Published in final edited form as:

Comput Inform Nurs. 2017 August ; 35(8): 417–424. doi:10.1097/CIN.0000000000000344.

Implementation of Electronic Health Records in U.S. Nursing Homes

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Abstract

While Electronic Health Records have emerged as promising tools to help improve quality of care, nursing homes have lagged behind in implementation. This study assessed electronic health records implementation, associated facility characteristics and potential impact on quality indicators in nursing homes. Using national Centers for Medicare and Medicaid Services and survey data for nursing homes, a cross-sectional analysis was conducted to identify variations between nursing homes that had and had not implemented electronic health records. A difference-in-differences analysis was used to estimate the longitudinal effect of electronic health records on commonly used quality indicators. Data from 927 nursing homes were examined, 49.1% of which had implemented electronic health records. Nursing homes with electronic health records were more likely to be non-profit/government owned (p -value=0.04), had lower percent of Medicaid residents (p -value=0.02) and higher CNA and RN staffing levels (p -values=0.002-0.02). Difference-in-differences analysis showed greater quality improvements after implementation for five long stay and two short stay quality measures (p -values=0.001-0.01) compared to those who did not implement electronic health records. Implementation rates in nursing homes are low compared to other settings and better resourced facilities are more likely to have implemented electronic health records. Consistent with other settings, electronic health records implementation improves quality in nursing homes but further research is needed to better understand the mechanism for improvement and how it can best be supported.

Keywords

Long-Term Care; Nursing homes; Quality Improvement; Electronic Health Records; Documentation

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Conflicts of Interest

The authors have no conflicts of interests to disclose.

BACKGROUND AND SIGNIFICANCE

Electronic health records (EHRs) are defined as an electronic version of a patient's medical history including key administrative clinical data relevant to that person's care,¹ and have emerged as a promising tool to improve health care quality. Research indicates that EHRs can improve documentation, thereby increasing the accuracy and completeness of patient data. This improves health care providers' ability to appropriately diagnose and treat their patients. Furthermore, EHRs can facilitate timely and accurate patient risk assessments and quality measurements, allowing for more prompt intervention as needed. Finally, many EHRs include tools that support clinical judgment and decision making, as well as care coordination and health information exchange.²⁻⁴ In the acute and primary care settings, EHRs have been found useful to prevent pressure ulcers and falls,⁵⁻⁸ decrease the incidence of catheter-associated urinary tract infections (UTIs)⁸ and improve vaccination rates.⁹ In light of promising evidence of the potential benefits of EHRs, significant federal investments are being made to encourage EHR implementation through the meaningful use incentive programs. However, these incentives are targeted towards acute and primary care, as well as office-based physicians of other specialties, and none are aimed at nursing homes.¹⁰⁻¹⁵ Facing substantial barriers, nursing homes are therefore lagging behind in EHR implementation rates compared to other health care settings.¹¹⁻¹⁶

With a growing aging population and rising complexities and costs of care for elderly patients, increased EHR use in nursing homes is imminently important. The need further grows as acute, primary and specialty care settings increasingly rely on electronic records for health information exchange in care transitions. In 2013, 78.4% of office-based physician practices¹⁷ and 59.4% of acute care hospitals¹⁸ had adopted EHRs. For acute care hospitals, implementation had risen to 75.5% in 2014. In comparison, the National Study of Long-Term Care Providers found that in 2014 only 19.0% of residential care communities, such as assisted living, had implemented EHRs¹⁹ and no equivalent information has been published for nursing homes. A study using the latest available data from the National Nursing Home Survey, collected in 2004, found that a majority of nursing homes used some form of electronic information system for Minimum Data Set reporting and billing. However, only 17.6% had electronic systems to document daily care and less than half (43.0%) had electronic systems for nurse or physician notes.²⁰ Studies suggest the low adoption rates in nursing homes may in part be attributed to financial barriers.^{15,21}

Due to the low implementation of EHRs in nursing homes, little is known about the impact of EHR implementation on quality and patient outcomes in the long-term care setting. However, some promising evidence has emerged on the potential benefits of computerized systems on prevention of pressure ulcers, malnutrition and falls in this setting.^{22,23} Further evidence is needed to better understand EHR implementation in nursing homes and its potential impact on quality of care in this setting.

