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Barriers and Facilitators to Implementation and Adoption of EHR in Home Care

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Abstract

Purpose: Assess the impact of implementing an electronic health record (EHR) in a home care agency, and identify barriers and facilitators to provider adoption and use of the EHR in home care.

Scope: Evaluate one point-of-care EHR in one home care agency in the following dimensions: patient, workflow, and financial outcomes; and Meaningful Use.

Methods: (1) We hypothesized that implementation of point-of-care EHR would result in significant improvements in patient, workflow, and financial outcomes. We evaluated this hypothesis by using an interrupted-time-series design. We collected quantitative data including EHR usage, patient outcomes, clinical documentation completion, reimbursement, and clinician satisfaction and qualitative data including EHR functionality, clinician observations, and clinician interviews about satisfaction. (2) We proposed design and implementation recommendations for barriers and facilitators to adoption by combining quantitative and qualitative data in a mixed methods analysis. (3) We also proposed policy recommendations for EHR Meaningful Use in home care. The analysis identified home care EHR functionality (e.g., view care plan) that differed from am-bulatory EHR functionality identified in Meaningful Use objectives.

Results:

Aim 1: Comparing the EHR post-implementation period to the EHR pre-implementation period: the EHR had an impact on some patient outcomes; clinicians were 15 to 269 times more likely to complete their documentation within time-to-completion compliance guidelines; and days to filing final claim fell while Medicare census rose.

Aim 2: Challenges to EHR adoption included: (1) frequent hardware problems coupled with lack of field support; (2) need for better initial and on-going training; and (3) mismatch of EHR usabil-ity/functionality and workflow resulting in decreased efficiency. Facilitators to adoption included support for team communication and improved timeliness of clinical data. Opportunities for im-proved adoption include sharing with front-line clinicians EHR data related to patient care pro-cess and patient health outcomes.

Aim 3: Detailed policy recommendations for Meaningful Use criteria for home care were sent to CCHIT.

Key Words: community; home care; electronic health record; EHR; Medicare; elderly; patient-centered care; implementation and use; protected health information data sharing

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Final Report

Purpose

While the impact on implementing EHRs in hospital and ambulatory care settings has been studied, little research has been done surrounding the implementation of an EHR in home care. This study addressed this gap in research by conducting an evaluation of a home care agency's point-of-care EHR. The three primary aims were:

Aim 1. Examine the impact of EHR implementation in a home care agency by comparing patient, workflow, and financial outcomes before and after point-of-care EHR implementation.

> **Hypothesis 1.1**: Point-of-care EHR will result in significant changes between pre- and post-implementation in (a) patients' Outcome and Assessment Information Set (OASIS) outcome measures for physiological health and behavioral health, and (b) percent of older patients requiring hospitalization or emergency care during a health care episode. OASIS was designed to promote quality improvement in Medicare home care through the collection of critical physiological, functional, cognitive, and emotional/behavioral health status indicators. (Patient outcomes)
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> **Hypothesis 1.2**: Point-of-care EHR will result in significant changes between pre- and post-implementation in (a) proportion of late clinical documentation for Request for Anticipated Payment and (b) proportion of late clinical documentation for Final Claim. (Clinician-level workflow impact)
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> **Hypothesis 1.3**: Point-of-care EHR will result in significant changes between pre- and post-implementation in (a) rejected Medicare billing submission rates and (b) Medicare reimbursement for patient care. (Organization-level financial outcomes)

Aim 2. Identify the barriers and facilitators to point-of-care EHR adoption and implementation in home care. (Implementation)

> **Hypothesis 2**: Significant reductions or improvements in clinician satisfaction across the Health Information Technology Reference-based Evaluation Framework (HITREF) dimensions will identify the barriers and facilitators to adoption and implementation across two time periods. HITREF is an evidence-based HIT evaluation framework that is described below.

Aim 3. Propose design, implementation, and policy recommendations that address the barriers and facilitators to implementation and Meaningful Use of the EHR in home care. (Implementation, policy)

Scope

Background and Context

As demand for home care services increases to support the health care needs of our aging population, more home health agencies in the United States are implementing electronic health records (EHR). Home care using skilled nursing services is an increasingly important and effective way to deliver care and manage chronic illnesses in our growing older population. Point-of-care electronic health records (EHR) in home care, as in hospital and ambulatory settings, are intended to enable clinicians' access to the most current patient health information at the appropriate time in the clinical process. Despite the large and increasing number of electronic health record (EHR) implementations, relatively little is known about the impact of EHR use in home care.

Home care is very different from hospital and ambulatory settings. Home care is provided to transition patients from hospital to home and to manage chronic illness using skilled clinical services (e.g., nurses, therapists, social workers) in the home. Over three million Medicare beneficiaries discharged from the hospital receive nearly 104 million home care visits annually.[1] Older patients prefer to receive care at home and home care providers are less costly than other care services such as long-term care homes. Home care clinicians are often faced with challenges around providing, planning, and coordinating high level care in the home due to limitations on resources and communication mechanisms. For example, home care services can involve a team of providers (e.g., physicians, nurses, physical therapists, social workers, etc.) who work together to plan, coordinate, and provide care. Unlike hospitals and ambulatory settings, each clinician visits the patient in the home at different times. These providers operate independently in the patient home and communication between providers is achieved by telephone, voice mail, or electronic charting.

Good communication regarding patient data, status and care plans between the home care providers is essential for ensuring efficiency, patient safety, and quality of care. An EHR that is available at the point-of-care for home care providers would help facilitate communication between providers and enable providers' access to the most current home patient health information in a timely fashion. By having patient data integrated and available in real time, an EHR can improve healthcare decisionmaking at the point-of-care and improve healthcare outcomes. To date, 29% of the 10,000 home care agencies in the United States report having implemented point-of-care EHR.[2]

In addition to directly impacting the clinical process, secondary data from the EHR can be used for quality assurance [3] and performance improvement.[4] However, there are few publications about integration of feedback from secondary data into the practice of the clinical team.[5]

This study seeks to better understand the adoption, implementation, and "Meaningful Use" of EHRs in home care in order to make best use of limited time, money, and energy to promote positive health outcomes. Meaningful Use (MU) is the intended impact of EHRs to achieve health and efficiency goals. To inform the development and implementation of EHRs in this unique and clinically effective setting as EHR adoption increases, this study: (1) assessed the impact of implementing an EHR in a home care agency; (2) identified barriers and facilitators to

EHR adoption; and (3) provided long term care “Meaningful Use” EHR criteria policy recommendations.

Methods

Overview

The study was a mixed methods evaluation with an embedded interrupted-time-series design to assess the impact of a point-of-care EHR implementation in a home care agency on clinical process. Specifically, we compared patient, workflow, and financial outcomes before and after the point-of-care EHR implementation. The mixed methods analysis was informed with prospective data from observations of clinicians using the EHR, clinician satisfaction surveys, and clinician follow-up interviews. We also compared observed EHR functionality and EHR functionality described in software documentation to a nationally recognized standard to develop recommendations for home care EHR Meaningful Use objectives. The clinician satisfaction survey data was gathered before the grant commenced in part as preliminary data and completed during grant proposal review. The Institutional Review Boards of Drexel University and the University of Pennsylvania approved the study.

