Title of Project: **Information Needs of Homecare Nurses During Admission and Care Planning**

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Structured Abstract

<u>Purpose</u>: Characterize home healthcare (HHC) admission nurses' information requirements, decision-making, and workflow, and if/how HIT systems support this decision-making.

<u>Scope</u>: Three diverse HHC agencies using three different HIT systems; 18 nurses admitting two patients each.

<u>Methods</u>: Observational study. Data collection: focus groups, observation, documentation review, international information standard comparison, interviews, think-aloud protocol. Quantitative, qualitative, mixed methods analyses. Annual Advisory Board consultation.

<u>Results</u>:

- 75% of information items needed by nurses mapped to the standard. No observation included all the standard data items in information available at admission. Patient medication self-management concepts absent in the standard and admission documentation.
- Pervasive polypharmacy and high-risk medications. For 91% of patients, the number of medications decreased between pre- and post-reconciliation medication lists. 41% of medications required changes. Nurses using interoperable systems made fewer changes than nurses using non-interoperable systems.
- For 5 problems, in 20% of observations the problem appeared in all three phases. In 25.6% the problem appeared in referral and/or assessment phases and not the plan of care (POC). In 20.5% the problem appeared in referral or assessment phases and the POC. In 5% the problem only appeared on the POC. EHRs lacked fields for rationale for including problems or not, and to identify active, resolved, or potential problems.
- Before entering the patient home, nurses had an information deficit and relied on experience to form their visit pattern decision. Following the visit, nurses provided different decisions indicating re-thinking of care. Nurses tended not to change decisions upon completion of EHR documentation.

<u>Key Words</u>: Transitional care, home health care agency, decision-making, nursing informatics, documentation, visit pattern, terminology, medication reconciliation, interoperability, International Classification of Diseases, nursing diagnosis

Purpose

The specific aims of the study, as proposed, were:

1. For admitting nurses at three agencies (serving rural, suburban, urban populations) using three different health information technology (HIT) systems, characterize information requirements, decision-making, and workflow.

2. Characterize if/how HIT systems support homecare admitting nurses' information requirements, decision-making, and workflow.

3. Develop and disseminate design and implementation recommendations that address the strengths and challenges due to homecare admitting nurses' information requirements, decision-making, and workflow.

The final study objectives did not include workflow characterization. The reason was that a few methods which worked in a laboratory setting did not work in the field.

Scope

Background

For 12 million older adults per year in the United States, transitioning into HHC provides skilled nursing care and other therapies to assist patients and their caregivers manage recovery and chronic disease. Effective communication between clinicians during transitions in care is fundamental to continuity of care (1-4) and sentinel events avoidance (5, 6) for over 3 million Medicare beneficiaries (7) receiving HHC annually. The process of admitting the transitioning patient to HHC impacts the quality of care and outcomes such as hospital readmissions.(8, 9) Unlike the teamwork common in acute care settings, HHC clinicians operate independently in the home under physician orders. The admission is the first home visit at the start of the HHC episode.

HHC nurse information needs. Problems exist with information transfer during the transition to HHC(5, 8, 10-15) and HHC clinicians often conduct the admission visit with incomplete or inaccurate clinical information.(10, 16-19) Arbaje(17) categorized this issue into four types – erroneous, information overload, underload, or scatter. To obtain needed information, nurses tend to rely on the patient or caregivers and this information is often not reliable.(20) The result can be inefficiencies and unsafe conditions for the patient or clinicians as clinicians may not be prepared for the start of care, or may not have the needed information to generate a high quality plan of care (POC) to prevent readmission.(21) From a human information processing perspective, complete and reliable information is the foundation for making consistent and accurate judgments and appropriate clinical decisions(22-24) and for providing safe patient care;(25) therefore nurses and patients are currently disadvantaged.

Nurses have access to patient information from the referral source and information that agency staff document during the intake process. Nurse work includes medication reconciliation, patient and home safety assessment, and plan of care development (patient problems to be addressed during the episode; planned interventions for assessment, education, care coordination, and treatment; and planned visit pattern-visit frequency and episode duration).

Medication reconciliation. The Joint Commission defines accurate communication of medication information across the transition in care as a national patient safety goal, and promotes medication reconciliation to reduce the risk for medication errors.(4) Medication errors are associated with 66% to 72% of the adverse events occurring after hospital discharge.(26, 27)

"Medication reconciliation refers to the process of avoiding such inadvertent inconsistencies across transitions in care by reviewing the patient's complete medication regimen at the time of admission, transfer, and discharge and comparing it with the regimen being considered for the new setting of care".(28)(para.1)

HHC nurses verify the medication list by communicating with patients and/or caregivers, viewing medications in the home, and, when needed, communicating with the doctor or the community pharmacist to resolve significant medication issues. Nurses generally obtain the medication list from the referral document or the discharge summary/progress note. This list is available as static data (a paper or scanned copy) or structured electronic data. After the visit, the nurse finalizes the medication list in the plan of care. This process has great value, as evidenced by the high prevalence (67-94%) of differences between pre- and post- home visit medication lists.(5, 29-32) We need solutions to improve communication of accurate medication information, and strengthen medication reconciliation to meet the goals of efficient, safe, timely, and effective care.(33)

Clinicians attribute inaccurate medication lists to inadequate communication between providers, insufficient HIT functionality, and the lack of interoperability between HIT systems in hospitals and post-acute care settings.(34-37) Here, we apply the Health.gov interoperability description: "secure exchange of electronic health information with, and use of electronic health information from, other health information technology without special effort on the part of the user."(38) With shared data, HHC clinicians and staff encountered fewer problems related to lack of information from the hospital, including medication problems.[15] Even when HHC nurses can view the referring facilities' electronic health record systems (EHRs), they may access only static data as opposed to structured data against which they can document (and thus imposing a documentation burden). There is limited published work identifying what information nurses need and what is available to them for decision making during the HHC admission.

Problems to include in the plan of care*.* An accurate, complete, and current patient problem list (health related needs that may benefit from clinical intervention) is valuable for concisely communicating clinical status.(39) An accurate problem list is associated with higher-quality care, while inaccurate or incomplete information could lead to inappropriate or delayed care.(20, 21, 39, 40) Thus, it is important to characterize whether the information on documents available during the admission process inform the POC problem list.

Visit pattern decisions*.* The planned skilled nursing (SN) visit pattern can impact patient outcomes including hospitalization.(9, 41) This decision, made to address the patient's needed level of attention (e.g. monitoring for condition change) and care intensity, has three components: Timing of the first visit, frequency (i.e., number of visits per week), and duration (i.e., number of weeks in episode). The timing decision is made by staff not included in our sample (i.e., not admission nurses) and is beyond the study scope. The nurse makes the frequency and duration decisions, which are the study's focus.

Frequency and duration were associated with hospitalization risk in a national sample, where patients with fewer than 4 SN visits or shorter episodes (less than 22 days) were more likely to be hospitalized.(42) During the two weeks following HHC admission, half of all unplanned hospitalization among these patients occurs.(43) Regarding frequency, early and intensive SN visits (frontloading) for high risk patients may reduce hospitalization risk(9) by enabling nurses to identify medication issues earlier, closely monitor the patient's condition, and maximize opportunities for teaching. Frontloading has been defined as providing in the first 14 days either 60% of planned visits,(9) or 5 or more visits,(42) and is recognized as an evidence-based best practice.(44-48) Visit duration is of heightened interest due to the Centers for Medicare and Medicaid Services (CMS) recent change in reimbursable episode length from 60 to 30 days.(49)

Settings

Three Pennsylvania HHC agencies in diverse geographic locations, with different commercial point-of-care EHRs, and with different interoperability capabilities participated. The rural agency was a stand-alone agency without interoperability with any referral source. The suburban and urban agencies were in health systems. The urban agency was in an integrated system with respect to the referring facilities' EHRs. The suburban agency had limited interoperability with its parent hospital and was able to receive a formatted electronic document with summary discharge information and referral information within a standard template. The urban agency had interoperability with its health system's tertiary care hospitals where the EHR populated the HHC EHR medication list as structured, updatable data. Referral documents received from non-tertiary hospitals within the health system were transmitted similar to the suburban agency as electronic documents. At each agency, nurses transcribed non-interoperable information into the EHR.

A challenge was that the urban agency specified in the study proposal was not able to participate due to personnel and policy changes. The team was able to locate a different urban agency which used an EHR not used by the other agencies which was willing to participate in the study.