OBJECTIVES

The purpose of this study was to assess the prevalence of EHR implementation in a national sample of nursing homes, examine facility characteristics associated with having implemented EHRs and explore the potential impact of EHR implementation on quality indicators. Specifically, the study aimed to answer the following research questions:

1. What is the prevalence of EHR implementation in a national sample of nursing homes?
2. What facility characteristics are correlated with having implemented an EHR in a national sample of nursing homes?
3. Does EHR implementation impact nursing home quality, as measured by quality indicators?

Methods

Data used in this study were collected as part of a larger study to examine infection prevention and control in US nursing homes (R01 NR013687). The larger study design was informed by the Donabedian conceptual framework, which defines healthcare quality along three broad dimensions: structure, process and outcome of care. According to Donabedian, structure refers to the conditions under which care is provided, including regulatory environment, staffing, organizational characteristics and available resources. The processes of care are the actions or activities that comprise the provision of care. Finally, the outcome of care are the results or consequences attributable to the structure and process of care. In addition to structure and process directly impacting outcome, a reciprocal relationship between structure and process exists as they influence each other.^{24,25} Tailoring this framework to the objective of the current study, the conceptual framework suggests that the structure of care, including the implementation of an EHR as a resource, may impact quality care outcomes both directly and indirectly, through impacting and improving care processes such as patient assessment, documentation and clinical decision making (Figure 1).

A cross-sectional survey of randomly sampled free-standing nursing homes was conducted between December 2013 and December 2014. Due to the larger study's focus on infection control, the 34-item survey was completed by the person in charge of the infection control program. Further details of the methods and results from that study have been previously described.²⁶ All study procedures were approved by the Columbia University Medical Center Institutional Review Board.

The following question was asked to assess whether EHRs had been implemented at the time of the survey: "Has your facility implemented electronic health records?" Respondents that answered affirmatively were asked to provide the year of implementation. Certification and Survey Provider Enhanced Reporting (CASPER, formerly called Online Survey Certification and Reporting [OSCAR]) data from 2014 and Centers for Medicare and Medicaid Services (CMS) Nursing Home Compare data from 2011 – 2015 provided information about nursing home characteristics, staffing and quality indicators. These data are publicly available on the CMS website²⁷ and are collected quarterly (every three

months). The time period, 2011–2015, was selected to examine data corresponding to the years of EHR implementation, among those nursing homes that had implemented EHRs, as well as one year before and one year after. CASPER data are collected as part of the certification process for Medicare and Medicaid during state inspections which occur at least every 15 months.²⁸ The nursing home characteristics and staffing variables from CASPER data were number of beds, occupancy, number of residents, region, setting (metropolitan, non-metropolitan with an urban population or rural), ownership (for profit, government or non-profit; ownership by a multi-facility organization), resident mix (percent of residents with dementia), payer mix (percent of residents on Medicare, Medicaid or other) and Certified Nursing Assistant (CNA), Licensed Practical or Vocational Nurse, and Registered Nurse (RN) staffing hours per resident day. One quality indicator from CASPER data, receiving a deficiency citation related to quality of care during the last state inspection, was included in cross-sectional analysis. The 13 quality measures for long term residents and five quality measures for short term residents from the CMS Nursing Home Compare data are listed in Table 1. In addition to these measures, the overall quality of care rating was included, which is calculated by CMS based on a combination of ratings from health inspections, staffing and other quality measures to provide a composite rating on a scale of one to five, with five being the best possible rating.^{29,30} These quality measures were used because they are validated and have been previously used in research and quality assurance projects and have been demonstrated to be impacted by EHR implementation in acute and primary care.^{6,7,9}

A cross-sectional complete case analysis, using all observations that had data for all variables of interest, was conducted to identify variations in characteristics between nursing homes that had and had not implemented EHRs. Descriptive statistics, including frequencies, means and standard deviations, were performed and Student's *t*, χ^2 , or Wilcoxon tests were used, as appropriate, for comparisons in bivariate analyses. Based on these tests, variables with *p*-value <0.10 were included in a multivariable logistic regression model to examine independent associations between facility characteristics and quality indicators and having implemented EHRs.