Setting

The study setting was Penn Care at Home in Philadelphia, a Medicare-certified, not-for-profit, skilled home care agency not unlike other home care agencies. As part of an academic, integrated health system, the agency provided home care services to 1,200 patients monthly who resided within five urban and suburban counties. Typical of home care operations, patient visits included developing care plans and documenting interventions and outcomes against the care plan. Care was reimbursed by Medicare based on the documentation of approximately 120 items in the Outcome and Assessment Information Set (OASIS) assessment instrument [7] and congruence with documentation of the care. The multi-disciplinary team included nurses (the predominant professional), social workers, physical and occupational therapists, and speech pathologists. Being in the patient’s home creates a different clinician/patient relationship than that found in hospitals or physician practices. Patient contact by home care clinicians is intermittent (2-3 times per week initially, then 1-2 times per week for an average of 5-6 weeks). The information source at the start of care is limited to hospital discharge referral documentation, which is often inadequate.[8,9]

The study time period contained three historic events occurred during the study period. First, management changes occurred between April 2008 and September 2009. Second, the EHR was implemented from February 2009 to August 2009 (i.e., transition period). Lastly, an internal quality improvement team was put in place to review clinical documentation for completeness and accuracy in February 2010 (i.e., start of post-implementation period 2).

Regarding the second historic event, the EHR was a point-of-care EHR from a leading vendor. It was a commercially available client-server application, and, as such, it was similar in architecture and functionality to other home care EHR software on the market. The EHR was not yet certified by the Certification Commission for Health Information Technology (CCHIT)[10],

as no long-term care EHR had been CCHIT certified at the time of the study. The EHR was configured to run on a laptop and to access the agency's server via a data card. Access to Internet email was via a cellular phone. In-house technical staff supported the EHR. The EHR supported home care organizational metrics for benchmarking (e.g., quality outcomes, reimbursement, and compliance with regulations).

The EHR was designed to enable clinicians to review patient charts and begin their care documentation while in the patient's home. The intended clinician use of the EHR was as follows. Clinicians started their day at their own home by connecting the laptop to the server via a data card to view the patient schedule for the day, access information about entering a patient's home or approaching a patient, and read messages from team members. The clinician traveled to the patient's home, found a space to set up the laptop, and documented patient care in the EHR. The clinician ended the day at home by connecting the laptop to the server to upload the information and check the next day's schedule and messages from the clinical care team. The point-of-care EHR replaced an office-based version that was updated via centralized clerical input from clinicians' paper records.

Participants

All Penn Care at Home clinicians who provided direct patient care and documented in the EHR (137 clinicians) as well as all Medicare patients cared for by the home care nurses during the study period were included in this study. Clinicians ranged in age from 21 to 70; most (90%) were women; and most (71%) were Caucasian, and a minority (20%) were African-American.

Study Design

We examined the impact of the point-of-care EHR on clinician satisfaction and clinical process in home care using the mixed methods approach. We investigated the EHR's impact at the clinician, patient, and organization (agency) levels. In the quantitative experiment (QUAN), we used a pre/post study design embedded in a mixed methods study to measure the impact of the EHR on documentation timeliness and patient outcomes. Clinician satisfaction surveys were administered post-implementation. The embedded qualitative component (Qual) consisted of observation and interviews for one post-implementation observation to gain a rich description of clinician perspectives. Qualitative data were used to help explain findings. Researchers (PS,KB) conducted mixed methods analysis by sorting results from each data source by theme, referring to the HIT Reference-based Evaluation Framework (HITREF),[6] and summarizing themes in a matrix. The HITREF, a comprehensive HIT evaluation framework firmly grounded in research evidence, was used to identify a range of HIT characteristics and dimensions to be measured. With an agency expert the researchers focused on the matrix to integrate the quantitative and qualitative results and recognize how the qualitative themes informed the understanding the quantitative findings. This analysis informed the development of design and implementation recommendations related to barriers and facilitators to EHR adoption.

The study design to develop design and policy recommendations related to Meaningful Use of the EHR in home care was qualitative and descriptive. The study design included qualitative data collection and observation of clinician EHR users 19 months post implementation. The EHR was studied as it was used.

HIT Evaluation Framework

The HITREF is firmly grounded in research evidence. It incorporates health information technology (HIT) evaluation criteria elicited from a comprehensive literature review of over 17,000 studies.[11,12] HITREF includes health services research evaluation methodologies to extend the informatics evaluators' focus beyond user, software, and organizational interactions to include the systematic and environmental levels. The HITREF supports perspectives of diverse stakeholders. The framework further suggests that clinicians have differing degrees of satisfaction towards each dimension. The HITREF provides a comprehensive list of criteria against which to evaluate HIT products and implementations. The six HITREF dimensions are:

i. **Structural Quality** [11] - the quality of the hardware, software, and organizational support;

ii. **Quality of Information Logistics** [11] - the quality of the data, whether or not the system is worth the time and effort to use it, confidentiality of the system and patient satisfaction with the use of the system;

iii. **Effects on Quality Of Processes** [11] - the effect of the system on the efficiency, delivery of appropriate patient care, team communication of the work processes of clinical care, and user involvement in system implementation;

iv. **Effects on Outcomes and Quality of Care** [11] - the effects of the system on patient care outcomes and health system outcomes such as morbidity, mortality, patient safety; costs of patient care; patient knowledge of their health condition; and patient satisfaction with their care;

v. **Unintended Consequences or Benefits** - clinicians' perception of unintended changes the system can introduce on patient care, whether these effects are positive or negative [12] and

vi. **Barriers or Facilitators to Clinicians' Adoption** – widely held perceptions of barriers or facilitators to adoption of systems, such as interoperability of the system that impacts implementation success [12].

The HITREF provides a comprehensive list of 20 criteria as themes for the study analyses and was operationalized in the clinician satisfaction survey.[13]

Data Sources/Collection/Analyses

The study's five data sources and eight data collection methods are described below. The quantitative component involved three data sources. Data collected from EHRs included patient health status outcome, clinician completion of clinical documentation, and clinician usage of the EHR. The financial system captured reimbursement data. Clinician satisfaction data was collected from a survey. The qualitative component consisted of observation and follow-up interviews of clinicians. The data sources and collection methods are organized by the related aim and hypothesis.

Aim 1. Patient, workflow, and financial outcomes

The analysis focused on longitudinal analyses and comparisons between the pre-implementation and post-implementation periods for the actual EHR use, financial, and patient outcomes data. Differences, or lack of differences, between those time periods were interpreted as the impact of the EHR on the outcome of interest.