Participants

Six nurses per agency participated in a focus group and were observed admitting two patients each (36 patients total). Nurses volunteered and provided consent. As part of a participatory protocol, nurses were informed that researchers were investigating information needs, decision-making, and nurse workflow. The study reimbursed the agencies for the nurses' time.

The agencies selected patients for the study independent of referring facility interoperability characteristic and patients provided consent to be part of the observations. The admissions occurred within two days of referral.

Referral came from six categories of settings: hospitals (22), rehabilitation facilities (5), skilled nursing facilities (SNFs) (4), physician offices (3), wound care center (1) and HHC infusion agency (1). Patient populations were predominately older, white, and lower socio-economic class (SES) at the rural agency; predominately older, white, and middle SES at the suburban agency; and predominately older, African American, and lower SES at the urban agency.

Methods

Study Design

The Drexel University Institutional Review Board approved this observational field study conducted in 2016-2018.

Data Sources/Collection

Based on the team's knowledge of the HHC admission process, and in the absence of related literature, we investigated four decisions as use cases:

1. Medication reconciliation (constructing the most accurate list of current patient medications, and comparing that list against the patient's discharge orders and the medications found in the home), and assessing patient medication self-management;

2. Problems to include in the plan of care (patient problems to be addressed in the home care episode, and the instructions for assessment, education, and performance of treatments);

3. Visit timing and frequency (establishing the weekly frequency of skilled nursing visits and the total number of follow-up visits); and

4. Inclusion of other disciplines ("Services") (determining which services are needed in the plan of care in addition to skilled nursing, such as physical therapy).

To address Aims 1 and 2, to examine nurses' information needs and also for the decisions, researchers observed the admission in the patient home. In addition, to address Aim 3, develop and disseminate design and implementation recommendations, the research team consulted annually with the Advisory Board. Members of the Board were a HHC nurse executive, the developer of a standardized terminology used in HHC; a HHC nurse informatics researcher; a HHC nurse informatician software company executive; and a human factors consultant.

Admission nurses received referral documents. The rural agency nurse had paper referral documents. At the suburban and urban agencies, referral information was available electronically. Intake documents were available at the rural (50) and urban agencies which contained patient information from the referral site.

Nurses performed patient and home safety assessments in patients' homes. HHC nurses sought, collected, and used information about the patients' responses to treatment, their symptoms, health behaviors, treatment adherence, and social determinants of health (50) to plan and implement care. The nurse may have requested from the patient a transition document (i.e., referral facility discharge summary, physician progress note) with care instructions. Nurses may have documented within the EHR. Nurses completed the admission documentation, including the plan of care (POC), in the home or at the agency. During the visit to the patient home, researchers made field notes, audio recorded, and photographed admission paperwork, hand-written notes, and EHR data entry.

Following the home visit, researchers video-recorded nurse admission completion at the agency including EHR documentation. The nurse spoke aloud as s/he documented the POC and related information in the EHR. Researchers asked questions outside of the patient home and at the agency.

Information needs and decisions

HHC nurse information needs. Researchers conducted focus groups with the nurses to determine what information they *need* during the admission process and we observed admissions to characterize what was *available* to the nurses at the start of the admission. Researchers conducted one focus group per agency with six admitting registered nurses at each until saturation (no new concepts) was reached. The nurses also reported

the information they need to conduct the admission (Start of Care). Follow-up phone calls and emails were performed for qualitative member-checking. In addition, five nurses from the rural agency who were in the original focus group volunteered to participate in a face-to-face member check session.

For each observation (unique patient admission), available information in documents at the start of the admission (either as hard copy or in the EHR) were photographed or obtained in hard copy from the nurse or the agency. The available documents types (i.e. referral, progress note, intake, internal communication) at the start of the admission varied by agency. Referral/progress note (herein referred to as referral) documents were present for all agencies. These documents were sent from the patient's previous clinical setting (e.g., hospital, skilled nursing facility, physician office). Referral information at the rural agency was on paper and at the suburban and urban agencies was available on the laptop computer EHR.

Intake documents were available at the rural and urban agencies. They were paper for the former and scanned for the latter. The suburban agency had two electronic internal agency documents available, referred to as Case Communication Reports, that were transcribed from external sources. One report summarized referral information. A second report contained insurance information.

Medication reconciliation. If the nurse made phone calls to the doctor or pharmacy, the researchers stopped recording because those on the phone had not provided consent. Nurses described call content.

Problems to include in the plan of care. Referral phase (R) information came from the patient's previous clinical setting: electronic and paper referrals, paper transition documents, and agency-created intake documents. The transition document was a discharge summary or the referring physician's progress note given to the patient. Referral phase documents contained problems in free text notes and medical diagnosis terms (ICD-10 codes).

Assessment phase (A) problems came from documentation of a) physical exam, patient and/or caregiver interviews about the patients' responses to treatment; b) symptoms, health behaviors, adherence, and social determinants of health;(50) c) home environment observation; and d) mandated Outcome and Assessment Information Set (OASIS) including functional status, clinical status, and service needs.(51)

POC phase problems were documented in the EHR POC (free-text and/or structured data) to be addressed within the care episode. For the rural agency, they were in nurse-emailed problem lists to other team members.(52)

Visit pattern decisions. Researchers audio-recorded three structured nurse interviews during the admission phases: Pre Visit, Visit, and Post Visit. Interviewers asked about the planned nurse visit pattern during the admission. Responses were recorded on data collection forms.

Advisory Board consultation. In year 1 of the study, the research team reviewed the study data collection methods and discussed interpretation of observations gathered. In the year 2 meeting, the team reviewed with the Board findings and HIT recommendations using exemplar manuscripts. The team elicited Board feedback on study HIT and EHR recommendations. During the year 3 meeting, the team obtained the Board's input on interpretation of HIT and EHR recommendations, and dissemination of findings.

Data Analysis

Researchers aggregated information requirements, decision-making processes, and workflow. Results are reported as significant at the $\alpha = 0.05$ level. The research team synthesized Advisory Board feedback to inform development of EHR and HIT recommendations, and dissemination.

HHC nurse information needs. The two information sets, the information nurses *need* during admission and the information *available* to the nurses at the start of the admission, were compared to a data standard to identify relevant data items. The universal presence of a data item would indicate that regardless of referral source, this data item tends to be communicated along the transition in care. Conversely, the infrequent occurrence of a data item may indicate the need for rigorous implementation of communication of the data item.

The research team sought to select a data standard against which both the needed and available data sets described above would be compared. We considered the Continuity of Care Document (CCD), a current, yet underutilized, international standard for patient summary information.(53) We reviewed the HL7 Implementation Guide for the CCD document to identify relevant CCD data items.(54) When compared to the recently announced U.S. Core Data for Interoperability (USCDI) standard,(55) the CCD contains more clinical data fields, with the exception of the data item, patient goals. Since the CCD contains a broader data set and is already in

use for some health care transition applications, we chose the CCD as the data standard for this analysis. For completeness, we compared the CCD to the Common Clinical Data Set from the Office of the National Coordinator (ONC).(56) The resulting list is the data standard for this study.

With respect to the *needed* information, two authors mapped each information theme from the focus groups analysis to the data standard code considered the best match. The mapping indicated (1) data items for which there was congruence of information needed and information available, and (2) completeness of the data standard relative to the information needed and to the information available.

With respect to the *available* information, each document's content was mapped to the related data standard code. Available information was organized by agency and corresponding patient admission.

Researchers reviewed the resulting data standard mappings, identified where needed information did not map to available information, and developed transitions-in-care information communication recommendations. They identified where the data standard was incomplete in regard to information that the nurses needed, organized the findings in the context of the four clinical decisions, and developed data standard recommendations.

To assess the interoperability effect on the occurrence of data items in the available information, each observation was characterized as having or not having an interoperable referral source. We used a two-sample t test to test for significance. If model adequacy assumptions were not met, we used the Wilcoxon rank-sum test with continuity correction.

