

Association Between Meaningful Use of Electronic Health Records and Patient Health Outcomes in Schizophrenia: A Retrospective Database Analysis

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Improving healthcare quality is a top priority for CMS, which is consistent with the Triple Aim of optimizing patients' quality of care and improving population health, while maintaining the affordability of healthcare.^{1,2} The use of electronic health records (EHRs) to appropriately diagnose, treat, and manage patient care through meaningful tracking and monitoring systems is an approach that is being widely adopted in the United States and elsewhere.

In the United States, the Health Information Technology for Economic and Clinical Health (HITECH) Act incentivized the use of healthcare technologies by providers to improve coordination of care.³ Meaningful use of EHRs, as defined in the HITECH Act, set the minimum standard for the incentives. Implementation of meaningful use occurred in 3 sequential stages with the objectives of each stage overlapping and building on those prior in a cumulative manner. Stage 1, which began in 2011, focused on capturing and sharing basic patient information through 15 core objectives.⁴ Stage 2, which began in 2014, focused on advanced clinical processes through 17 core objectives (eg, identifying patients who should receive preventative/follow-up care, identifying patient-specific education resources, using secure electronic messaging to communicate with patients).⁵ Stage 3, which began in 2017, focused on improving patient outcomes.⁶ The specific requirements and timelines for stages 2 and 3 have since been modified by newer legislation.^{6,7}

The majority of providers utilize some form of EHR, and most believe EHR use improves quality of care.⁸ A review of the literature identified increased productivity, better quality, and improved data management as the most frequently reasons for adoption of EHR, while the most commonly reported barriers to adoption of EHR were data errors, a lack of standards, and productivity loss.⁹ At one academic healthcare center, EHRs were found to be a substantial burden on primary care physicians' time (5.9 hours per day),¹⁰ although the time to complete the same clinical process using paper charts was not estimated. Critics have argued that there is no consistent evidence that EHR use leads to improved patient outcomes.^{11,12} Although the meaningful use of EHRs has been correlated with enhanced healthcare quality and processes,¹³⁻¹⁷ the impact of the meaningful use of

ABSTRACT

Improvements in patient outcomes from the meaningful use of electronic health records (EHRs) have not been extensively studied among patients with schizophrenia. This study assessed the association between EHR use, provision of quality care, and patient outcomes. Providers who were at least 50% compliant with current requirements for the CMS Electronic Health Records Incentive Program were classified as EHR providers. Quality of mental health care was assessed using 4 Healthcare Effectiveness Data and Information Set indicators. Patient outcomes included inpatient admissions and emergency department visits. A total of 18,305 providers (EHR: 16.6%; non-EHR: 83.3%) treated 27,153 patients with schizophrenia. EHR use was associated with improved rates of diabetes screening (77.9% vs 72.4%; $P < .001$), diabetes monitoring (72.1% vs 61.4%; $P < .001$), and better antipsychotic adherence (54.7% vs 36.6%; $P < .001$). EHR use was also associated with fewer inpatient admissions (15.9% vs 25.2%; $P < .001$) and emergency department visits (32.2% vs 49.3%; $P < .001$). These data suggest that EHR use may have a positive influence on the process and outcomes of psychiatric care when treating patients with schizophrenia. More research is needed to identify the drivers of the influence of EHRs and to develop programs that ensure all EHR users enjoy the same potential benefits as demonstrated here.

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EHRs on patient outcomes, especially in treating serious mental illness such as schizophrenia, has not yet been determined.

Schizophrenia is uncommon, affecting only 0.5% to 1% of the population in the United States^{18,19}; however, it is one of the most expensive and disabling mental illnesses.²⁰ In 2013, the total cost—including direct healthcare costs, direct nonhealthcare costs (eg, law enforcement, homeless shelters, and research and training), and indirect costs (eg, unemployment, productivity loss, premature mortality, and caregiving)—of schizophrenia in the United States was estimated at \$155.7 billion, with \$37.7 billion reflecting the direct healthcare costs.²¹ Schizophrenia ranks as the sixth most disabling disease worldwide, due in part to severe psychiatric symptoms such as delusions, hallucinations, and social withdrawal.²⁰ In addition, patients with schizophrenia also tend to have higher rates of diabetes and cardiovascular disease compared with the general population.²² Many of the atypical antipsychotics that are the first-line treatment for schizophrenia^{19,23} cause weight gain, which in turn can exacerbate these comorbid conditions.^{24,25}