A difference-in-differences analysis was used to estimate the longitudinal effect of implementing EHRs on quality indicators. Each quality indicator was averaged over four quarters for each year to ensure consistency across nursing homes. We compared nursing homes that had and had not implemented EHRs, controlling for ownership, staffing and payer mix. Nursing homes that had implemented EHRs at the time of the survey were included if they had three consecutive years of CASPER and Nursing Home Compare data available (one year prior to implementation [i.e., baseline], year of implementation and one year following implementation). These were compared to all nursing homes that had not implemented EHRs at the time of the survey that also had available CASPER and Nursing Home Compare data for years corresponding to those of nursing homes with EHRs. This difference-in-differences analysis was conducted using a linear mixed regression model with a group and time effect interaction term, which controls for overall trends over time.³¹ Data were analyzed using SAS version 9.3.

Results

A total of 990 nursing homes participated in this study. The final analytical sample was comprised of 927 nursing homes that had complete data. About half of nursing homes (49.1%) had implemented EHRs at the time of the survey. The prevalence of EHR implementation over time, among the nursing homes that had implemented EHRs, is shown in Figure 2. Over half of nursing homes with EHRs had implemented them in 2012 or later and one third had implemented them in 2013 or 2014.

In the overall sample, the average bed size was 117 (standard deviation [SD] =70) and the mean occupancy was 81.8% (SD=15.5). The sample was geographically diverse, with 35.1% of nursing homes located in the midwest, 21.9% in the northeast, 29.7% in the south and 13.4% in the west. A majority (69.4%) of nursing homes were for profit and 54.9% were owned by a multi-facility organization. On average, 60.6% (SD=21.0) of residents were on Medicaid and 14.3% (SD=12.5) were on Medicare. The average Nursing Home Compare overall quality rating was 3.4 (SD=1.3) on a scale of 1–5 and 63.2% of facilities had received a quality care citation at their most recent annual state survey inspection. Results of the bivariate analyses for nursing homes that had and had not implemented EHRs are shown in Table 2. Nursing homes with EHRs were more likely to be non-profit or government owned (p-value=0.04), had lower percent of Medicaid residents (p-value=0.02), and higher percent of residents who were not on Medicaid or Medicare (p-value=0.02). They also had higher CNA and RN staffing levels (p-values=0.002 and 0.02, respectively) and lower percent of long stay residents who had been assessed and appropriately given seasonal influenza vaccination (p-value=0.03).

The results of the multivariable analysis showed an inverse association between the percent of long stay residents assessed and appropriately given seasonal influenza vaccination and having implemented EHRs (OR=0.98; 95% confidence interval=0.96–0.99; p-value=0.004). None of the other nursing home characteristics made a statistically significant contribution to the model (data not shown).

The analytical sample for the difference-in-differences analysis was comprised of 383 nursing homes that had complete data on all variables of interest for three consecutive years. The results of the difference-in-differences analysis for each of the quality indicators in Nursing Home Compare showed a significant longitudinal effect for five of the twelve long stay quality measures and two of the five short stay quality measures (Figure 3). After the implementation of EHRs, there were significantly greater decreases in the percent of long stay residents who lost too much weight (p-value=0.002), had a catheter inserted and left in their bladder (p-value=0.01), had a UTI (p-value=0.01) and had depressive symptoms (p-value=0.002). Furthermore, the analysis showed a greater decrease over time in the percent of short stay residents who self-reported moderate to severe pain (p-value<0.001) and who newly received an antipsychotic medication (p-value=0.001). Finally, after the implementation of EHRs, a greater increase over time was identified in the percent of long stay residents assessed and appropriately given the pneumococcal vaccine (p-value=0.002). Other quality measures showed similar, but non-significant, trends.