Hypothesis 1.1: **Patients' OASIS outcomes and hospital visits**. Patient outcomes at the home care site were assessed using the OASIS assessment instrument, which is mandated by the Centers for Medicare and Medicaid Services (CMS.) The OASIS collects data on critical physiological, functional, cognitive, and emotional/behavioral indicators of health status.[14,15] Because care is reimbursed by Medicare based on the OASIS, the OASIS data was considered to be complete.

The patient population of Medicare beneficiaries over 65 years of age was 28% of agency patients (340 per month). Beneficiaries became eligible for the home care benefit if they had a medical condition that required skilled care and were considered homebound. The study population of patients included all Medicare patients (de-identified) whose care was documented using EHR (either office-based or point-of-care) during the course of the study.

Agency staff (RN or therapist) used observation and information gathered directly from the patient or caregiver to collect OASIS data at admission, every 60 days, and at discharge for every user of Medicare home care services. The study also collected information on hospitalization or Emergency Department (ED) use. These outcomes were among those publicly reported as measures of quality. All OASIS assessments for all Medicare patients with an episode of care recorded in the EHR was requested.

The criteria for selection of OASIS measures are (1) whether measures are consistent in both question and response between version B, used for pre-implementation data collection, and version C which became effective January 2010, and (2) whether home care was expected to impact the measure (i.e., Activities of Daily Living measures were excluded because home care was not expected to impact the measures). Major outcome measures for patient health status were selected OASIS measures of physiological health, behavioral health status, and hospitalization or emergent care. The OASIS measures of physiological health were dyspnea, urinary tract infection, and bowel incontinence. The OASIS measures of behavioral health status were confusion, anxiety, awareness, and behavioral symptoms. These selected OASIS measures were assessed for stabilization or improvement from admission to discharge.

Hypothesis 1.2: **Clinical documentation**. Clinicians who provided direct patient care, documented in the EHR, and had completed their orientation period were the participants. Clinicians were observed. An agency programmer de-identified and extracted from the EHR data related to clinician documentation of the clinical note.

Observations were intended to discern how clinicians accessed and recorded information in the EHR and what information was recorded. Observations were conducted by the researcher (PS) being present during a patient visit while a clinician provided direct patient care. The observation approach was designed to account for differences in team and role (based on the clinician's licensure) Consented clinicians selected to be observed were chosen by work sampling [16] to cover each role from each team. The next appropriate, consenting clinician on the list of users replaced those who refused. The researcher (PS) observed clinicians during their

workday over a multi-week period and documented in field notes. Clinicians in each role were observed until saturation; that is, observations offered no new information or a functionality was seen at least three times.[17](1087 Frattaroli, S. personal communication, 2007)

Clinician EHR data was coded for clinician role (e.g., nurse, physical therapist) and team. Data specific to the visit was either clinician-input or system-input. The EHR generated the date/time for start of orders and start and completion of clinical notes. Note completion had two stages: documented ("attached") and finalized ("completed"). The clinician documented visit type (e.g., assessment, revisit, discharge) and date/time for patient admission, patient assessment documentation, and clinician arrival and departure from the patient home. The EHR computed contact time (in minutes) using the arrival and departure times.

Hypothesis 1.3: **Medicare billing**. The financial system provided summarized agency data on time to final billing of Medicare reimbursements. This reimbursement data was expected to be reliable, as it was an internally reported reimbursement metric. Monthly average figures of days-to-final-claim, and number of Medicare patients were provided to the researchers.

Aim 2. Barriers and facilitators to EHR adoption and implementation

Hypothesis 2: Clinician satisfaction. The impact of the use of an EHR on the satisfaction levels of clinicians with regards to clinical process was assessed using observation (described above), interview, and a 21-item survey instrument, the EHR Nurse Satisfaction (EHRNS) survey. (Available at the Agency for Healthcare Research and Quality Knowledge Library Health IT Survey Compendium: http://healthit.ahrq.gov/portal/server.pt/community/knowledge_library/653/survey_compendium/12713)

In-depth interviews were undertaken to elicit information from the clinicians about their areas of concern or satisfaction with the EHR. These interviews further explored survey responses and issues raised in studies of nurse use of EHRs (the majority of the clinicians were nurses). Clinicians selected to be observed were also interviewed. Semi-structured interviews were conducted with individuals face-to-face by the lead author and responses were documented in field notes and audio-recorded with digital tape recorders. The interviews were kept to no more than 45 minutes. The interview guide included a series of open-ended questions organized by the HITREF domains. Interview questions embodied the major themes identified in previous clinician satisfaction interviews in a different setting.[13] All major questions on the guide were asked in the specified order and probes were introduced when the participant did not spontaneously raise the topic.

All clinicians who provided patient care and documented in the EHR were invited to complete the EHR Nurse Satisfaction survey (EHRNS) post implementation. The EHRNS survey operationalized the HITREF and included dimensions of patient, workflow, and financial outcomes. The survey was previously developed and validated.[13] Each item had a six-point Likert-type response indicating the magnitude of agreement or disagreement. Response choices ranged from Strongly Disagree (0) indicating most dissatisfied to Strongly Agree (5) indicating most satisfied. Five items were negatively worded, indicating dissatisfaction. The prompt at the end of the survey (a semi-directed, open-ended question) asked respondents what worked well with the EHR or if they had any concerns related to the implementation and use of the EHR. To describe the respondents, questions were asked about their demographics and experience with

computers. The researcher (PS) administered the survey during staff meetings. Clinicians not present at staff meetings were sent the survey via postal mail.

Aim 3. Recommendations for barriers/facilitators to implementation and meaningful use

To formulate EHR design and implementation recommendations, the researchers (PS, KB) synthesized themes that emerged from analysis of the matrix in Aim 2. To develop MU recommendations, the researcher (PS) compared a reduced set of long-term post-acute care (LTPAC) CCHIT functionality criteria [18] to the home care agency's EHR to assess their presence. The reduced set of LTPAC CCHIT criteria was intended to represent criteria that were likely to be universally available in commercial home care EHRs based on the author's preliminary observations of home care clinicians. The set of criteria was selected using the following procedure. First, the author identified CCHIT categories for inclusion and exclusion. Included categories were those related to functionality likely to be used by clinicians at the point-of-care (e.g., patient record and demographics, problem list, patient history). Excluded categories were those not likely to be used at the point-of-care (e.g., patient views, clinical research, administrative, backup/recovery). Second, within the retained categories, the author identified criteria for inclusion or exclusion. Included criteria were: (i) more relevant to clinicians; (ii) more general and inclusive; and (iii) simpler functionality and therefore more likely to be attained.

The reduced set of LTCPAC CCHIT functionality criteria was compared to data collected during observation of clinician use and analysis of software documentation from the EHR provider. First, 'available' EHR functionality was identified. Available functionality was already specified in the EHR software documentation or identified by the agency's EHR experts. Next, 'observed' functionality was identified. Observed functionality was that which the researcher (PS) saw being used as a clinician documented patient care during a patient visit. The observation approach was described above.