Recognizing these issues, the National Committee for Quality Assurance added Healthcare Effectiveness Data and Information Set (HEDIS) measures to specifically address metabolic care for patients with mental illness. These 4 measures include diabetes screening, diabetes monitoring, cardiovascular monitoring, as well as the assessment of antipsychotic medication adherence.²⁶ The results of a recent retrospective insurance claims database study indicated that over 80% of patients with schizophrenia who were taking antipsychotics received the recommended HEDIS metabolic monitoring.²⁷ However, it remains unclear if meeting these specific quality-of-care metrics actually leads to improved patient outcomes. Thus, the current study assessed the association between the meaningful use of EHRs, the quality of patient care, and patient outcomes in schizophrenia.

Methods

Study Design and Data Source

This retrospective database analysis examined the meaningful use of EHRs and patient outcomes in schizophrenia utilizing 3 large datasets, which were linked through physicians' National Provider Identifier (NPI) numbers. The Inovalon "More² Registry"—a multi-payer medical and pharmacy claims database from private and public (Medicare Advantage or Managed Medicaid) sector health plans in all 50 US states that contains information on 252 million unique patients—contained all of the data with the exception of providers' EHR use.²⁸ All patient health data in the Inovalon More² Registry were de-identified in compliance with the Health Insurance Portability and Accountability Act.

Meaningful use of EHR information came from 2 separate CMS datasets. Providers in the Inovalon More² Registry were grouped into either the EHR providers group or the non-EHR providers

group. Those who were listed in the CMS Electronic Health Records Incentive Program dataset as at least 50% compliant with current requirements were identified as having meaningful use of EHR. Those who were not identified in this dataset were either not participating in meaningful use of EHR or simply not seeing Medicare or Medicaid patients. Therefore, all non-EHR providers were also required to be in CMS's "Medicare Provider Utilization and Payment Data: Physician and Other Supplier" dataset. Less than 0.5% of providers were excluded because they were not identified in either of these 2 datasets.

Because these data were analyzed at the provider rather than patient level, the claims of all patients who met the study inclusion or exclusion criteria were linked with their providers. Based on the patient-provider linkages, the group of patients under the care of a provider during the study period was labeled the patient panel for that provider. If a single patient saw multiple providers, the patient was included on the patient-panels for each of the providers that saw the patient.

Patient Inclusion/Exclusion Criteria

Patients were included if they were 18 years or older and diagnosed with schizophrenia (*International Classification of Diseases (ICD)-9-Clinical Modification (CM) 295.xx*). Schizophrenia diagnosis was determined by either a single inpatient admission or ED claim with a primary diagnosis of schizophrenia, or 2 outpatient claims with a primary diagnosis of schizophrenia within a 1-year period. Patients were required to have continuous enrollment with medical and pharmacy eligibility from January 1, 2014, through December 31, 2014. Patients also needed to qualify for at least 1 of the 4 HEDIS mental health quality measures (ie, diabetes screening, diabetes monitoring, cardiovascular monitoring, assessment of antipsychotic medication adherence) assessed in 2014 as part of the primary analysis. See the [eAppendix](#), available at [ajmc.com](#), for detailed definitions.

Provider Inclusion/Exclusion Criteria

Providers were included if they met all of the following criteria: accepted commercially insured and Medicare or Medicaid members, had at least 1 patient qualifying for 1 of 4 HEDIS mental health quality measures, and were not part of a group practice. Providers with an NPI number associated with a group practice were excluded if there was no other NPI number that identified him or her as an individual provider because the care could not be attributed to a single physician.

High- vs General-Quality Provider Definition

Providers were categorized as delivering either high- or general-quality care using CMS' "Guide to Quality Performance Scoring Methods for Accountable Care Organizations," which outlined

33 measures of quality care in 4 domains: Patient/Caregiver Experience, Care Coordination/Patient Safety, Preventive Health, and At-Risk Population.²⁹ Providers were defined as high-quality providers if at least 90% of their patients achieved all measures for which they were eligible; otherwise, the providers were classified as general-quality providers.