Medication reconciliation. To characterize the work to ensure the completeness and accuracy of the medications list, we identified changes by comparing medication lists *before* (Stage 1) and *after* (Stage 2) the home visit. Stage 1 sources included referral documents and referring facility progress and/or discharge notes. The Stage 2 source was the HHC plan of care. Medication list analysis entailed a nurse researcher: (1) creating a medication list for each patient using Stages 1 and 2 sources; (2) classifying each medication according to type (i.e., prescription, over the counter) and risk level (i.e., high-risk, non high-risk); and (3) identifying the medications added, deleted, or modified (i.e., dosage, frequency/administration time, tablet type) between stages. High-risk medications were those that most frequently caused serious, fatal, and non-fatal medication errors.(57) Two additional nurse researchers reviewed the data for accuracy. To compare count data we used the Wilcoxon rank-sum test via R's Wilcox test. We conducted 2-sample test for equality of proportions using R's prop.test with continuity correction. To support analysis, if the numerator for a proportion is zero, we conducted the test using a 1 in the numerator. Trends are reported at α of 0.1.

We also identified observations in which the nurse expressed the need to call the doctor and/or pharmacy and the reasons for those calls by analyzing home audio and agency video. Two researchers separately and independently extracted nurses' descriptions of medication related question(s) to the doctor or pharmacy from the transcribed home and agency recordings. Using the transcribed data, one researcher identified and recorded the nurses' explanation (s) for the calls in an Excel spreadsheet. To assign reasons, the researcher used conceptual content analysis to systematically identify and interpret concepts in the extracted quotes. The researcher codified the quotes and related concepts into reasons. Three other researchers reviewed the quotes and codified reasons using consensus discussion. The observation identifier was retained for each quote and related reason(s). Results were then analyzed by interoperability status.

Problems to include in the plan of care. Researchers analyzed the contents of the admission related documents, OASIS, and EHR screens. Researchers included documentation of abnormal signs and symptoms or problems and ICD-10 coded medical diagnoses. To standardize, we mapped terms to the Omaha System Problem Classification Scheme (58) (59) that organizes standardized signs and symptoms for 42 problems. A one-agency analysis(50) using 42 problems and the HHC common problem literature (60-62) informed our approach of using five Omaha System problems as use cases: (1) Circulation; (2) Cognition; (3) Medication Regimen; (4) Respiration; and (5) Skin. We did not expect every patient to have all problems.

Two nurse co-authors established coding rules, coded two cases together, then coded separately, and came to consensus. For example, coccyx pressure ulcer was coded as the Omaha System problem, Skin; dementia or forgetfulness as Cognition; and dyspnea or pneumonia as Respiration.

For each observation, we coded problems as being present or absent in each phase in a Microsoft Excel spreadsheet. As the unit of analysis, phase patterns supported investigation of the influence of problems appearing in different phases. There were eight possible patterns: not appearing (none), each phase alone (R-

referral, A-assessment, POC-plan of care), pairwise combinations (R-A, R-POC, A-POC), and all (R-A-POC). Test of proportions were used to compare the frequency of concordant combinations (none, R-A-POC) to the others by problem.

We also characterized how the example EHRs recorded problem information in assessment and POC phases: either as free text (e.g., in a blank field) or structured data (e.g., pull-down menu). We reviewed EHR screen photos displaying the fields in which the problem was documented. As for EHR functionality, we observed nurse EHR use and focused on what facilitated work and what additional functionality might have been helpful.

Visit pattern decisions. Researchers applied quantitative, qualitative, and mixed methods analysis ap-proaches. For the quantitative analysis, three authors independently compared the availability of visit pattern information in the documents accessible to the nurses. Data were stored in a Microsoft Excel spreadsheet. They coded three responses types: No-indication (e.g., unsure, had not yet made any decision) and answers, coded as such; and non-response coded as absent. Researchers analyzed visit pattern information availability and response type for each interview, and comparison of responses across the interviews.

Qualitative research methods included thematic analysis of transcribed interviews to identify visit pattern deci-sion rationale. Three team members independently reviewed the transcribed interviews. Two team members extracted quotes which stated a reason for the decision using conceptual content analysis to systematically identify and interpret concepts in the responses. They independently extracted and compared until consensus was reached. Three researchers codified quotes into broader themes using the information contained within theme(63) using consensus discussion. A fourth researcher subsequently independently reviewed and grouped themes to produce group codes (Table 1). Further group code organization produced patient-specific themes, agency-specific themes, and system themes which the team reviewed. Theme separation allowed dif-ferent levels of analysis of the decision-making process.

The mixed methods analysis matched, by phase, quantitative data (i.e., nurse response counts) with qualitative data (i.e., interview quotes). The latter provided context to the quantitative data.

Table 1. Nurse response quotes organized by phase and theme

Phase(s)	Theme	Quote
Pre Visit	*Information Deficit*	"I don't see anything as far as the orders. I guess I'll be deciding." (H07)
		"That would depend too on my assessment once we got there to see what kind of shape he's in." (H10)
	Nurse Experience	"She sounds fairly routine post-op. She had her knee revised, she had a total knee revision. We've had her as a patient before so my guess is that it would be one or two nursing visit follow ups for pain." (H11)
Pre Visit and Visit	*Policy Driven*	"9 weeks, just the way how it falls, 9 weeks falls on a Sunday, but we have to bulk it out to the end of the certification period." (P13)
		"I make my orders for the entire start period even if I don't think that the patient's going to need to be seen for the entire start period because then if I only put in orders for 3 weeks and something changes in this patient in the next 3 weeks ...she's [the following nurse] not calling the doctor saying I have no orders: can you sign all of these new orders…at least she can add visits if needed. So I usually do a little more than I think." (A10)
	Other Clinicians are Involved	"Physical therapy is coming out to see her, occupational therapy is coming out to see her. We're almost seeing her every day, but different disciplines...Therapy goes out 3 times a week or so. We'll say Monday Wednesday Friday, so we go Tuesday Thursday, so we keep our eyes on you, evaluating how well you're progressing." (H05)
		"We can't go and see a patient on the same day they see their doctor. It's double dipping." (H04)
Pre Visit and Post Visit	*Patient is Stable*	"I mean after assessing his wound, it is fairly healed at this point so I won't have anybody coming out tomorrow to teach or reevaluate or anything like that." (H07)
		"I want to give him enough time to get the depression and eating disorder addressed, that's still our primary goal – CHF…Keep him out of the hospital for 30 days and give him as much education as we possibly can…make sure his vital signs aren't changing and his lungs aren't changing." (A04)
All	*Acute Needs*	"If he has a lot of edema, if I hear a lot of rails, if I don't think he has his meds, and I need that follow up, then I put him in for the next day." (A04)
		"Most patients require twice a week, if they're of medical concern." (A03)
		"I knew with the wound care we might be [out there often] but he looks like he's pretty fragile so we'll come out more to see him…just to make sure the wound care is getting done and that he's not declining because he looks like he had a pretty big decline." (H06)
Infrequently mentioned with no discernable pattern	*Patient/Caregiver Education*	"There's still questions that need clarification. And particularly with those few medication questions. I want to make sure that's all right. I want it right before she goes to the doctor." (A03)
	Insurance Restrictions	"Part of it is going to be he has Keystone 65 and they gave us 12 visits...for the first month." (A04)
		"So starting tomorrow we're going to start teaching the caregiver to do the wound care because Medicare won't pay for us to come out every day." (H06)
	Quality of the Caregiver	"After seeing him and seeing all the care that he gets it doesn't seem like he's going to need as intensive nursing care because he does have around the clock, good, knowledgeable caregivers." (A12)
		"Wife unable to pack [wound] due to recent illness…we'll have to get wound care orders changed at that point in time to see if…[we could] go maybe to a daily dressing." (H04)
	Patient/Caregiver Preference	"I would have preferred to have him on Sunday but I can't, I got to go by what he wants so at least he'll let us in Monday."(A05)
	Depends on the day	"we can avoid Mondays by adding patients because they're [nurses] always already very busy, then I go to Tuesday or Wednesday"(H10)
	Staffing	"I don't always work on Wednesday so sometimes I have to move that [visit]."
	Patient burden consideration	"tomorrow he's going to be completely exhausted, usually the second day you come home you're tired" (A04)
	Frontloading	"Normally when I admit a patient I usually like to have them seen quite often in the beginning just to make sure they're doing okay so it will probably 2-3 visits initially, then that can be based off of when I go in here, things may change." (P01)

Limitations

The study proposal included the following methods which were not incorporated in the final study. In addition, we did not have sufficient data to analyze inclusion of other services.