Outcomes and Analytic Plan

Aim 1. Examine the impact of EHR implementation in a home care agency by comparing patient, workflow, and financial outcomes before and after point-of-care EHR implementation

Hypothesis 1.1: Patients' OASIS outcomes and hospital visits. The impact of EHR implementation on the change in the various OASIS outcomes of interest were measured over time. For the statistical analysis of continuous OASIS data we determined differences in mean changes relative to the baseline outcome. In addition, we assessed the proportion of older patients who required either emergency care or re-admission to an acute care hospital and we used logistic regression methods to adjust for possible confounders. The assumption that any changes in outcome were not due to significant changes in patient profiles was tested as follows. Demographic data such as race, gender, and age, in addition to intake diagnosis, was compared between patients with data prior to the implementation of OASIS and those with data collected

after the implementation. If significant differences existed among any of the variables, they were added to the main outcome analysis as covariates.

Hypothesis 1.2: Clinical documentation. Longitudinal analysis of EHR data was focused on two time periods – pre-point-of-care EHR implementation and the first post-implementation period which ended when the quality improvement team was implemented. The analysis methods used were Analysis of Variance (ANOVA) for continuous outcomes and logistic regression for binary outcomes with adjustments for serial correlations over time and comparisons between the pre-implementation and post-implementation periods. Clinicians in the post-implementation period were not matched to clinicians in the pre-implementation period. Differences or lack of differences between those time periods were interpreted as the impact of the EHR on the outcome of interest. Clinician survey, observation, and clinician interview data were used to help explain findings.

The findings related to the number of notes documented per month in the study periods prompted further analysis of the impact of EHR use on productivity. Productivity related to clinician completion of documentation was computed for each study time period (i.e., pre-, first post-, second post-) as a ratio. The numerator was the total number of completed notes. The denominator was the total full time equivalent (FTE) contribution. An FTE of 1.0 is an employee who was paid for working full time during the pay period: if the employee was paid for overtime, the FTE was greater than 1.0; if the employee was paid for less than full time hours or worked part-time, the FTE was less than 1.0. The FTE contribution was computed as the average FTE during the study time period multiplied by the number of months in the study period. The rationale for the use of this calculation was to account for the months of missing data in the FTE data files.

Assessing productivity was not included in the original aims. New data from another source, human resources, was required. Acquiring this data introduced a delay.

Hypothesis 1.3: Medicare time to final billing. Time to final billing measures were treated as continuous measures and examined as changes over time with descriptive statistics.

Aim 2. Barriers and facilitators to EHR adoption and implementation

Hypothesis 2: Clinician satisfaction. Clinician satisfaction survey responses were statistically analyzed for general associations and tests of trends using SAS.[19]. Quantitative analysis of nominal (e.g., gender) and ordinal categorical data (e.g., clinical role, survey responses) applied chi-square or Fisher's Exact (for sparse data) tests for general associations, and tests of trend (for ordinal categorical data). The Fisher's Exact test is a non-parametric test designed to assess the statistical association between two categorical variables without making any explicit assumptions about the sample distribution. This is the preferred method when any of the contingency table cell-sizes are less than 5. [20] Statistical analysis of clinician demographic characteristics and survey responses using Fisher's Exact identified demographic variables that might be confounders of overall satisfaction.

Concurrent with entering and analyzing the quantitative data (i.e., the primary data set), the secondary, qualitative data from observations and interviews were analyzed using NVIVO.[21] Using principles of thematic content analysis, data about (i.e., observations) and from (i.e., interview responses) the clinicians were analyzed inductively to identify descriptive or topical

categories. The HITREF was used to identify a range of EHR characteristics and dimensions to be measured. The HITREF conceptual framework was used to sensitize the initial organization of the categories as well as their development, but use of the HITREF did not exclude possibilities for new organization. Using this start list, coding categories and themes were developed for the data through a process of constant comparative analysis. In this technique the researchers (PS, KB) independently read interviews as individual cases, disassembled interviews through coding categories, rearranged coding categories into patterns, and reintegrated the patterned categories into a conceptualization that encompassed the experiences of all subjects.[22]These members of the research team met regularly to compare their application of the categories and resolve any differences in their analyses. Ongoing refinements and clarification of the categories and guidelines for application of the categories were discussed during frequent meetings of these researchers to resolve any differences in their coding.

Barriers and facilitators to adoption were identified using mixed methods analysis as shown in Table 1. The investigator(s) searched for themes in the quantitative and qualitative findings by reviewing and arranging findings along HITREF themes. All data for each category of patient outcome, clinician use of EHR, clinician satisfaction, and reimbursement were retrieved using the analytic software used in each study. Data retrieved from statistical software were scores on study instruments along with pertinent outcome measures summary statistics. Qualitative data was retrieved from NVIVO. All data for each data source were arranged in a matrix as dimensions and sub-dimensions of the HITREF. The matrix was analyzed to determine the major themes related to the barriers and facilitators home care clinicians experienced regarding adoption of the EHR.

Aim 3. Recommendations for barriers/facilitators to implementation and meaningful use

Data analysis related to developing recommendations related to barriers and facilitators t EHR implementation were completed during Aim 2. To produce recommendations for home care EHR CCHIT criteria to be included in MU recommendations, the following analysis and synthesis was undertaken.

Table 1. Mixed Methods Data Collection Procedures for Evaluating Point-of-Care EHR in a Home Health Agency

Specific Aims	Procedures	Products
Aim 1 (Data collected concurrent with Aim 2): Compare patient, workflow, and financial outcomes in a home health agency before and after EHR point-of-care implementation.	Pre- and post- implementation: • Extract from EHR: o OASIS data o Time-to-complete documentation • Extract from financial system: o Medicare time-to-final bill • Extract from EHR audit logs: usage data.	Quantitative OASIS outcomes measures for thousands of patients during study timeframe; Quantitative measure of time-to-complete-Medicare documentation for the agency (137 clinicians); Quantitative measures of changes in Medicare time-to-final bill for the agency; Quantitative EHR usage data for the agency.

Specific Aims	Procedures	Products
Aim 2 (Data collected concurrent with Aim 1): Identify the barriers and facilitators to point-of-care EHR adoption and implementation related to patient, workflow, and financial outcomes.	Post implementation: • Observe selected clinicians. • Administer clinician satisfaction with EHR (EHRNS) survey to clinicians. • Interview selected clinicians. • Extract from EHR audit logs: usage data.	Qualitative field notes from 8 clinicians; Quantitative survey responses for 71 clinicians; Qualitative interview responses from 6 clinicians; Quantitative EHR usage data.
Aim 3: Propose design and implementation recommendations that address the barriers and support the facilitators to implementing point-of-care EHR in home care.	Integration and interpretation of quantitative and qualitative results from Aims 1 & 2.	Generalizable and replicable model that addresses barriers to point-of-care EHR implementation.
Aim 4: Propose policy recommendations regarding meaningful use of EHR in home care.	Compare EHR functionality identified in Aims 1 and 2 to ambulatory EHR functionality specified in the Department of Health and Human Services Final Rule on meaningful use Stage 1 Objectives.	Policy recommendations for home health EHR meaningful use objectives.