Outcome Measures

The quality of care provided in mental health was evaluated using the proportion of 4 HEDIS quality measures met by the provider’s patient panel. The specific HEDIS measures were defined based on the National Committee for Quality Assurance definitions for diabetes screening (for those treated with antipsychotics), diabetes monitoring (for those with diabetes), cardiovascular monitoring (for those with cardiovascular disease), and antipsychotic medication adherence (for those treated with antipsychotics).²⁶

In addition, patient outcome proxy variables were computed and aggregated at the provider level. Two relapse-related proxies based on healthcare service utilization included: (1) at least 1 ED visit with a primary diagnosis of a relevant mental health condition (*ICD-9-CM 295.xx–305.xx*); and (2) at least 1 inpatient admission with a primary diagnosis for schizophrenia (*ICD-9-CM 295.xx*).

Among the subset of patients who had relevant lab values, mean values of glycated hemoglobin (A1C) and low-density lipoprotein cholesterol (LDL-C), as well as the proportion of patients with elevated A1C of at least 7% and patients with LDL-C of at least 160 mg/dL, were examined.

Statistical Analysis

Means and standard deviations were computed for continuous variables, and frequencies and proportions were computed for discrete or event-related variables. All indicators were computed at the provider level. A patient’s data could contribute to multiple providers’ patient-panels. Patients who saw more than 1 provider—both those who engaged in meaningful use of EHR and non-EHR—were only included in patient-panels of the most common provider type (see eAppendix for details). The grand mean across providers in meaningful use of EHR and non-EHR groups, as well as the CMS high- and general-quality groups, were computed and weighted by the providers’ patient-panel sizes. Outcome measures were compared between meaningful use of EHR and non-EHR providers using *t* tests for continuous variables and Chi-square tests for categorical variables with a 2-tailed alpha of 0.05. All analyses were completed using SPSS Statistics for Windows (IBM Corporation; Armonk, NY).

Results

Provider Characteristics

A total of 18,305 providers met the eligibility requirements. The meaningful use of EHR providers (n = 3046; 16.6%) had an average

patient-panel size of 1.9 patients (SD = 2.3; range = 1-58), whereas the non-EHR providers (n = 15,259; 83.3%) had an average patient-panel size of 4.0 patients (SD = 14.3; range = 1-1022). About one-third of the providers (n = 5856; 32.0%) met the CMS criteria for high-quality providers with an average patient-panel size of 1.5 patients (SD = 1.0; range = 1-19), with the remaining general-quality providers (n = 12,449; 68.0%) having an average patient-panel size of 4.6 patients (SD = 15.8; range = 1-1022). CMS high-quality providers were over-represented among the meaningful use of EHR providers (27.1%) compared with the non-EHR providers (19.4%).

Patient-Panel Characteristics

The 18,305 providers treated a total of 27,153 unique patients with schizophrenia. Patients could see multiple providers and, therefore, could be included on more than 1 provider’s patient-panel. Non-EHR and meaningful use of EHR providers appeared to have patient-panels that were relatively similar in demographic characteristics

TABLE 1. Providers’ Patient-Panel Characteristics^a

Characteristic	Non-EHR (N = 60,866)		Meaningful Use of EHR (N = 5,656)	
	n	%	n	%
Age, mean (SD)	48.5	[16.3]	50.7	[14.8]
Gender, n %				
Female	28,532	46.9%	2838	50.2%
Male	32,334	53.1%	2818	49.8%
Ethnicity, n %				
White	14,380	23.6%	1822	32.2%
African American	16,710	27.5%	1433	25.3%
Asian or Pacific Islander	2477	4.1%	120	2.1%
Hispanic or Latino	6588	10.8%	292	5.2%
Other	1873	3.1%	150	2.7%
Missing	18,838	30.9%	1839	32.5%
Region, n %				
Northeast	31,309	51.4%	2608	46.1%
North Central	3153	5.2%	609	10.8%
South	22,695	37.3%	2048	36.2%
West	3565	5.9%	362	6.4%
Missing	144	0.2%	29	0.5%
Payer Type, n %				
Commercial	1374	2.3%	282	5.0%
Managed Medicaid	35,264	57.9%	2986	52.8%
Medicare Advantage	22,473	36.9%	2231	39.4%
Missing	1755	2.9%	157	2.8%

EHR indicates electronic health record; SD, standard deviation.