Data collection: Extraction from EHR (i.e., **u**sage, documentation times to calculate documentation time-to-completion) was not conducted as this information did not inform the analysis. The admission end-point for the study was the production of the plan of care, not the completion of the admission documentation.

Data analysis: In the proposal, we had planned to conduct a Critical Cue Inventory (CCI) and Situation Assessment Record (SAR). We substituted analysis of the four decisions for these methods. The CCI addresses what information does the nurse use, and where does the nurse get that information. The focus group data allowed us to answer that question. Instead of representing the information in a CCI, we developed our own representation. The SAR helps determine how an expert makes a judgment about the situation given the decision-making context. Instead of using the SAR, we did look at what information supports each of the four decisions. However, we did not represent the information in the SAR structure: cues/knowledge, expectations, goals, and decision points for each judgment and assessment.

We also planned to develop decision ladders (e.g., higher level decisions and strategies) using decision points identified in the SARs. However, we did not document how nurses make their decisions, and did not create decision ladders.

We proposed to conduct hierarchical task analysis (HTA) to represent workflow in a hierarchy of tasks and subtasks. Instead, we documented tasks using the focus group data but we stayed at the high level. Also, we planned to develop a keystroke level model using data entry logs and the HTA. Unfortunately, our attempts with a number of keystroke tracking software packages to run the tracking within the EHRs was unsuccessful, and we were unable to build the models.

We also planned to conduct heuristic evaluation, a usability inspection method to find problems in a user interface. However, we did not have the ability to get versions of the EHRs to conduct this test.

Results

Principal Findings

HHC nurse information needs
Creating a data standard to compare to the needed and available information. Four codes in the ONC's Common Clinical Data Set (*Physical Assessment*, *Smoking Status*, (clinician) *Goals*, and (clinician) *Health Concerns)* did not appear in the CCD. Thus, we enhanced the CCD. The ONC list is a Federal standard applicable to EHRs and thus, for completeness, these additional items not present in the CCD were considered in the analysis. We refer to the combined data set of CCD and Common Clinical Data Set as the CCD/S. This 26 CCD/S item set is considered as the comparison standard. For readability, CCD/S codes are italicized, and both CCD/S codes and themes are capitalized.

Information Needed by Nurses to Support Decision Making and CCD/S Adequacy. One focus group at each agency attained saturation. Fifty-three information themes resulted from the focus groups that discussed decision making during a HHC admission. Examples include: (1) Assistance in the Home; (2) Home Environment; and (3) Patient Not Taking Medication on List. Four themes were not applicable. Most (84%; 41 out of 49) information themes mapped to the CCD/S. Information themes were represented within six CCD/S categories: (1) Patient (e.g., Diagnosis, Level of Knowledge, Physical Findings, Level of Function—physical and cognitive, Goals, Care Needs); (2) External Resources (e.g., Insurance Approval and Requirements, Recommendations from Referral Source, Availability of Equipment); (3) Home Care Agency (e.g., Care the Admission Nurse Would Provide, Resources Available from the Agency); (4) Medication Reconciliation (e.g., Medication List Availability); (5) Care Giver Availability; and (6) Home Environment Condition (e.g., Cluttered).

The seven unmatched themes were related to medication self-management (e.g., High Risk Medication, Patient Ability to Understand Medications). The CCD/S code *Medication* did not include the patient medication self-management concept, and this concept was not explicitly included in any other CCD/S code.

Conversely, the nurses did not identify one-third of the CCD/S codes as needed to support decision making at admission. Three of these codes (*Patient Guardian*, *Next of Kin*, and *Emergency Contact)* were related to the patient's support sources. Three additional CCD codes were not mentioned: *Family History*, *Medication Activity (i.e., medication administered)*, *Supply Activity.* Three of the four ONC codes were not mentioned by the nurses*: Smoking Status,* (clinician) *Goals, and* (clinician) *Health Concerns.*

Information Available at Admission. The CCD/S codes distribution among the information documents varied by agency. For example codes such as *Advance Directives* and *Next of Kin* never appeared among the urban observations while *Patient Caregivers* never appeared among the rural ones. Seven CCD/S codes occurred frequently (for at least 80% of total agency observations): *Assessment, Problems, Medications, Vital Signs,*

Results, Encounters, and Healthcare Providers. Most (18) did not appear frequently or at all in the available information documents.

Across the agencies, 13 CCD/S codes were tagged to one or more of the four clinical decisions. Each decision relied on information related to between 2 and 12 codes. All decisions relied on information related to two codes, *Medications*, which occurred in all but one observation; and *Functional Status* which occurred in over two-thirds of the observations. However, no code explicitly contained one aspect of the Medication Reconcilitation decision: Patient medication self-management information. Therefore, nurses did not receive all the needed information in any of the observations. Three decisions (i..e, Medication Reconciliation, Visit Timing and Frequency, Problems) identified needing information associated with a third code, *Plan of Care*, which also occurred in over two-thirds of the observations. The Visit Timing and Frequency decision and the Problems decision relied on information related to the most codes (12 and 10 respectively). One of these codes, *Problems*, was only missing in 1 observation. The fourth decision, Services, had the fewest related codes, 2 (i.e., *Functional Status*, *Medications*), which appeared in all decisions.

The other 13 CCD/S codes were not tagged to a clinical decision. Among these codes, two addressed additional information needed for the Start of Care: *Allergies* and *Immunizations*. The remaining CCD/S codes which mapped neither to a clinical decision nor to the Start of Care were: (1) *Patient Guardian*, (2) *Next of Kin*, (3) *Emergency Contact*, (4) *Family History*, (5) *Social History,* (6) *Supply Activity*, (7) *Results*, (8) *Procedures*, (9) *Healthcare Providers*, (10) *Smoking*, and (11) *Health Concerns*.

Interoperability. There were more non-interoperable (21: 12 rural, 6 suburban, 3 urban) observations than interoperable (15: 6 suburban, 9 urban). CCD/S code occurrence in available information documents from the referral sources for the 21 patients referred from non-interoperable locations was compared to the 15 interoperable ones. The Wilcoxon rank sum test with continuity correction indicated no statistically significant difference between the number of code occurrences by interoperability (W = 342, p = 0.573).

However, two findings emerged from the analysis. Where we expected interoperable observations to have more information, only 3 CCD/S codes (i.e., *Problems, Medications, Results*) were present among all these observations. In contrast, no code was universally present among non-interoperable observations. Yet, for some codes, more non-interoperable observations contained the code as compared to interoperable observations (i.e., *Family History, Supply Activity, Goals, Advance Directive).* Second, one code (*Advance Directive)* present in the non-interoperable observations was not present in the interoperable observations.

Medication reconciliation
Medication Analysis. The medication change analysis included 34 observations with both Stage 1 and Stage 2 documents: rural (0 interoperable, 10 total – 2 observations excluded due to missing stage 1 documents), suburban (0 interoperable, 12 total), and urban (9 interoperable, 12 total). There was no standard format for medication list communication from the referring facilities to the agencies.

Type of Work. Table 2 summarizes the medications by category, stage and agency. Polypharmacy, defined as more than 5 medications,(64-66) was present in 31 observations. In Stages 1 and 2, medication lists included a mean 13.1 medications (SD=6.6) and 12.0 medications (SD=6.1) (V = 218.5 p = 0.051), respectively. For prescription medications the average number of medications significantly decreased after reconciliation (from 9.8 (SD=5.2) to 8.7 (SD=4.8)) (V = 225.5, p=0.007) while it did not significantly change for high-risk medications (6.9 (SD=3.4) to 6.4 (SD=2.9)) (V = 125.5, p=0.081). Descriptively, for each agency, Stage 2 had the same or fewer total, prescription, and high-risk medications as compared to Stage 1.

Table 2. Medication Categories by Agency and Stage

Stage	Medication Category	Urban (12 obs.)		Suburban (12 obs.)		Rural (10 obs.)		Total (34 obs.)	
		n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)
1	All meds.	163	13.6 (8.3)	129	10.8 (5.2)	155	15.5 (5.5)	447	13.1 (6.6)
	Prescription meds.	117	9.8 (6.1)	98	8.2 (4.9)	118	11.8 (4.2)	333	9.8 (5.2)
	High-risk meds.	83	6.9 (4.2)	69	5.8 (3.1)	81	8.1 (2.3)	233	6.9 (3.4)
2	All meds.	144	12.0 (8.4)	129	10.8 (4.1)	135	13.5 (4.8)	408	12.0 (6.1)
	Prescription meds.	99	8.3 (6.1)	92	7.7 (3.9)	104	10.4 (4.1)	295	8.7 (4.8)
	High-risk meds.	76	6.3 (3.8)	68	5.7 (2.5)	73	7.3 (1.9)	217	6.4 (2.9)

Table 3 presents the change types between stages as well as by interoperability status. 41.2% of medications were changed in some way in Stage 2: 16.8% dropped, 7.6% added, 8.7% dose / administration frequency

change, 5.8% change in administration time and 2.9% change in the tablet type. Five medications had more than one change type.