Discussion

This national study confirmed that EHR implementation in nursing homes is low compared to what has been reported in acute care and office-based physician practices. Although it appears to be increasing steadily in all three settings, implementation in acute, primary and other specialty care settings increased more rapidly after the introduction of the meaningful use incentive programs.¹⁴ We found that government or non-profit facilities were more likely to have implemented EHRs compared to for-profit facilities. This is consistent with prior research on EHR use in residential care communities, home health and hospice care,^{15,32} although the reasons for this association remain unclear. In this study, facilities that were better resourced in terms of staffing and payer mix were also more likely to have implemented EHRs. While staffing and payer mix are not synonymous with nursing homes' financial profile, this may indicate differences in financial resources. This is consistent with previous research that found cost to be the most common barrier to implementing EHRs in long term care.³³

The transition from paper-based to electronic records is expensive at the onset, requires substantial time and resources for implementation, training and evaluation and there is a lack of evidence on return of investment.³⁴ Staff may be reluctant to support the transition if it initially requires increased effort and time for documentation or does not take into account established workflow. Indeed, others have found that the time nursing staff spent on documentation increased in the first 12 months after EHR implementation, although the documentation times returned to pre-implementation levels after 23 months.³⁵ In the fast-paced nursing home environment, this increase in documentation time in the short term may be perceived as an irreconcilable cost to many staff and administrators, particularly among facilities with limited staffing and financial resources, unless benefits can be demonstrated to outweigh those costs.

Consistent with previous research in other settings, our findings indicate that EHR implementation is significantly associated with performance on several quality indicators in nursing homes. The significant decrease in percent of residents who lose too much weight may indicate improved documentation of nutritional status and early detection of residents at risk of malnutrition. Similarly, the decrease in percent of residents with indwelling catheters and UTIs may indicate that improved documentation led to a better overview of residents with in-dwelling catheters and at risk for UTIs, enabling nurses to adjust care plans accordingly to reduce risk. The impact of EHR implementation on residents with depressive symptoms is less frequently reported in the literature, although it is possible that EHR implementation allowed for better documentation and screening of depressive symptoms leading to appropriate treatment and medication prescription. More research is needed to examine this further. Overall, these findings support the assertion that implementing EHRs, adding them as a resource to the structure of care in nursing homes, positively impacts quality outcomes of care. This improvement in quality indicators is likely driven by an improvement in certain care processes, such as documentation, risk assessments and reporting and clinical decision support (Figure 1). EHRs can enable nurses to quickly identify at-risk residents and appropriately intervene with appropriate treatment or

preventive measures, in turn improving quality and resident outcomes, as findings from other settings have indicated.⁵⁻⁹

Contrary to previous research indicating that EHRs can improve influenza vaccination rates in primary and acute care settings,⁹ our longitudinal analysis showed no significant difference between those with EHRs compared to those without. However, the implementation of EHRs did significantly increase the percent of long stay residents assessed and appropriately given the pneumococcal vaccine. It is plausible that having accurate and accessible documentation on pneumococcal vaccinations is more impactful, given that the pneumococcal vaccine is only given once to each resident, as opposed to annually like the seasonal influenza vaccine, and therefore potentially more difficult to track. This may also explain why the increase was non-significant among short stay residents, as the impact of improved documentation related to EHR implementation may only be significant over a longer period of time.

There is very little evidence on the implementation and benefits of EHRs in nursing homes, as opposed to in other healthcare settings, with much of it based on staff perceptions rather than objective measures of quality and outcomes.³⁸ To our knowledge, this is one of the largest surveys assessing EHR implementation in US nursing homes and the analysis was strengthened by the inclusion of secondary longitudinal data using validated measures, thereby adding to the limited body of knowledge on this topic. However, this study has limitations. First, we did not collect information about the specific components of EHRs being used, only whether they had been implemented. Second, we relied on self-reported survey data, which may have resulted in the misclassification of EHR implementation. Finally, our sample of respondents had a higher quality performance, including vaccination use, compared to non-respondents.²⁶ Despite this, we were able to identify associations between EHR implementation and several quality indicators and they are unlikely to be spurious because selection into the study, while potentially linked with quality performance, is unlikely to have been linked with EHR implementation.

CONCLUSIONS

EHR implementation in nursing homes is lagging behind that of acute, primary and specialty care settings, although improvements have been made in the past few years. The findings of this study indicate that EHR implementation is associated with nursing home quality. To support continued implementation in nursing homes, financial incentives and other economic support might be helpful based on progress in other settings. Furthermore, there is a need to further examine the mechanism behind quality improvements in nursing homes related to EHR implementation and how these improvements can best be facilitated.