^aThe provider was the unit of analysis. Patients may have been seen by multiple providers and included on more than 1 providers’ patient-panel.

(Table 1). The patient-panels (values shown here as non-EHR vs EHR) were approximately evenly split on gender (male: 53.1% vs 49.8%), were primarily located in the Northeast (51.4% vs 46.1%) or South (37.3% vs 36.2%) regions, and were predominately covered by either Managed Medicaid (57.9% vs 52.8%) or Medicare Advantage (36.9% vs 39.4%) plans.

EHR Use and Provision of Quality Healthcare

Significantly more EHR providers delivered quality patient care as measured by HEDIS mental health quality measures (44.9%) than the non-EHR providers (29.4%; $P < .001$). Specifically, meaningful

use of EHR providers were more likely to deliver diabetes screening (77.9% vs 72.4%; $P < .001$) and diabetes monitoring (72.1% vs 61.4%; $P < .001$), and had patient-panels with better antipsychotic adherence (54.7% vs 36.6%; $P < .001$) than non-EHR providers (Figure).

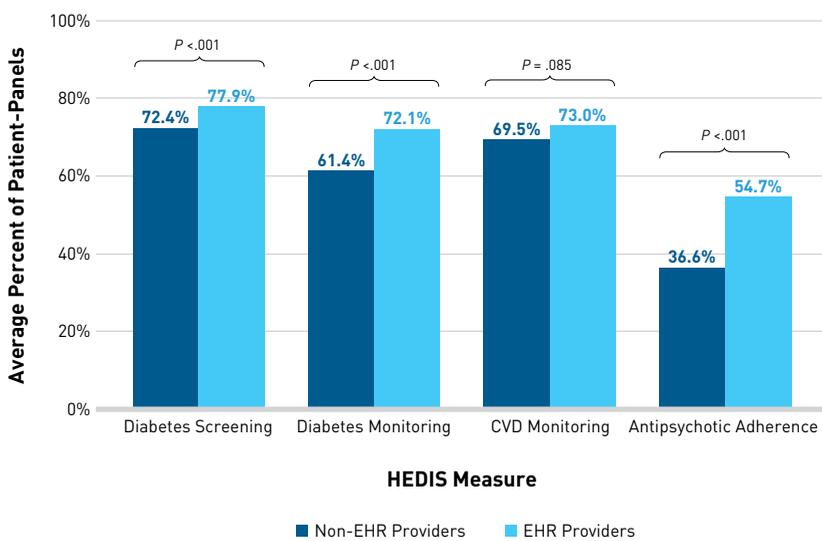
Meaningful Use of EHR and Patient Outcomes

As shown in Table 2, meaningful use of EHRs appeared to lead to better patient health outcomes. Compared with non-EHR providers, EHR providers had significantly fewer patients with relapse-related healthcare utilization, such as inpatient admissions (16.9% vs 25.2%; $P < .001$) and ED visits (32.2% vs 49.3%; $P < .001$). Similarly, EHR providers were less likely to have patients with elevated A1C ($\geq 7\%$) values (32.9% vs 37.8%; $P = .043$) and elevated LDL-C (≥ 160 mg/dL) values (2.8% vs 6.8%; $P = .007$) among the approximately 2000 patients with these laboratory values available.

Patient Outcomes by CMS Provider Quality and Meaningful Use of EHR

For the analysis, groups were stratified by high- and general-quality providers within their level of EHR use to assess if the associations between meaningful use of EHR and patient health outcomes were a function of the quality of the provider. Within each stratum (high- or general-quality providers), meaningful use of EHR providers had better patient health outcomes than non-EHR providers. In addition, across the 4 subgroups, the high-quality and meaningful use of EHR provider subgroup had the best patient outcomes, whereas the

FIGURE. Provision of Quality Care by Meaningful Use of EHR



CVD indicates cardiovascular disease; EHR, electronic health record; HEDIS, Healthcare Effectiveness Data and Information Set.