Table 3. Medication Changes by Interoperability and Risk Status *

Change type	All Medications			High-Risk Medications		
	Interoper-able (130 meds.)	Non-In-teroperable (317 meds.)	Total (447 meds.)	Interoperable (65 meds.)	Non-Interop-erable (168 meds.)	Total (233 meds.)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Medications with at least 1 difference	30 (23.1)	154 (48.6)	184 (41.2)	15 (23.1)	81 (48.2)	96 (41.2)
Deletions	20 (15.4)	55 (17.4)	75 (16.8)	7 (10.8)	25 (14.9)	32 (13.7)
Additions	6 (4.6)	28 (8.8)	34 (7.6)	4 (6.2)	12 (7.1)	16 (6.9)
Dose or freq. of administration changes	4 (3.1)	35 (11.0)	39 (8.7)	4 (6.2)	21 (12.5)	25 (10.7)
Time of day of administration changes	0 (0)	26 (8.2)	26 (5.8)	0 (0)	13 (7.7)	13 (5.6)
Tablet types (release type) changes	0 (0)	13 (4.1)	13 (2.9)	0 (0)	10 (6.0)	10 (4.3)

Interoperability. Table 4 summarizes the medication types by interoperability status and stage. Stage 2 had fewer total, prescription, and high-risk medications as compared to Stage 1.

Table 4. Medications Categories by Interoperability Status and Stage

Stage	Medication Category	Interoperable (9 obs.)		Non-Interoperable (25 obs.)	
		n	Mean (SD)	n	Mean (SD)
1	All meds.	130	14.4 (9.1)	317	12.7 (5.7)
	Prescription meds.	93	10.3 (6.2)	240	9.6 (4.9)
	High-risk meds.	65	7.2 (4.5)	168	6.7 (3.0)
2	All meds.	116	12.9 (9.4)	292	11.7 (4.6)
	Prescription meds.	81	9.0 (6.4)	214	8.6 (4.3)
	High-risk meds.	62	6.9 (4.0)	155	6.2 (2.4)

Thirty of 130 (23.1%) interoperable observations' medications had some change type, whereas 154 of 317 (48.6%) non-interoperable ones had changes (X^2 (1)=23.17, p<0.001). Deletions occurred in 20 of 30 (66.7%) of the medications in the interoperable observations and 55 of 154 (35.7%) of the non-interoperable ones. Additions were also common (6 of 30 (20.0%) among interoperable and 28 of 154 (18.2%) among non-interoperable). Only 4 of 30 (13.3%) of interoperable observations had dose or administration frequency changes as compared to 35 of 154 (22.7%) of non-interoperable ones. Regarding modifications due to time of day or tablet type, there were no changes for interoperable and 39 non-interoperable changes.

For high-risk medications, 15 of 65 (23.1%) interoperable observations' medications had some change type, whereas 81 of 168 (48.2%) non-interoperable observations' medications had changes (X^2 (1)=11.21, p<0.001). The most common change types included deletions (7 of 15 (46.7%)) among interoperable and 25 of 81 (30.9%) among non-interoperable). Additions occurred in 4 of 15 (26.7%) interoperable observations and 12 of 81 (14.8%) of the non-interoperable ones. Regarding modifications due to dose or administration frequency changes, 4 of 15 (26.7%) of interoperable and 21 of 81 (25.9%) of non-interoperable had changes. With respect to modifications due to time of day or tablet types, the interoperable ones had no changes but 23 non-interoperable did.

Regarding differences in medication lists between stages, most (7 of 9) interoperable and most (24 of 25) non-interoperable observations had some change type (Table 3). For the 3 observations (2 interoperable, 1 non-interoperable) with no differences, patients each had 5 or fewer medications.

Phone Call Analysis

Work effort. Nurses expressed the need to call the doctor and/or pharmacy in 24 of the 36 observations (66.7%). The nurse expressed the need to call the doctor in 23 observations and the need to call the pharmacist in 2 observations, 1 of which also included a call to the doctor.

Thematic analysis of calls to the doctor indicated some calls were made for more than one reason. The most common reason was to review medication details on the referral medication list. The second most frequently noted reason was to report a new patient complaint that may require new medication(s). Less frequently noted were requests for new or renewed prescriptions and mismatches between clinical problem and medication. One call during a non-interoperable observation requested the medication list from the referral facility.

Interoperability. For 7 interoperable and 16 non-interoperable observations, the nurses expressed the need to call the doctor for a medication issue. In 1 interoperable and 1 non-interoperable observation, the nurse expressed the need to call the pharmacy to verify the medication delivery status. The non-interoperable one also included a call to the doctor. Another reason to call the doctor was to report a risk of drug interactions, which occurred only with non-interoperable observations.

Problems to include in the plan of care

Each phase pattern was observed (Figure 1). Of the 180 cases, the selected problems did not appear at all for 52 (28.9%) (NONE, Figure 1). Below we report patterns among the 128 problems that occurred.
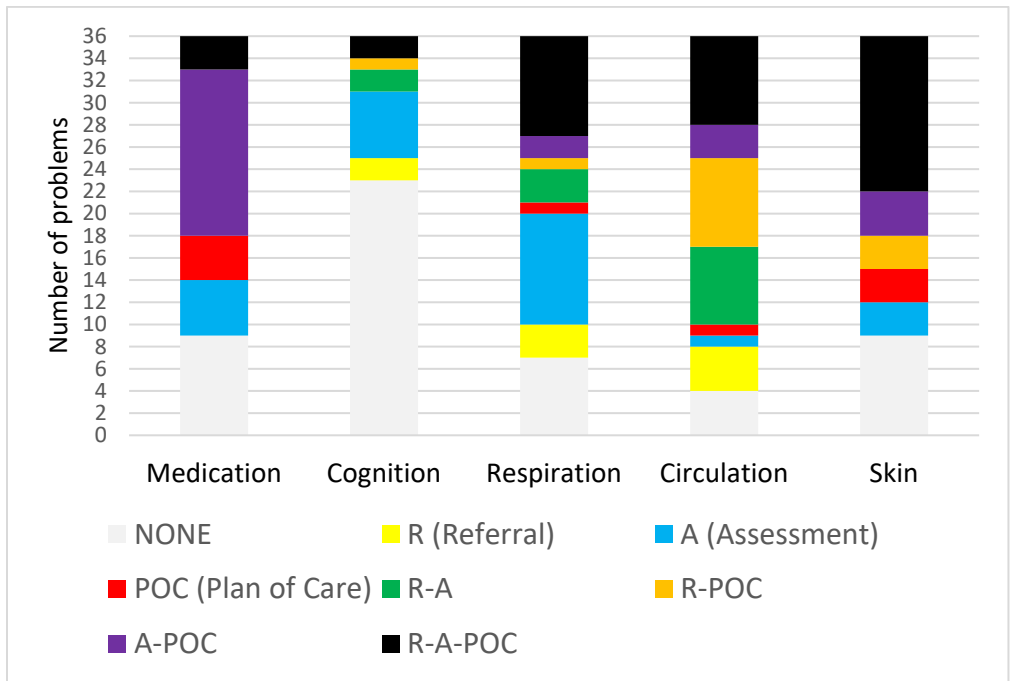

Figure 1. Frequency of Presence and Absence Phase Patterns by Omaha System problems

The referral phase. Problems appeared in the referral phase for only 54.7% of cases (R, R-A, R-POC, R-A-POC). Of the 27 patients who had wounds, referral documents communicated *Skin* problems, such as wounds, 17 times (63%).

The assessment phase. Problems appeared in the assessment phase in 75.8% of the cases (A, R-A, A-POC, R-A-POC); in 38.3% of cases, the problem first appeared in the assessment.

The POC phase. Problems appeared in the POC phase in 64.1% of the cases (POC, R-POC, A-POC, R-A-POC). In 7% of cases, problems appeared only on the POC.