Software documentation and observations were analyzed inductively using principles of thematic content analysis to identify descriptive or topical categories related to EHR functionality. Coding categories and themes were obtained from the reduced CCHIT criteria. EHR functionalities related to CCHIT criteria that were not identified in the software documentation were reviewed with the agency EHR experts. If the expert verified the functionality was in the software, the functionality was added to the list of available functionality.

Observed EHR functionality was elicited from the data through a process of constant comparative analysis, a technique in which the investigator (PS) simultaneously collected information through observation, read observation field notes as individual cases, disassembled observation field notes through coding categories, rearranged coding categories into patterns, and reintegrated the patterned categories into a conceptualization that encompassed the experiences of all subjects.[22] Elicited EHR functionality that did not fit the CCHIT coding categories were assigned to new coding categories.

The EHR functionality data was summarized in a matrix with EHR functionality (noted as available and/or observed) on one axis and the reduced list of CCHIT criteria on the second axis. Each new coding category elicited from observed EHR functionality was compared to the published LTPAC CCHIT criteria. A match indicated the reduced criterion had been identified in the documentation and/or observed, and the absence of a match indicated the criterion was not in the published list. Lastly, meetings of the investigator (PS) and home care agency's clinical EHR expert verified point-of-care EHR functionality and differences between EHR functionality and CCHIT criteria. Attendees also considered whether there was agreement between the researcher and the home care expert, and whether there were plausible explanations for identified

differences in functionality. The researchers summarized findings as policy recommendations for home care EHR MU objectives and documented rationale for recommended functionality that differed from CCHIT criteria.

Results

Each clinician was eligible to participate in the study with different levels of participation in each method. For instance, all were included in EHR documentation completion analysis (N = 137), and only consented clinicians (n = 77) were observed (n = 8), surveyed (n = 71), and interviewed (n = 6).

Aim 1. Patient, workflow, and financial outcomes

Hypothesis 1.1: Patients' OASIS outcomes and hospital visits. Clinicians were neither satisfied nor dissatisfied with the EHR's impact on patient outcomes. EHR impact on patient outcomes was limited to some behavioral outcomes. For all the selected physiological conditions, the assessed patient population was neither more nor less likely to remain the same or improve in health outcome in the first post-period as compared to the pre-period (e.g., odds ratio near 1.0). The odds ratio indicating an improvement in dyspnea was statistically significant, although probably not clinically significant, and may be a consequence of an abundance of data. Patients assessed for selected behavioral conditions (i.e., anxiety, awareness, or confusion) were more likely to improve in health outcome. All other behavioral, cognitive, and psychiatric conditions remained unchanged. Comparing the post- periods, patients were likely to improve except those with urinary tract infections. In each comparison, an indicator (i.e., dyspnea in the first comparison, behavioral assessment in the second) while statistically significant, is probably not clinically significant and may be a consequence of an abundance of data.

Having found limited EHR impact on physiological outcomes across the patient population, the researchers narrowed the focus to a selected physiological measure related to a chronic condition. The researchers analyzed patients with a diagnosis of cardiac heart failure (CHF) and who reported shortness of breath. We found a surprisingly small number of patients with CHF, such that there was insufficient sample size for the analysis. Further investigation with colleagues who use OASIS data and with an agency manager who used the data suggested that clinicians may not record all ICD9 diagnosis codes for a patient. As a result, not all CHF patients were identified for the analysis.

The researchers planned to assess the impact of the EHR on patient outcomes related to emergency care and hospital readmission. The sample size of patients who went to the hospital while receiving home care was unexpectedly small, and insufficient for subsequent analysis. We learned from the agency manager and nurses that patients may not inform their clinicians that they have gone to the hospital, and the EHR may not be updated accordingly. Clinicians rely on their patients for this information as the home agency EHR is not updated by the local hospitals due to lack of interoperability.

Hypothesis 1.2: Clinical documentation. Clinicians were satisfied with documentation timeliness and team communication. Of the 137 clinicians who documented in the EHR, 71 clinicians (52%) completed surveys. Respondents had a median of 21 years work experience in

healthcare and a median age of 49 years; 88% were women, 54% were nurses, 34% physical therapists, 10% occupational therapists, 1% social workers, and 1% speech pathologists. Some respondents (35%) had previous EHR experience outside the research site, averaging 3 years of prior EHR experience. Respondents self-rated their computer skills as average. Clinicians reported in survey responses they were satisfied with the completeness/correctness of the data (Item 6; 3.7, SD 1.1) as well as EHR impact on Team communication (Item 11; 4.0 median, SD 1.0) where response choices ranged from Strongly Disagree (0) indicating most dissatisfied to Strongly Agree (5) indicating most satisfied.

Of the 77 clinicians who consented, we purposefully selected 26 to be observed (34%) until we observed 8 clinicians (10%) to meet our goal of representing each team and clinical role; 18 clinicians refused to be observed or did not reply to email requests. Clinicians observed were men and women who were nurses, physical therapists, and occupational therapists. Their age ranged from mid-twenties with under 5 years of healthcare experience to middle-aged with greater than 10 years of experience. Observation indicated clinicians documented at the point-of-care, as intended, and also documented after the patient visit. While nurses and therapists documented in separate areas of the EHR, they were observed accessing each other's documentation. Clinician communication solely via EHR was observed among and between clinical roles.

Implementation of the point-of-care EHR improved timeliness of clinical documentation completion resulting in statistically significant improvement in compliance with timeliness guidelines compared to prior paper documentation as shown in Table 2. In the 14-month pre-period, 14,563 notes were documented. The proportion of clinicians who were in compliance pre-period ranged between 0 and 30% as shown in Figure 1. Following implementation, 56,702 notes were completed in the 7-month first post-period and 168,782 notes completed in the 14-month second post-period. The proportion of documents completed within 1 day rose in a random walk upward from 50% to above 90%. Comparing the first post-period to the pre-period, documentation was about 19 times as likely to be in compliance (within 1 day of patient visit) as compared to pre-implementation (7 days) and was statistically significant.