TABLE 2. Patient Health Outcomes by EHR Use*

	Non-EHR Providers			Meaningful Use of EHR Providers			P
	Mean	SD	n	Mean	SD	n	
Relapse-Related Healthcare Utilization							
Inpatient admission	25.2%	35.4	15,259	16.9%	32.9	3046	<.001
ED visit	49.3%	41.6	15,259	32.2%	42.3	3046	<.001
Diabetes							
A1C laboratory value (%)	7.37	1.86	2186	7.15	1.91	402	.031
Elevated A1C ($\geq 7\%$)	37.8%	44.9	2186	32.9%	45.2	402	.043
Cardiovascular Disease							
LDL-C laboratory value (mg/dL)	95.9	39.3	927	88.0	30.5	161	.004
Elevated LDL-C (≥ 160 mg/dL)	6.8%	24.8	927	2.8%	16.1	161	.007

A1C indicates glycated hemoglobin; ED, emergency department; EHR, electronic health record; LDL-C, low-density lipoprotein cholesterol; SD, standard deviation. *The analysis was performed at the provider level. For each provider, the mean or percentage of the patient-panel was calculated. Next, patient-panel means or percentages were averaged across providers and weighted by the panel size.

general-quality and non-EHR provider subgroup had the worst patient outcomes (Table 3).

Discussion

At the time of our research, only a single prior study evaluating the impact of EHRs on patients with schizophrenia was identified. This 2017 study, conducted in a mental health facility in Ontario, Canada, found implementation of EHRs led to an increase in metabolic monitoring (from 76.7% to 81.6%), as well as a 19.7% decrease in the use of restraints.³⁰ To our knowledge, ours is the first study in the United States examining the association between meaningful use of EHRs and patient outcomes in schizophrenia. The current study was conducted using claims data from the calendar year 2014 when providers were incentivized for implementing stage 1 or stage 2 of meaningful EHR use. Higher quality of care was delivered by providers who used EHRs across 4 of the HEDIS process measures specific to mental health. More importantly, the patient outcomes for providers who used EHRs were significantly better, as measured by fewer patients with psychiatric inpatient admission and ED visits, as well as

fewer patients with elevated laboratory values for diabetes and cardiovascular disease. For both CMS-defined high- and general-quality providers, those engaging in the meaningful use of EHRs delivered better quality of care and had better health outcomes in patients with schizophrenia.

Outside of schizophrenia, most US-based studies have examined the effects of EHRs on quality of care rather than patient outcomes; nevertheless, the results of those examining the effects of EHRs on patient outcomes have been mixed.^{11,12} In a large study of Medicare fee-for-service beneficiaries in New York State, there was no meaningful reduction in readmissions following the implementation of EHRs that electronically captured data.³¹ In contrast, a meta-analytic review synthesizing 24 individual studies found that the implementation of new health information technology in hospitals led to a 15% decrease in inpatient mortality.³² A 2018 study examining inpatient mortality rates among Medicare beneficiaries found more nuanced results: mortality rates decreased over time as EHRs incorporated more functionality.³³ The emerging evidence surrounding patient outcomes suggests that the benefits of EHRs do not come from simply collecting data electronically,³² but from

TABLE 3. Patient Health Outcomes and Meaningful Use of EHR Stratified by Provider Quality^a

	Non-EHR Providers			Meaningful Use of EHR Providers		
	Mean	SD	n	Mean	SD	n
General-Quality Providers						
Relapse-Related Healthcare Utilization						
Inpatient admission	26.9%	34.3	10,771	17.8%	33.2	1678
ED visit	51.5%	39.5	10,771	34.0%	41.0	1678
Diabetes						
A1C laboratory value	7.42	1.87	1725	7.31	2.05	242
Elevated A1C (≥7)	37.6%	44.2	1725	35.0%	45.4	242
Cardiovascular Disease						
LDL-C laboratory value	97.2	37.4	739	90.4	31.3	89
Elevated LDL-C (≥160 mg/dL)	5.7%	22.6	739	2.8%	16.5	89
High-Quality Providers						
Relapse-Related Healthcare Utilization						
Inpatient admission	21.0%	37.6	4488	13.5%	32.4	1368
ED Visit	44.1%	45.8	4488	30.0%	43.7	1368
Diabetes						
A1C laboratory value	7.17	1.83	461	6.90	1.62	160
Elevated A1C (≥7)	38.9%	47.9	461	29.8%	44.7	160
Cardiovascular Disease						
LDL-C laboratory value	91.1	45.8	188	85.1	29.5	72
Elevated LDL-C (≥160 mg/dL)	11.4%	31.7	188	2.8%	16.5	72