Problem occurrence patterns. In 36 cases (28.1%), the problems appeared in all phases (R-A-POC in Figure 1). For the remaining 92 cases, problems appeared in some phases. In 9 cases (7%) a problem only appeared in the referral, in 25 cases (19.5%) only in the assessment, and in 7% only on the POC phase. 12 cases (9.4%) appeared in the referral and the assessment, 13 cases (10.2%) in the referral and the POC, and 24 cases (18.8%) in the assessment and the POC.

In aggregate, problems appeared in the referral and/or assessment and not in the POC in 46 cases (35.9%). Problems appeared in the referral and/or assessment and in the POC in 73 cases (57%). Across phases, problems appeared in the referral phase in 70 cases (54.7%) and appeared in the assessment phase in 97 cases (75.8%): these problems may have appeared in the POC phase.

Circulation appeared most frequently in the Referral (27) while Skin appeared for 17, Respiration 16, Cognition 7, and Medication only in 3. In the assessment phase, Circulation appeared for 19 patients (8 fewer) while the rest of the problem occurrences increased: Respiration appeared for 24 (eight more), Medication appeared for 23 (20 more), Skin appeared for 21 (four more), and Cognition for 10 (3 more). By the POC phase, Skin was the most frequent (24). Cognition was the least documented overall.

<u>Pattern concordance</u>. The proportions of concordant cases (absent or present in all phases) compared to the non-concordant ones (present in one or two phases) were significant for four problems: Cognition (25/36 vs. 11/36, X^2 = 9.39, df = 1, p = 0.002); Medication and Circulation (12/36 vs. 24/36, X^2 = 6.72, df = 1, p = 0.009), and Skin (23/36 vs. 13/26, X^2 = 4.500, df = 1, p = 0.034).

<u>EHR fields and functionality</u>. No EHR had structured referral data while all had structured data fields for recording assessment and POC problems. However, the rural agency nurses reported that the POC pull-down menus were cumbersome and instead documented in free text fields copied from external Word$^©$ templates. All EHRs required redundant documentation of problems in the assessment and in the POC. No EHR generated a problem list or alerted the nurse to mismatches between the problems identified in the referral or assessment phases and those placed on the POC. Therefore, incongruence alerts were not possible.

Visit pattern decisions

<u>Information availability</u>. Across the agencies, future visit pattern information was almost universally unavailable to the nurses in the Pre Visit and Visit phases. The exception was for two patients at the rural agency, where two SN facilities (SNF) included visit frequency information in referral documentation.

<u>Quantitative analysis</u>. Nurses did not always provide information in the pre-visit timeframe. From Pre Visit interview to Visit interview, both frequency (15 of 19 observations, 79%) and duration components of the visit patterns (10 of 19, 53%) changed. Nurses tended to make fewer visit pattern changes upon completion of EHR documentation (Visit to Post Visit: 6 of 19, 31% frequency decision; 3 of 29, 10% duration). Frequency changes from Visit to Post Visit were non-existent in the rural and urban agencies; over half the suburban observations had changes (6 of 11). Duration changes were more common from Pre Visit to Visit (10 of 19 observations, 53%), but not common from Visit to Post Visit (3 of 29 observations, 10%). The latter changes occurred only at the suburban agency.

A pattern unique to the urban agency responses was that all but one nurse (a specialized nurse) responded with similar frequency plans: 1 to 2, or 2 to 3 visits per week for each week. Also, all nurses replied with a duration of the maximum number of weeks in an episode.

Qualitative analysis. Fourteen group themes emerged to elucidate nurses' rationales for visit pattern changes. Below, we discuss the six most conspicuous group themes by phase with the referenced quote in Table 1.

Two Pre Visit themes were mentioned. *Information Deficit* refers to a lack of sufficient information to make a determination (quote H07): nurses preferred to physically assess the patient before making this decision (H10). The less frequent occurrence of *Information Deficit* in subsequent phases suggests the nurse collected all needed information during those phases. The *Nurse Experience* theme refers to reliance on nurse clinical judgement in decision-making. Nurses conceptualized an image of the patient based on the information provided and past experiences with similar patient profiles or conditions, and used their clinical judgement to decide (H11).

The Pre Visit and Visit phases shared two themes. *Policy Driven,* which referred to policies (e.g., *Insurance Restrictions* such as CMS reimbursement (P13)) or agency guidelines. The theme *Other Clinicians are Involved* referred to scheduling visits to accommodate a patient's clinical appointments. These appointments offer additional clinical 'eyes on the patient' between nurse visits (H05). Nurses schedule visits when there is no other clinician surveillance (H04). We observed when nurses had information about other clinicians' schedules they shifted visit days within the week and did not change the pattern.

The sole conspicuous Post Visit theme, *Patient is Stable,* incorporated information from the nurse's patient physical assessment and information gathering. Visits to a stable patient were to monitor recovery rather than perform nursing procedures, so as to reduce visit frequency (H07). Also, a care focus shift from acute to chronic condition management influences duration decisions (A04).

The *Acute Needs* theme was mentioned with comparable occurrence among all phases. Similar to *Patient is Stable, Acute Needs* refers to patient conditions that typically require increased time, attention, and equipment and therefore increased frequency (A04, A04, H06) and duration.

Few responses mentioned caregivers (i.e., *Quality of the Caregiver, Patient/Caregiver Education)*, patient considerations (i.e., *Patient Burden Consideration*, *Patient Caregiver Preference)*, or some scheduling factors (i.e.,

Frontloading, Depends on the Day, Staffing). Absent from responses was mention of documents or EHR as a source of patient information.

Mixed methods analysis. Mixed methods analysis gave context to the high rate of changes during the Pre Visit phase; nurses with an information deficit tended not to indicate the patient's future visit pattern, and relied on experience to form their decision. Accordingly, *Information Deficit* appeared frequently in this phase. Following patient interaction in the Visit phase, nurses changed the majority of decisions from the Pre Visit, as supported by the occurrence of patient condition themes in the Visit phase. In approximately four-fifths of cases in the Post Visit phase, nurses made no alterations to their Visit phase decision, indicating that visit pattern decisions tended not to change during the EHR documentation activity. Notable was frontloading nonappearance. One agency (one-third of observations) had a pattern of a consistent number of weekly visits which did not exemplify frontloading. Across agencies *Frontloading* was seldom mentioned.

Discussion

We discuss findings and offer related HIT and EHR recommendations for the three clinical decisions analyzed. A study strength lies in its design. We observed admissions, and collected and analyzed quantitative data in a field study at three diverse HHC agencies using a mixed methods approach. The analysis was limited to 36 patients. The patients were selected by the agencies based on nurse availability and patient agreement and as a result may not be representative of the typical HHC patient. Nurse effort might have been affected by nurse characteristics which were not controlled for, as nurses volunteered for the study. Future work to improve generalizability would add additional EHR systems.

HHC nurse information needs. Our investigation indicated that most of the information that HHC nurses said they *needed* at admission to support the four important clinical decisions were represented within the CCD/S. Nurses did not identify three of the additional four codes from the ONC Common Clinical Data Set as useful. Based on these findings we recommend using the existing CCD standard augmented with the CCDS code, *Assessment,* to electronically transfer the needed codes from the referral source to HHC. The intent is to improve the amount and quality of information available at the HHC admission.

We also recommend the addition of information about medication self-management capability to attain completeness, enable transmittal of structured data, and better meet HHC admission nurses' information needs. The lack of medication self-management information in referral documents was an important finding. Nurses reported needing this information to support all four clinical decisions. Missed medications, wrong doses, and other medication errors due to inability to self-manage medication can lead to adverse events and unfortunately are too common during transitions in care.(5) Patients who cannot self-manage medications may need to be visited earlier or more often, may need a social work consult to help with obtaining/affording medications, and could need medication management added to the care plan as a problem. Therefore, timely medication reconciliation would be important. Our study highlights the importance of this missing CCD concept, and that it be made explicit in the CCD instead of possibly being recorded in a subsection such as "Medication Instructions" or "Plan of Care". Explicit CCD specification would support data transmittal from the hospital EHR. Furthermore, patient medication self-management may be relevant in other settings, particularly mental health. Unfortunately, medication self-management information is not included in the impending USCDI standard.(55) Electronic transfer of this information could increase efficiency, prevent errors, and also alert nurses to patients likely to have issues with medications, a risk factor for readmission.(67)

This lack of medication self-management information indicates a need for communication of medication self-management capability data across settings to assist the next level of care in understanding what patient challenges exist. Receipt of physical function and cognition data as standardized measurements, as specified by the Impact Act, may reduce variability in assessment thereby improving the quality of these data for the HHC nurse. The Act requires a uniform comprehensive assessment across all post-acute care settings. However, acute care settings, a common HHC referral source, are excluded from the mandate.(68) At present, the Impact Act is not a solution to the absence of standardized patient assessment information across the transition from acute care to HHC.