Table 2. Odds Ratio of Compliance with Each Time Period's Documentation Guidelines by Clinical Role

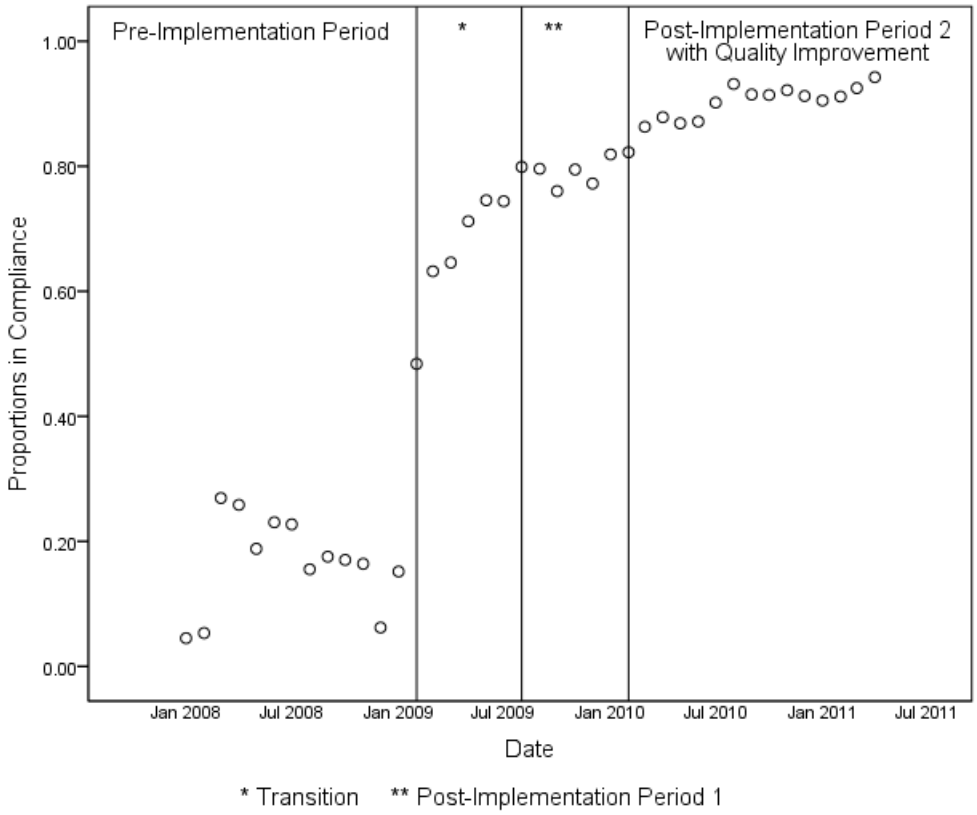
Clinical Role	1st Post- vs. Pre-Odds Ratio (95% CI; *p*-value)	1st Post- vs. Pre-Odds Ratio (95% CI; *p*-value)	1st Post- vs. Pre-Odds Ratio (95% CI; *p*-value)
All Clinicians	18.8 (17.9–19.7; $p < 0.001$)	44.4 (42.4–46.5; $p < 0.001$)	2.4 (2.3–2.4; $p < 0.001$)
Nurses	15.4 (14.6–16.2; $p < 0.001$)	35.4 (33.8–37.2; $p < 0.001$)	2.3 (2.2–2.4; $p < 0.001$)
Therapists	114.7 (89.5–147.0; $p < 0.001$)	269.3 (210.4–344.7; $p < 0.001$)	2.3 (2.2–2.5; $p < 0.001$)

Nurses comprised almost three-quarters of the clinician population and completed most of the documentation in the pre- and post- periods. However, in the pre-period, nurses completed disproportionally more documents (86%) than their representation in the clinician population (74%); physical and occupational therapists (PT/OT) (13% notes, 22% clinicians), speech pathologists and social workers (SP/SW) (1% notes, 4% clinicians) completed disproportionally less documents. This trend reversed in the post-periods when nurses created disproportionally fewer documents (66% 1st post- period, 62% 2nd post-period); PT/OT and ST/SW created

disproportionally more documents (27% and 7% respectively in 1st post-period; 28% and 10% in the second post period).

Productivity related to documentation completion was 12.38 completed notes per FTE contribution in the pre-period. Following implementation, productivity in the first post-period was 95.76 and productivity in the second post-period was 127.06. In addition to difficulty obtaining the data, there was missing data which had to be addressed in our analytic methods.

Figure 1. Proportion of Documents Completed Within the Compliance Guidelines (7 days pre-implementation period; 1 day post-implementation period) during the Study Period



Related to Hypotheses 1.1 and 1.2, the extraction of billing and quality reporting (OASIS) data from the EHR for retrospective analysis was a challenge. The research team employed the services of the agency's contract programmer who regularly extracted data from the EHR to meet operational needs. The programmer was unable to extract one data field, and found it difficult to extract a few other data fields. Despite these challenges that delayed our analysis, working with electronic data is preferable to working with data on paper because the data is more easily readable and accessible.

Hypothesis 1.3: Medicare time to final billing. The number of days required to process clinician documentation into final claims oscillated between 40 and 100 days in the pre-period and between 100 and 30 days in the first post-period; they plateaued at under 20 days in the second post-period as shown in Figure 2. This substantial decrease in the second post-period

coincided with implementation of the quality improvement team which reviewed completed clinical documentation for completeness and accuracy. The peak and trough remained unexplained by financial administrators. Considering that the number of staff who processed claims was fixed, the number of days to final claim may have been impacted by increased or decreased volumes of claims to process. However, in the pre-period, the Medicare census remained relatively steady varying from 400 to 500 patients. Following implementation, the Medicare census began to increase toward 700 patients while days to final claim fell, as shown in

Figure 2. Trends in Medicare Census (MC) and Elapsed Days to Filing of Final Claim During Pre-EHR Implementation, Transition, Post-EHR Implementation, and Post-EHR Implementation with Quality Improvement Periods