A1C indicates glycated hemoglobin; ED, emergency department; EHR, electronic health record; LDL-C, low-density lipoprotein cholesterol; SD, standard deviation. ^aThe analysis was performed at the provider level. For each provider, the mean or percentage of the patient-panel was calculated. Next, patient-panel means or percentages were averaged across providers and weighted by the panel size.

implementing additional clinical functionality, such as computerized physician orders and clinical guidelines.³³ As meaningful use of EHRs progresses beyond stage 1, greater gains may be seen in patient outcomes.

Although the research linking EHR use to patient outcomes has been limited, several prior studies have associated EHR use with improved healthcare quality. A meta-analytic review of 47 studies linked EHR use to better healthcare quality, including greater guideline adherence, fewer medication errors, and fewer medication adverse events, particularly for EHR use with greater functionality, such as decision-support systems.¹⁷

Improving the quality of care is likely an important intermediate step to improving patient outcomes. Past research has reported that a 10% improvement in antipsychotic adherence (based on the medication possession ratio) was associated with a 13% reduction in the odds of hospitalization.³⁴ The 18% increase in antipsychotic adherence found in this study may be part of the mechanism that led to the 10% reduction in inpatient admissions. Similarly, increased healthcare quality through higher rates of screening and monitoring of potential metabolic adverse events associated with some antipsychotics may also contribute to the lowered inpatient admission and ED visits. Patients with schizophrenia and diabetes have been found to have more ED visits (7.5 visits/year) than those with only schizophrenia (5.3 visits/year).³⁵ Likewise, patients with schizophrenia and cardiometabolic comorbidities have been found to have higher admission rates and healthcare costs than those with fewer or no cardiometabolic comorbidities.³⁶ Meaningful use of EHRs likely leads to improvements in the quality of care, which in turn leads to better patient outcomes.

Schizophrenia was one of the most expensive psychiatric conditions in the United States in 2013, with \$37.7 billion in direct healthcare costs.²¹ Inpatient admissions and ED visits were the primary cost drivers, with a combined annual cost of \$17.8 billion in 2013.²¹ Implementing meaningful use of EHRs appears to be associated with improved metabolic monitoring, which may reduce the metabolic adverse events associated with some atypical antipsychotics and improve antipsychotic adherence. These improvements in quality of care could then possibly lead to improved patient outcomes and reduced healthcare resource use costs.

Limitations

This cross-sectional study assessed the association between the meaningful use of EHRs and patient outcomes at a single point in time; therefore, future longitudinal research is warranted to understand the impact of EHR use on long-term improvements in patient outcomes. Further, more research is needed to identify the drivers of the influence of EHRs and to develop programs that ensure that all EHR users experience the same benefits as demonstrated here. Notwithstanding this limitation, to our knowledge

this descriptive analysis is the first study of this kind in schizophrenia to assess the association between EHR use, healthcare quality, and patient outcomes. Providers who utilized EHR systems but were not enrolled in the CMS incentive program would have been misclassified as non-EHR providers based on the study definition, potentially underestimating the impact of EHR use on outcomes. As previously noted, only a small percentage (0.5%) of the providers were not identified in the CMS incentive program. Finally, patient outcomes data could have contributed to multiple providers, potentially violating the independence assumption of the statistical tests. The authors, however, attempted to account for repeated observations of patients across EHR and non-EHR providers by including patients who saw both EHR and non-EHR providers in patient-panels of the most common provider type only (see eAppendix for details and additional operational definitions).