The less than universal availability of information related to each CCD code needed for all four important clinical decisions indicates an information deficit during the transition in care to HHC. This deficit is of concern because making appropriate clinical decisions and providing safe patient care depends on having adequate and

accurate information (17, 69, 70). Patient outcomes and quality of care may be impacted by the quality and amount of information available to clinicians.(2, 71, 72)

We also found that approximately half of the CCD/S codes were not mentioned by nurses as being needed for the four decisions. We do not recommend that the unmentioned codes be removed from the CCD/S. Instead, we suggest future research expand the investigation beyond the four important decisions use cases to identify potential use.

Medication reconciliation. Medication changes were required in most observations (31 of 34) in three diverse HHC agencies, findings consistent with results from single-agency studies.(5, 29-32) Most changes were medications dropped, medications added, and dose or frequency/administration time changes. The nurse expressed the need to call the doctor and/or pharmacy to clarify these and other medication-related questions in two-thirds of observations. Required effort appeared to increase with polypharmacy, which was pervasive. Consistent with other studies, polypharmacy can lead to many medication discrepancies during transfer from hospital to HHC.(31) This could lead to increased risk for adverse drug events.(26)

Almost half of all medications were high risk, of which 41.2% had some type of changes made during reconciliation. This finding about high-risk medications highlights the potential serious clinical implications of medication list inaccuracy or errors and the importance of conducting medication reconciliation in the home soon after discharge for early issue identification. This timing is much earlier than HEDIS[73] and CMS(74) guidance of 30 days post transfer. However, a visit within 24 hours is not always possible or even available for most patients, underscoring the importance of carefully reviewing the medication list at the referral site to reduce risk of errors in the list provided to patients at discharge and communicated to the HHC agency.

Limitations include that nurses did not document their rationale for medication changes. The content of doctor and pharmacy calls could not be verified beyond what the nurses expressed due to the IRB approval.

Future research is warranted to study medication reconciliation impact on patient outcomes and whether reconciliation timeliness makes a difference. While investigating the referring site medication list development was outside the study scope, we urge exploration of solutions to increase medication list accuracy before communication to the patient and HHC. Other studies found significant medication list discrepancies between hospital EHR records and documents given to the patient upon discharge, suggesting the referring facility medication list may be inaccurate.(26, 75) Additional research should include reviewing medication reconciliation on admission and/or discharge from the referring facility, and assessing impact on HHC medication reconciliation. An integrated study combining the process of how the referring facility generates the medication list coupled with what changes are made in the home could provide great insights.

Problems to include in the plan of care. Using five common HHC patient problems, this study illustrates the extent to which patient problem information changes across the admission process phases. In almost three-quarter (71.9%) of the patient-problem cases, the problem list changed across the process. Four problems had statistically significant differences based on concordant patterns. Possible reasons and impacts of these incongruences are discussed.

Problems appeared less often in the referral phase (54.7% of cases). This indicates information underload which could result in inefficiencies and treatment delays such as if correct supplies or wound care orders are missing at the first visit. Monsen et al. identified the need for referral phase information about functional self-care abilities, health behaviors, and social determinants of health.(76) An interprofessional documentation standard such as the Omaha System could provide terminology to document patient needs in domains that cover these missing elements.(58, 77, 78)

One reason is that terms in the referral phase documents were medical diagnoses and lacked signs, symptoms, or patients' responses to medical conditions; information captured by the Omaha System terminology. For example, a referral document with only the ICD-10 code for heart failure. would not communicate other issues such as nutrition, fall risk, and pain and medication management issues. Additionally, in the assessment phase, the nurse documents in the OASIS which covers broader functional, service, and clinical domains to inform the POC.(79) While the referral document's focus is to summarize an acute care episode, our study and others(14) indicate a lack of the broader picture of patients' problems needed to support HHC and transition to self-care.

For example, *Cognition* was more frequent in the assessment than other phases. If it were in the referral, nurses may prioritize the timing of the first visit. Given that, in general, 32% of individuals in HHC have Alzheimer's or other dementias,(80) knowing about cognitive status prior to entering the home could improve safety and quality of care for a significant number of patients.

Problems not appearing in the assessment phase, but occurring in the POC (R-POC, POC) arose 17.2% of the time. An EHR that captures signs/symptoms and diagnoses from all documents and displays them throughout the admission phases could reduce missing or dropping critical information from the POC. Alternatively, the incongruence of problems that first appear in the assessment and make it to the POC (18.8% of cases) underscores the significance of the assessment in problem identification. For example, medication self-management is rarely communicated in the referral(81) and is an aspect of medication reconciliation during the home visit and is an important problem associated with readmission.(26)

We also saw 35.9% of problems appeared in the referral and/or assessment phases and did not appear on the POC. Included are 19.5% of problems which were discovered during assessment and did not appear in the POC. Critical respiration problem symptoms such as dyspnea were documented but did not appear on the POC in 10 of 29 (34.5%) cases. Reasons for purposeful problem exclusion from the POC include the problem was resolved/stable or of low priority relative to the patient's other problems. Because the HHC nurse documents by exception and the EHRs did not support problem descriptors, we could not determine the rationale (e.g., resolved, low priority), or if it was missed. Exploration of the reasons for incongruences were outside the scope of this document analysis. Future research is warranted.

Limitations. The analysis examined just 5 of the 42 Omaha System problems which may have biased findings, but it met our goal to illustrate data change and loss over time. Future work to improve generalizability would increase the problems examined.

Visit pattern decisions. Due to information unavailability, nurses enter the home unprepared to make the decision about the recommended visit frequency or duration, despite variation among agencies in the content, medium, and availability of referral and transition documents. Information needed to inform the decision as identified in nurse responses(50) and missing in referral documents included medication self-administration capability,(50) caregiver quality, and other clinician appointments. Needed information which might be in the referral documents was often incomplete, inaccurate,(82, 83) and scattered.(83) Examples include medical equipment, laboratory orders, wound appearance, and skin condition.

Based on a picture of the patient which emerged during the visit, decisions evolved causing nurses to re-think the care. Perhaps having better information earlier could help. Future research is needed to determine whether nurses rely on the in-home visit because it is the best information source, or due to the referral information deficit. For example, if nurses would rely on patient physician appointment information in the EHR instead of the patient or caregiver, a recommendation would be electronic communication of physician appointment information to the agency EHR.

Following patient assessment, in most cases the decision was unchanged when the nurse documented in the EHR. This change infrequency indicates documenting in the EHR does not have a discernable effect on the decision. The exception was the suburban agency which had changes from Visit to Post Visit. Further research is needed to determine whether changes were related to EHR use or care plan formulation.

Regarding frequency decisions, frontloading seldom appeared. This finding was unexpected considering the emphasis on this approach to reduce hospitalizations,(9, 41, 84, 85) and that frontloading is an evidence-based best practice. (44-48) Consistent with our results, frontloading has not been universally applied as indicated in recent national studies of heart failure (only 23% of patients received frontloaded nursing visits)(84) and sepsis patients (44.7%).(86) Also, frequency decisions were not changed due to coordination with other clinicians.

As for duration decisions, findings suggest nurses were constrained by agency convention which reflect CMS policy (*Insurance Restrictions)* as well as the home care agency procedures (*Policy Driven*): Nurses tended to plan that the patient have the maximum 60-day duration. The impact of CMS reimbursement for reduced episode duration on visit pattern decisions is unknown and warrants study. Future research could analyze Medicare data to assess 30-day episode impact on hospitalizations. Results could be compared to the hospitalization risk related to visit frequency and duration before the policy change.(42)

The pattern of consistent weekly visits for maximum episode duration among most nurses at an agency suggests the visit pattern plan was not meaningful. The plans lacked individualization, nurse decision-making, and communication about intensity of care to nurses who conduct follow-up visits. Future research would interview nurses to seek an explanation about the data and compare planned and actual visit patterns.