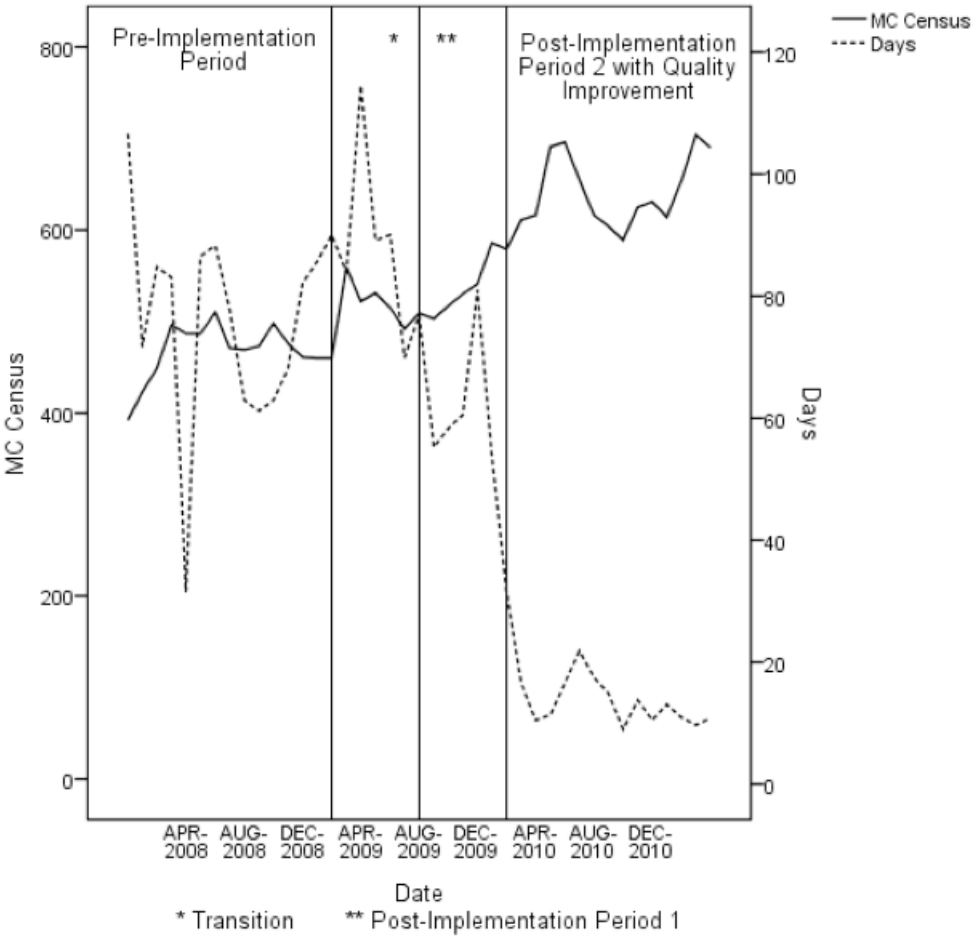


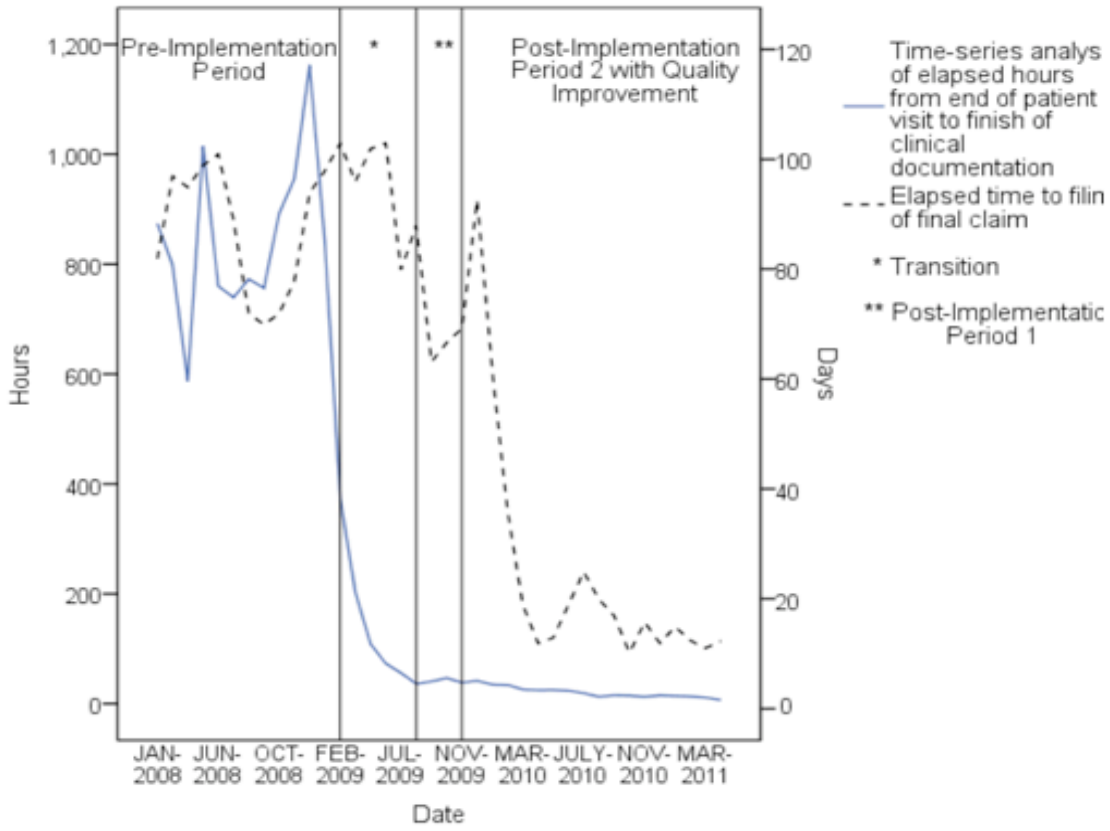
Figure 3. In summary, the days to Medicare claims fell from 100 days pre-implementation to 30 days post-implementation while the census rose.

Considering that the number of staff who process claims was fixed, the number of days to final claim may have been impacted by increased or decreased volumes of claims to process. However, in contrast to the oscillation in elapsed days to final claim during the pre-implementation period, the Medicare census remained relatively steady varying from 400 to 500

patients. Following implementation, the Medicare census began to increase toward 700 patients while days to final claim fell.

Quantitative analysis of EHR data indicated implementation of the point-of-care EHR had a positive impact on timeliness of clinician completion of documentation and reduction of days required to produce a final patient bill as shown in Figure 3.

Figure 3. Elapsed Time to Completing Clinical Documentation and Filing Reimbursement Claim Before and After Electronic Health Record Implementation



Aim 2. Barriers and facilitators to EHR adoption and implementation

Among the HITREF evaluation criteria, 11 important themes related to clinician satisfaction with EHR impact on the clinical process emerged from the mixed methods analyses. Clinicians expressed satisfaction across all assessment methods with: (1) hardware availability; (2) EHR data completeness/ correctness/ timeliness; (3) appropriateness of patient care; and (4) team communication. Clinicians expressed satisfaction on surveys and dissatisfaction in interviews with: (1) organizational support; (2) software usability; (3) software functionality; and (4) efficiency. Also, clinicians expressed dissatisfaction across all assessment methods with: training and unintended consequences. Lastly, clinicians had neutral perceptions of the EHR impact on patient outcomes while the EHR had minimal impact on patient outcomes. These themes translated to the following EHR adoption challenges: (1) hardware problems coupled with lack of field support; (2) inadequate training; and (3) mismatch of EHR usability/functionality and

workflow resulting in decreased efficiency. As observed in this study, an EHR designed for one clinical discipline, such as nursing, may introduce inefficiency in the clinical process of another discipline on the clinical care team, such as physical therapy. Adoption facilitators were support for team communication and improved clinical data timeliness.

