Hsu J. The next step towards making use meaningful: electronic information exchange and care coordination across clinicians and delivery sites. *Med Care*. 2014;52(12):1037-1041. doi:10.1097/MLR.0000000000000245
32. Misky GJ, Wald HL, Coleman EA. Post-hospitalization transitions: examining the effects of timing of primary care provider follow-up. *J Hosp Med*. 2010;5(7):392-397. doi:10.1002/jhm.666
33. Lin CY, Barnato AE, Degenholtz HB. Physician follow-up visits after acute care hospitalization for elderly Medicare beneficiaries discharged to noninstitutional settings. *J Am Geriatr Soc*. 2011;59(10):1947-1954. doi:10.1111/j.1532-5415.2011.03572.x
34. Hernandez AF, Greiner MA, Fonarow GC, et al. Relationship between early physician follow-up and 30-day readmission among Medicare beneficiaries hospitalized for heart failure. *JAMA*. 2010;303(17):1716-1722. doi:10.1001/jama.2010.533
35. Hess CN, Shah BR, Peng SA, Thomas L, Roe MT, Peterson ED. Association of early physician follow-up and 30-day readmission after non-ST-segment-elevation myocardial infarction among older patients. *Circulation*. 2013;128(11):1206-1213. doi:10.1161/CIRCULATIONAHA.113.004569
36. DeLia D, Tong J, Gaboda D, Casalino LP. Post-discharge follow-up visits and hospital utilization by Medicare patients, 2007-2010. *Medicare Medicaid Res Rev*. 2014;4(2):E1-E19. doi:10.5600/mmrr.004.02.a01
37. Graff CA, McDonald FS, Ruud KL, Liesinger JT, Johnson MG, Naessens JM. Effect of hospital follow-up appointment on clinical event outcomes and mortality. *Arch Intern Med*. 2010;170(11):955-960. doi:10.1001/archinternmed.2010.105
38. Mistaen P, Poot E. Telephone follow-up, initiated by a hospital-based health professional, for postdischarge problems in patients discharged from hospital to home. *Cochrane Database Syst Rev*. 2006;2006(4):CD004510. doi:10.1002/14651858.CD004510.pub3
39. Gurwitz JH, Field TS, Ogarek J, et al. An electronic health record-based intervention to increase follow-up office visits and decrease rehospitalization in older adults. *J Am Geriatr Soc*. 2014;62(5):865-871. doi:10.1111/jgs.12798
40. Lammers EJ, Adler-Milstein J, Kocher KE. Does health information exchange reduce redundant imaging? evidence from emergency departments. *Med Care*. 2014;52(3):227-234. doi:10.1097/MLR.000000000000067
41. Furukawa MF, King J, Patel V, Hsiao CJ, Adler-Milstein J, Jha AK. Despite substantial progress in EHR adoption, health information exchange and patient engagement remain low in office settings. *Health Aff (Millwood)*. 2014;33(9):1672-1679. doi:10.1377/hlthaff.2014.0445
42. Adler-Milstein J, DesRoches CM, Jha AK. Health information exchange among US hospitals. *Am J Manag Care*. 2011;17(11):761-768.
43. Shortell SM, Casalino LP, Fisher ES. How the Center for Medicare and Medicaid Innovation should test accountable care organizations. *Health Aff (Millwood)*. 2010;29(7):1293-1298. doi:10.1377/hlthaff.2010.0453
44. Coleman EA, Parry C, Chalmers S, Min SJ. The care transitions intervention: results of a randomized controlled trial. *Arch Intern Med*. 2006;166(17):1822-1828. doi:10.1001/archinte.166.17.1822
45. Kocher KE, Nallamothu BK, Birkmeyer JD, Dimick JB. Emergency department visits after surgery are common for Medicare patients, suggesting opportunities to improve care. *Health Aff (Millwood)*. 2013;32(9):1600-1607. doi:10.1377/hlthaff.2013.0067
46. Toth M, Holmes M, Van Houtven C, Toles M, Weinberger M, Silberman P. Rural Medicare beneficiaries have fewer follow-up visits and greater emergency department use postdischarge. *Med Care*. 2015;53(9):800-808. doi:10.1097/MLR.0000000000000401

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## eAppendix

A1. Association between shared inpatient-outpatient EHR and follow-up care 30 days after discharge

	Adjusted %		Shared Inpatient-Outpatient EHR vs Outpatient EHR Only		
	Outpatient EHR Only	Shared Inpatient- Outpatient EHR	Adjusted OR	95% CI	
<b>Follow-up within 30 days after hospital discharge</b>					
Any follow-up care	94.78%	94.05%	0.87	0.80,	0.94
In-person office visit	90.56%	87.94%	0.75	0.68,	0.83
Phone visit	19.32%	19.72%	1.03	0.97,	1.09
Secure message	20.72%	21.93%	1.08	1.01,	1.16
Lab test	57.47%	57.86%	1.02	0.98,	1.06

A2. Among non-elective hospitalizations: Association between shared inpatient-outpatient EHR and follow-up care 7 and 30 days after discharge

	Adjusted %		Shared Inpatient-Outpatient EHR vs Outpatient EHR Only	
	Outpatient EHR Only	Shared Inpatient-Outpatient EHR	Adjusted OR	95% CI
Follow-up within 7 days after hospital discharge				
Any follow-up care*	78.18%	72.37%	0.72	0.68, 0.77
In-person office visit*	59.36%	52.23%	0.75	0.70, 0.79
Phone visit	12.14%	11.54%	0.94	0.84, 1.04
Secure message	10.83%	11.24%	1.05	0.94, 1.17
Lab test*	46.25%	41.49%	0.82	0.77, 0.87
Follow-up within 30 days after hospital discharge				
Any follow-up care*	96.46%	95.80%	0.84	0.72, 0.97
In-person office visit*	91.47%	88.69%	0.73	0.66, 0.80
Phone visit	23.89%	23.78%	0.99	0.92, 1.07
Secure message	20.22%	21.09%	1.06	0.97, 1.16
Lab test*	73.19%	71.43%	0.91	0.86, 0.97