Conclusions

The meaningful use of EHRs in schizophrenia was associated with better quality of care, including improved antipsychotic adherence, better diabetes screening and monitoring, as well as reduced relapse-related healthcare utilization. Although schizophrenia only affects 0.5% to 1% of the US population, it was estimated to have direct healthcare costs of \$37.7 billion to the US healthcare system in 2013. For schizophrenia, greater use of EHRs may serve the Triple Aim of improving the quality of patient care, improving population health, and reducing healthcare costs.³ Further research using longitudinal studies is needed to confirm these findings and to isolate drivers linking EHR use with improved outcomes. ■

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REFERENCES

- Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. *Health Aff (Millwood)*. 2008;27(3):759-769. doi: 10.1377/hlthaff.27.3.759.
- Mueser KT, Bond GR, Drake RE, Resnick SG. Models of community care for severe mental illness: a review of research on case management. *Schizophr Bull*. 1998;24(1):37-74.
- Gold M, McLaughlin C. Assessing HITECH implementation and lessons: 5 years later. *Milbank Q*. 2016;94(3):654-687. doi: 10.1111/1468-0009.12214.
- HITECH Act: Medicare and Medicaid Programs; Electronic Health Record Incentive Program. *Fed Regist*. 2010;75(144):44313-44588.

5. CMS, HHS. Medicare and Medicaid programs; Electronic Health Record Incentive Program—stage 2. final rule. *Fed Regist*. 2012;77(171):53967–54162.
6. CMS, HHS. Medicare and Medicaid programs; Electronic Health Record Incentive Program—stage 3 and modifications to Meaningful Use in 2015 through 2017. final rules with comment period. *Fed Regist*. 2015;80(200):62761–62955.
7. Waldren SE, Solis E. The evolution of Meaningful Use: today, stage 3, and beyond. *Fam Pract Manag*. 2016;23(1):17–22.
8. Manca DP. Do electronic medical records improve quality of care? yes. *Can Fam Physician*. 2015;61(10):846–847, 850–851.
9. Kruse CS, Stein A, Thomas H, Kaur H. The use of electronic health records to support population health: a systematic review of the literature. *J Med Syst*. 2018;42(11):214. doi:10.1007/s10916-018-1075-6
10. Arndt BG, Beasley JW, Watkinson MD, et al. Tethered to the EHR: primary care physician workload assessment using EHR event log data and time-motion observations. *Ann Fam Med*. 2017;15(5):419–426. doi: 10.1370/afm.2121.
11. Greiver M. Rebuttal: do electronic medical records improve quality of care? no. *Can Fam Physician*. 2015;61(10):e436
12. Windle JR, Windle TA. Electronic health records and the quest to achieve the “Triple Aim.” *J Am Coll Cardiol*. 2015;65(18):1973–1975. doi:10.1016/j.jacc.2015.03.038
13. Burton LC, Anderson GF, Kues IW. Using electronic health records to help coordinate care. *Milbank Q*. 2004;82(3):457–481.
14. Garg T, Lee JY, Evans KH, Chen J, Shieh L. Development and evaluation of an electronic health record–based best-practice discharge checklist for hospital patients. *Jt Comm J Qual Patient Saf*. 2015;41(3):126–131.
15. Simpao AF, Ahumada LM, Desai BR, et al. Optimization of drug–drug interaction alert rules in a pediatric hospital’s electronic health record system using a visual analytics dashboard. *J Am Med Inform Assoc*. 2015;22(2):361–369. doi: 10.1136/amiajnl-2013-002538.
16. Chaudhry B, Wang J, Wu S, et al. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Ann Intern Med*. 2006;144(10):742–752.
17. Campanella P, Lovato E, Marone C, et al. The impact of electronic health records on healthcare quality: a systematic review and meta-analysis. *Eur J Public Health*. 2016;26(1):60–64. doi: 10.1093/eurpub/ckv122.
18. Saha S, Chant D, Welham J, McGrath J. A systematic review of the prevalence of schizophrenia. *PLoS Med*. 2005;2(5):e141. doi: 10.1371/journal.pmed.0020141.