Due to the information deficit prior to the admission visit, nurses must quickly collect and process information and make visit timing and frequency decisions so as to inform patient expectations and plan the episode. Unknown is whether this information insufficiency impacts patient care or patient satisfaction, a future research question. If information insufficiency does have this impact, another area for future research is whether providing structured, formatted, and complete EHR data, that nurses use to make visit decisions before the admission visit, reduces the nurses' information deficit and supports patient care or patient satisfaction.

This study explored planned visit patterns: Out of scope was examination of the first visit's timing and actual visit patterns. Without the latter we cannot determine how visit patterns changed during the episode.

Interoperabilty. Considering current efforts to implement interoperability,(55) unexpectedly, our study did not find a statistically significant difference in information availability from referral sources with interoperability as compared to referral sources without interoperability. A possible reason is that the study may have been underpowered to detect a difference. Future research should support investigating generalizability by including more observations and agencies – both those with interoperability and those without interoperability. Another possible explanation is that interoperability is a nuanced concept along a number of dimensions. For example, we observed different levels of interoperability (i.e., electronic document, structured medication records) between agencies and within an agency. A third consideration is that interoperability does not guarantee the completeness of information transferred from the referral source. A fourth is that interoperability does not assure that the communicated data are structured. For example, while the urban health system had the functionality to electronically communicate structured clinical data, this capability was limited to sharing the medication list with the HHC. Therefore, the urban hospitals' EHR did not make available to the HHC EHR all structured data essential for the four clinical decisions. This unavailability of structured clinical information was not due to interoperability, as the communication was functionally possible. Instead this unavailability likely resulted from a decision constraining the data to be communicated along the transition in care. We suggest that while interoperability is necessary for information transmission along the transition in care, interoperability alone is not sufficient: Data standards implementation is needed for the information to be available.

The electronic communication of medication lists may have had a positive impact on referral site medication list accuracy, with fewer changes to medication dose, administration frequency and time of day, and tablet type. Interoperability was associated with a reduced number of calls to report a drug interaction risk or to review list details. These impacts indicate the value of interoperability in reducing the nurses' burden of updating the EHR medication list: "rework" that can be avoided. Most calls in observations with interoperable EHRs were made for reasons other than updating the medication list, including a new patient complaint or a mismatch with a stated clinical problem. A possible explanation was that nurses who had interoperable data may have had more time to address other questions (as explained by a nurse subject matter expert outside the study), since they had fewer discrepancies to address and did not transcribe medications. This explanation potentially underlines another positive interoperability impact on efficiency, quality of care, and patient safety. The interoperability findings emphasize the need for more research in this area. Interoperability helped but did not eliminate medication list changes or doctor calls.

Pharmacy calls to obtain the prescription status highlight the potential benefits of interoperability with the pharmacy. In both interoperable and non-interoperable observations, medications were not delivered to the patient prompting the nurse to express the need to call the pharmacy about medication status.

HIT and EHR recommendations. We recommend EHR redesign to capture structured CCD/S (or USCDI) data to eliminate intake nurse referral data transcription. Further research is needed to ascertain whether, if additional data were included in the CCD/S, nurses would use these data.

Medication reconciliation HIT opportunities include interoperable medication lists which could benefit the agency by reducing updating of the HHC EHR with medication lists. However, interoperability was not sufficient to eliminate issues identified during medication reconciliation. A combination of solutions may be needed, such as a medication list with structured data, a standard medication list format,(64) and order communication to the doctor and pharmacy for newly prescribed medication delivery. HIT supported pharmacy status updates to

HHC on doctor order reception and medication delivery might eliminate the need for calls about these issues: an opportunity for future research. Regarding doctor and pharmacy calls, future research could investigate whether EHR task management solutions are warranted to document and track call status.

Regarding problems to include in the POC, we offer 5 HIT recommendations. First, the EHR should enable the nurse to categorize problems along two dimensions: status (active, potential, or resolved problems),(58) and priority (high or low) as structured data. Problem status would provide a documentation trail for a purposeful omission from or addition to the POC. This capability would also facilitate alerts regarding errors of omission and provide rationale and context for changing the problem status or priority.

The EHR should enable the nurse to add problems (e.g., from an assessment) to the referral list of existing problems to produce a potential POC problems list. Also, the EHR should use a standard terminology for problem description such as the Problem Classification Scheme of the Omaha System.(58) This will enable electronic capture and communication and provide comparable, retrievable data across cases and agencies.

A second recommendation is that the EHR should make available the status of all patient problems. This recommendation would ensure that problems are not dropped or forgotten. For example, the Omaha System's Problem Classification Scheme supports communication and documentation of each problem's status, priority, and rating of the knowledge, behavior, and severity status over time.(58) Linking an abnormal finding to a corresponding Omaha System problem could support problem list generation and review. Documentation of problem status over time provides information to describe the population and measure progress.(87) Low priority or resolved problems may not be selected for the POC. No study EHR demonstrated these capabilities.

A third recommendation is for structured data for referral documents. Structured referral data such as diagnosis codes, signs and symptoms, medications, vital signs, and laboratory results could facilitate detecting problems.(39) Structured problem information in all phases could enable EHR logic to cross validate data and alert clinicians to changes across phases.

Nurses documented patient problems in the OASIS assessment and POC including signs and symptoms and patients' responses to medical conditions. These issues are addressed by the interprofessional team in HHC including physicians, nurses, social workers, and therapists. If the referring clinicians document problems in their EHRs,(88) problems could be communicated as structured data in standardized terminology to the HHC EHR. Documentation of hospital data as ICD-codes and HHC data as OASIS data would facilitate data communication in contrast to the impediments resulting from free text. The HHC EHR should support mapping medical diagnoses and OASIS data to an interprofessional terminology, such as the Omaha System. The Omaha System is integrated into interprofessional reference terminologies such as the National Library of Medicine's Metathesaurus, the Systematized Nomenclature of Medicine-Clinical Terms (SNOMED-CT), the Logical Observations Identifiers Names and Codes (LOINC),(58) and the nursing problem list subset of SNOMED CT.(89) Using standardized terminologies links all terms within a database to a reference terminology and supports interprofessional care planning, data retrieval and interoperability that are needed for managing the complex HHC patient.(78)

A fourth recommendation is that preliminary data (e.g., data in an admission record not yet finalized) be available to the care team in real time (i.e., without synchronizing data on the server and without finalizing the admission note). Team access to preliminary data should reduce the need for communication outside the EHR, such as email, and avoid communication delays. We echo Arbaje and colleagues' recommendation for centrally located care plan summaries for HHC clinicians.(17) The multiple and varied forms in use across referral sources and agencies are problematic.

Conclusions

Investigation of HHC nurse decision making and EHR use during the admission identified HIT opportunities to better meet nurses' information needs. These opportunities include improved HHC EHR design, standardized terminologies, and data sharing (interoperability). We recommend EHR design to enable the nurse to: (1) note problem status and make this status available; (2) add problems to the referral list of existing problems to produce a potential POC problems list; and (3) access centrally located POC summaries. The EHR should contain structured data at referral, assessment, POC; and make preliminary data available to the care team. Also, standardized terminologies should be used for referral documents, and throughout the EHR. Specifically, medical diagnoses and OASIS data should be mapped to an interprofessional terminology; and the EHR should

capture structured CCD/S (or USCDI) data. Adoption of standardized terminologies would enable terminologies mapping and interoperability among HIT systems, for referrals, physician appointments, and pharmacy status updates on doctor order reception and medication delivery. Enabling data sharing across settings would assist the next level of care in understanding the patient challenges.

List of Publications and Products

1.   Sockolow PS BK, Wojciechowicz C, Bass EJ. Incorporating home health care nurses' admission information needs: Informing data standards. J Am Med Inform Assoc. in press.

2.   Champion CL, Sockolow PS, Bowles KH, Potashnik S, Yang Y, Pankok C, Le N, McLaurin E, Bass EJ. Getting to complete and accurate medication lists during the transition to home health care. JAMDA. in press.

3.   Sockolow PS, Le N, Potashnik S, Bass EJ, Yang Y, Pankok C, Champion CL, Bowles KH. There's a problem with the problem list: Patterns of patient problem occurrence across phases of the home care admission. JAMDA. in press.

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