Acknowledgments

We thank our research team, Monika Pogorzelska-Maziarz, Andrew Dick, John Engberg and Elaine Larson as well as the advisory board of the Prevention of Nosocomial Infections and Cost Effectiveness in NHs (PNICE-NH) study for their contributions. We are also grateful to the NHs that participated in the PNICE-NH survey.

Source of Funding

This study was generously funded by the National Institute of Nursing Research (NINR) (R01 NR013687).

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Figure 1.

Graphic representation of the Donabedian conceptual framework of healthcare quality,^{24,25} as it relates to the hypothesized impact of electronic health record implementation on quality of care in nursing homes.

Figure 2.

Bar chart showing the prevalence of electronic health record (EHR) implementation in nursing homes over time, as shown by the cumulative percentage of nursing homes that had implemented EHRs at each year, among those nursing homes that had reported implementing EHRs at the time of survey and provided their year of implementation (n=358).

Figure 3.

Results of difference-in-differences analysis (n=383), showing the percent of long stay residents who A) lost too much weight, B) had a catheter inserted and left in their bladder, C) had a urinary tract infection, D) had depressive symptoms and E) were assessed and appropriately given the pneumococcal vaccine. Also shown are the percent of short stay residents who F) self-reported moderate to severe pain and G) newly received an antipsychotic medication. The percent of residents was compared between nursing homes with and without electronic health records (EHRs) at corresponding years and is shown as

the least square mean percent of residents. For nursing homes with EHRs, data are shown one year before the implementation of EHR, during the year of implementation and one year after implementation. The interaction term for the interaction between time and group (EHR compared to no EHR), i.e., the difference-in-differences, were significant for these seven quality indicators at a 5% level of significance.

Table 1

List of 13 long stay and five short stay quality indicators from the Centers for Medicare and Medicaid Services Nursing Home Compare database.²⁹

Quality measures from Nursing Home Compare

Long Stay Residents
Percent of Residents Whose Need for Help with Activities of Daily Living Has Increased
Percent of Residents Who Self-Report Moderate to Severe Pain
Percent of High-Risk Residents with Pressure Ulcers
Percent of Residents Who Lose Too Much Weight
Percent of Low-Risk Residents Who Lose Control of Their Bowels or Bladder
Percent of Residents Who Have/Had a Catheter Inserted and Left in Their Bladder
Percent of Residents with a Urinary Tract Infection
Percent of Residents Who Have Depressive Symptoms
Percent of Residents Who Were Physically Restrained
Percent of Residents Experiencing One or More Falls with Major Injury
Percent of Residents Assessed and Appropriately Given the Seasonal Influenza Vaccine
Percent of Residents Assessed and Appropriately Given the Pneumococcal Vaccine
Percent of Residents Who Received An Antipsychotic Medication
Short Stay Residents
Percent of Residents Who Self-Report Moderate to Severe Pain
Percent of Residents with Pressure Ulcers that are New or Worsened
Percent of Residents Assessed and Appropriately Given the Seasonal Influenza Vaccine
Percent of Residents Assessed and Appropriately Given the Pneumococcal Vaccine
Percent of Residents Who Newly Received an Antipsychotic Medication

Table 2

Results of bivariate analyses of associations between nursing home characteristics and electronic health record implementation.

Bivariate analysis of associations between nursing home characteristics and electronic health record implementation