19. Falkai P, Wobrock T, Lieberman J, et al; WFSBP Task Force on Treatment Guidelines for Schizophrenia. World Federation of Societies of Biological Psychiatry (WFSBP) guidelines for biological treatment of schizophrenia, part 1: acute treatment of schizophrenia. *World J Biol Psychiatry*. 2005;6(3):132–191.
20. World Health Organization. The global burden of disease: 2004 update. WHO website. who.int/health-info/global_burden_disease/2004_report_update/en/. Published 2008. Accessed February 6, 2019.
21. Cloutier M, Aigbogun MS, Guerin A, et al. The economic burden of schizophrenia in the United States in 2013. *J Clin Psychiatry*. 2016;77(6):764–771. doi: 10.4088/JCP.15m10278.
22. Henderson DC, Vincenzi B, Andrea NV, Ulloa M, Copeland PM. Pathophysiological mechanisms of increased cardiometabolic risk in people with schizophrenia and other severe mental illnesses. *Lancet Psychiatry*. 2015;2(5):452–464. doi: 10.1016/S2215-0366(15)00115-7.
23. Patel KR, Cherian J, Gohil K, Atkinson D. Schizophrenia: overview and treatment options. *P T*. 2014;39(9):638–645.
24. Rummel-Kluge C, Komossa K, Schwarz S, et al. Head-to-head comparisons of metabolic side effects of second generation antipsychotics in the treatment of schizophrenia: a systematic review and meta-analysis. *Schizophr Res*. 2010;123(2–3):225–233. doi: 10.1016/j.schres.2010.07.012.
25. American Diabetes Association; American Psychiatric Association; American Association of Clinical Endocrinologists; North American Association for the Study of Obesity. Consensus development conference on antipsychotic drugs and obesity and diabetes. *Diabetes Care*. 2004;27(2):596–601.
26. HEDIS 2013: Technical specifications for health plans. Vol. 2. 2012. National Committee for Quality Assurance website. www.ncqa.org. Published 2012. Accessed September 6, 2018.
27. Ng-Mak D, Rajagopalan K. Examining quality of care for individuals treated for mental health using the HEDIS mental health quality measures. *Cur Med Res and Opin*. 2019;35(1):87–95.
28. MORE² Registry overview. Inovalon website. inovalon.com/resources/more2-overview. Accessed April 16, 2019.
29. Guide to quality performance scoring methods for accountable care organizations. CMS website. cms.gov/medicare/medicare-fee-for-service-payment/sharesavingsprogram/downloads/2012-11-aco-quality-scoring-supplement.pdf. Published 2012. Accessed September 6, 2018.
30. Riahi S, Fischler I, Stuckey MI, Klassen PE, Chen J. The value of electronic medical record implementation in mental health care: a case study. *JMIR Med Inform*. 2017;5(1):e1. doi: 10.2196/medinform.6512.
31. Unruh MA, Jung HY, Vest JR, Casalino LP, Kaushal R; HITECH Investigators. Meaningful use of electronic health records by outpatient physicians and readmissions of Medicare fee-for-service beneficiaries. *Med Care*. 2017;55(5):493–499. doi: 10.1097/MLR.0000000000000695.
32. Thompson G, O’Horo JC, Pickering BW, Herasevich V. Impact of the electronic medical record on mortality, length of stay, and cost in the hospital and ICU: a systematic review and metaanalysis. *Crit Care Med*. 2015;43(6):1276. doi:10.1097/CCM.0000000000000948
33. Lin SC, Jha AK, Adler-Milstein J. Electronic health records associated with lower hospital mortality after systems have time to mature. *Health Aff (Millwood)*. 2018;37(7):1128–1135. doi: 10.1377/hlthaff.2017.1658.
34. Weiden PJ, Kozma C, Grogg A, Locklear J. Partial compliance and risk of rehospitalization among California Medicaid patients with schizophrenia. *Psychiatr Serv*. 2004;55(8):886–891. doi: 10.1176/appi.ps.55.8.886.
35. Shim RS, Druss BG, Zhang S, et al. Emergency department utilization among Medicaid beneficiaries with schizophrenia and diabetes: the consequences of increasing medical complexity. *Schizophr Res*. 2014;152(2–3):490–497. doi: 10.1016/j.schres.2013.12.002.
36. Correll CU, Ng-Mak DS, Stafkey-Mailey D, Farrelly E, Rajagopalan K, Loebel A. Cardiometabolic comorbidities, readmission, and costs in schizophrenia and bipolar disorder: a real-world analysis. *Ann Gen Psychiatry*. 2017;16:9. doi: 10.1186/s12991-017-0133-7.