Aim 3. Recommendations for barriers/facilitators to implementation and meaningful use

Recommendations for LTPAC Meaningful Use criteria includes a list of 40 criteria in 32 categories intended to represent functionality more likely to be universally present in point-of-care home care EHRs. Additional criteria related to functionality unavailable in the home care EHR should be considered for inclusion in MU criteria across LTPAC settings. For instance, the function – associating clinical data with codes from standardized nomenclature – is important for the interchange of data and should be retained. Similarly, criteria that were not expected to be available in an EHR in a stand-alone home care agency, such as interoperability or physician access to the EHR, may be available to a home care agency or other long-term care setting in an integrated health system. Additional criteria (e.g., clinical decision support functionality) may be available after advanced functionality is incorporated into the EHR. If these criteria are desired objectives for LTPAC MU, they should be considered for inclusion in the criteria list. We also recommend that MU objectives include usability considerations. Examples include the number of screen changes required to access or document patient information, and efficient navigation (e.g., displaying care plan information in the documentation screen rather than requiring clinicians to navigate to the care plan screen while documenting care. The resulting home care EHR CCHIT criteria recommendations from this study have been communicated to AHIMA, a national home care organization, and to CCHITT.

Adoption recommendations focus on the untapped potential of the study EHR's functionality to provide clinicians with quality assurance and care management feedback. The EHR was able to be queried by management to produce reports to improve performance related to timely clinical documentation completion. Similarly, we suggest information from the EHR can be presented to clinicians to support the agency's clinical quality assurance efforts, such as identifying diabetics or patients due for seasonal vaccinations. We also suggest that redundant clinician documentation can be reduced when EHR administrative reports, such as daily activity reports, replace paper-based reporting. In addition, the documentation quality efforts incurred a cost to clinicians with little benefit. We suggest that since clinicians are motivated to improve patient care and patient safety, sharing patient care process or health outcome data with clinicians may motivate clinicians to use the EHR as intended. In the absence of providing clinicians with data from the EHR to help them improve patient care and safety, clinicians may not have perceived the EHR as providing value to them in their workday. Clinicians become frustrated, perceive the system is forced on them, and do not fully engage with the system. Clinicians are more likely to use the system as intended if they value the information received from the system because it helps improve the care they provide and they understand that the source is the system into which they document.

Conclusions

Key findings were that real time EHR data availability supported clinicians in their provision of homecare and communication among team members. The point-of-care EHR, when used as intended, displayed patient visit documentation to clinicians as they made clinical care decisions. Despite access to timelier point-of-care documentation, clinicians' perception of EHR impact on patient outcomes was neutral, and EHR impact on patient outcomes was minimal. In addition, implementation of the EHR significantly improved the timeliness of clinical documentation and billing for reimbursement. The data in the EHR enabled administrators to manage the timeliness of clinician documentation and improve the workflow process. Although documenting in the EHR required more time than documenting on paper, the nearly 10-fold increase in documentation and patient visits suggest that clinician use of a point-of-care EHR enabled a slightly larger clinical staff to provide 10 times more patient visits.

Clinician access to accurate and timely documentation, which supported team communication, was an incentive to use the EHR at the point of care. However, not all clinicians used the EHR as intended. Related factors that are addressable by the agency include providing field support and dependable hardware, improving on-going training, and reducing redundant documentation requirements to reduce the workload and improve workflow, and working with the EHR vendor to address functionality and software usability issues for all clinical disciplines on the care team. Lastly, presenting information from the EHR in support of patient quality and safety efforts could improve clinicians' perception of the EHR 's value and increase adoption.

Recommendations related to Meaningful Use are that a suggested list of 43 home care point-of-care EHR CCHIT criteria be included in MU LTPAC objectives. These finalized list objectives should accommodate the diverse organizational characteristics and EHR characteristics of LTPAC settings. We also recommend that MU objectives include usability considerations.

Study challenges were access to and use of operational data for research. Data which were said to be available at study conception, in fact was not available. Examples include patient hospitalization and emergent care data which were infrequently available to nurses to document, rejected Medicare billing data, and Medicare revenue data. In addition, a limitation of the time-to-completion data was that 6% of the data was dropped possibly due to poor data quality resulting from data entry errors. Dropping this amount of data was not unexpected, as we were using retrospective data for a purpose different from its intended purpose.

Regarding the methods, extracting data from the EHR required a specialized programmer familiar with the vendor's data schema and the meaning of the data. Similarly, analysis of data extracted from the EHR required a biostatistician familiar with operational clinical data stored in EHRs. For example, the biostatistician had to understand the organization of data into episodes of care, as well as standardized coding such as ICD9. The biostatistican also understood that a large amount of missing data was to be anticipated when researchers re-purpose operational data for research.

In addition, researchers should be warned that Survey Monkey is incapable of consistently managing two survey administered to the same person. During this study, we followed Survey Monkey instructions and were unable to identify the respondent of the first survey administration. This failure resulted in a loss of response data and delay incurred due to re-administration of the survey via other means. Furthermore, matching sequential survey

administrations at the respondent level was not possible, causing the researchers to use face-to-face and postal mailings to administer surveys.

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List of Publications and Products

Outcomes Related to Aim 1

Sockolow PS, Bowles KH. Completeness of the Health Information Technology Reference-based Evaluation Framework for evaluating electronic health records in community health settings. (Poster) AMIA Public Health Informatics Conference 2011, May 2011, Orlando FL.

Sockolow PS. Completeness of the Health Information Technology Reference-based Evaluation Framework for mixed methods analyses in community health settings. 7th International Mixed Methods Conference, June 2011, University of Leeds, United Kingdom.

Sockolow PS, Adelsberger M, Liao C, Chittams JL, Bowles KH. Evaluation of the Impact of an EHR on Patient Outcome in Home Care. CBMi's 5th Annual Healthcare Informatics Symposium, April 2012, Philadelphia PA.

Sockolow PS, Adelsberger M, Liao C, Chittams JL, Bowles KH. What Clinicians Say and What They Do: An Evaluation of an Electronic Health Record in Home Care. 8th International Mixed Methods Conference, June 2012, University of Leeds, United Kingdom.

Sockolow PS, Liao C, Chittams JL, Bowles KH. Evaluating the Impact of Electronic Health Records on Nurse Clinical Process at Two Community Health Sites. In: Abbott PA, editor. Proceedings of the 11th International Congress on Nursing Informatics; 2012 June 23-27 Montreal, CAN.

Sockolow PS, Bowles KH, Adelsberger M, Liao C, Chittams JL. Impact of Home Care Electronic Health Record on Timeliness of Clinical Documentation and Reimbursement. In: Hersh WR, editor. Informatics: Transforming Health and Healthcare: Proceedings of the AMIA 2012 Annual Symposium; 2012 Nov 3-7 Chicago (IL).

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Outcomes Related to Aim 2

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Outcomes Related to Aim 3

Sockolow PS, Adelsberger M, Bossone C, Bowles KH. Identifying certification criteria for home care electronic health record meaningful use. In: Evans RS, editor. Improving Health: Informatics and IT Changing the World: Proceedings of the AMIA 2011 Annual Symposium; 2011 Washington, DC. 1280-1289 PMID: 22195189

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