Characteristic	EHR (n=455)	No EHR (n=472)	p-value
	<i>n (%)</i>	<i>n (%)</i>	
Number of beds			0.47
Small (≤ 100 beds)	206 (45.3)	225 (47.7)	
Large (>100 beds)	249 (54.7)	247 (52.3)	
Region			0.55
Midwest	166 (36.5)	159 (33.7)	
Northeast	91 (20.0)	112 (23.7)	
South	135 (29.7)	140 (29.7)	
West	63 (13.9)	61 (12.9)	
Setting			0.75
Metropolitan	324 (71.2)	346 (73.3)	
Non-metropolitan with an urban population	114 (25.1)	111 (23.5)	
Rural	17 (3.7)	15 (3.2)	
Ownership			0.04*
For profit	301 (66.2)	342 (72.5)	
Government/Non-profit	154 (33.9)	130 (27.5)	
Owned by multi-facility organization	258 (56.7)	251 (53.2)	0.28
>50% residents with dementia	225 (49.5)	224 (47.5)	0.54
Quality care citation at last inspection	289 (63.5)	297 (62.9)	0.85
	<i>Mean (SD)</i>	<i>Mean (SD)</i>	
Staffing (Hours per resident day)			
CNAs	2.5 (0.9)	2.4 (1.0)	0.002*
LPN/LVNs	0.8 (0.5)	0.8 (0.5)	0.81
RNs	0.8 (0.4)	0.7 (0.3)	0.02*
Percent occupancy	81.3 (15.5)	82.2 (15.5)	0.31
Number of residents	98.9 (70.0)	94.7 (60.3)	0.44
Percent of residents on Medicare	14.6 (12.6)	14.1 (12.4)	0.39
Percent of residents on Medicaid	58.7 (22.0)	62.5 (19.8)	0.02*
Percent of residents not on Medicare or Medicaid	26.7 (19.1)	23.3 (16.1)	0.02*
Overall quality rating (5 point scale)	3.5 (1.3)	3.3 (1.4)	0.06
Long stay resident quality measures			
Percent of Residents Whose Need for Help with Activities of Daily Living Has Increased	15.5 (6.9)	16.1 (7.2)	0.20
Percent of Residents Who Self-Report Moderate to Severe Pain	8.5 (6.9)	8.1 (6.2)	0.78
Percent of High-Risk Residents with Pressure Ulcers	6.0 (3.9)	6.0 (4.0)	0.66

Characteristic	EHR (n=455)	No EHR (n=472)	p-value
	<i>n</i> (%)	<i>n</i> (%)	
Percent of Residents Who Lose Too Much Weight	7.5 (3.9)	7.3 (3.7)	0.70
Percent of Low-Risk Residents Who Lose Control of Their Bowels or Bladder	45.4 (17.0)	43.9 (17.4)	0.37
Percent of Residents Who Have/Had a Catheter Inserted and Left in Their Bladder	3.3 (2.5)	3.3 (2.5)	0.66
Percent of Residents with a Urinary Tract Infection	6.3 (4.6)	6.1 (4.3)	0.49
Percent of Residents Who Have Depressive Symptoms	5.9 (10.0)	6.6 (9.9)	0.58
Percent of Residents Who Were Physically Restrained	1.2 (2.2)	1.7 (3.3)	0.17
Percent of Residents Experiencing One or More Falls with Major Injury	3.1 (2.3)	3.1 (2.2)	0.74
Percent of Residents Assessed and Appropriately Given Seasonal Influenza Vaccination	94.5 (9.7)	95.9 (6.7)	0.03 [*]
Percent of Residents Assessed and Appropriately Given the Pneumococcal Vaccine	94.9 (10.5)	96.0 (7.7)	0.51
Percent of Residents Who Received An Antipsychotic Medication	21.2 (11.3)	20.8 (11.3)	0.55
Short stay resident quality measures			
Percent of Residents who Self-Report Moderate to Severe Pain	18.7 (11.2)	18.6 (11.0)	0.86
Percent of Residents with Pressure Ulcers that are New or Worsened	1.4 (2.2)	1.2 (1.8)	0.08
Percent of Residents Assessed and Appropriately Given the Seasonal Influenza Vaccine	84.0 (17.7)	85.5 (15.7)	0.41
Percent of Residents Assessed and Appropriately Given the Pneumococcal Vaccine	83.0 (19.2)	83.9 (17.6)	0.43
Percent of Residents Who Newly Received an Antipsychotic Medication	2.7 (2.9)	2.8 (3.1)	0.85

Note.

^{*} =p-value < 0.05. SD=Standard Deviation, EHR=Electronic Health Record, CNA=Certified Nursing Assistant, LPN/LVN=Licensed Practical/Vocational Nurse, RN=Registered Nurse