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High Prevalence of Medication Discrepancies Between Home Health Referrals and CMS 485 Plans of Care and its Potential to Affect Patient Safety in Vulnerable Elders

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Abstract

Background: Many homebound older adults require Home Healthcare (HH). Nurses in HH go to a patient's home, conduct an assessment and may request changes to the plan of care (including medications), which is returned to the referring provider for approval. To date, little research has examined prevalence of discrepancies in medication lists between HH referrals and the HH plan of care.

Objective: The study sought to describe prevalence of discrepancies between medication lists created by referring providers and HH nurses.

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Setting: Single large hospital and HH agency in the Western United States

Participants: 770 patients referred for HH from the hospital in 2012.

Design: The active medication list from the hospital at time of HH initiation was compared to the HH agency's plan of care medication list. We developed an electronic algorithm to compare the two lists for discrepancies.

Measurements: Prevalence was calculated for discrepancies including medications missing from one list or the other, and differences in dose, frequency, or route for medications contained on both lists.

Results: Patients were primarily male (96.3%) older (median age 71) and had multiple medical problems (median of 16 active problems). Individuals took a median of 15 medications (range 1–93). Every patient had at least one discrepancy: 90.1% of HH lists were missing at least one medication prescribed by the referring provider, 92.1% of HH lists contained medications not on the referring provider's list, 89.8% contained medications having naming errors. 71.0% contained dosing discrepancies, 76.3% contained frequency discrepancies.

Conclusions: Discrepancies between HH and referring provider lists are common. Future work is needed to address possible patient safety and care coordination implications of discrepancies in this highly complex population.

Keywords

Patient Safety; Medication Reconciliation; Care Coordination; Home Health; Transitional Care

Introduction

Medication errors are a leading cause of iatrogenic morbidity and mortality.¹ A large body of research has found medication errors may be particularly prevalent and dangerous during transitions in care, where multiple providers and settings are involved.^{2,3} Patients referred for home healthcare (HH) are often older with multiple chronic conditions, and are, by definition, limited in their functional capacity.⁴ Therefore, HH is an important domain in which to address potential medication errors for this vulnerable population.

Patients who are homebound as a result of recent illness or surgery often require HH services. Amongst other clinical data, HH referrals normally include a list of the patient's medications from the referring provider's records. After an assessment in the home, generally performed by a registered nurse, the medications actually being taken in the home are reviewed and included as part of a revised plan of care (CMS 485) that is sent to the attending provider. Changes may be requested by the HH clinician to this medication list (and other elements of the plan of care). Once approved or edited by the provider, the revised plan of care is returned to the HH clinician for them to enact and amongst other tasks, to educate patients and assist them with adherence. Discrepancies between the referring providers' records and HH records may occur frequently,³ and represent a significant *potential* source of harm to the patient that is not always addressed.

While we are unaware of a comprehensive list of the causes of medication discrepancies in this setting, common sources of errors include problem in recording the medication history,^{5,6} the referrer not being made aware of medications prescribed by outside providers,^{6,7} and patient factors such as adherence, or taking an over the counter medication, herbal remedy or supplement.⁶

A number of studies have examined interventions that are intended to reduce medication errors as patients transition from the hospital to HH. Some of these interventions have been efficacious; however, they often require intensive use of human resources and changes in clinical workflow.^{8,9} Our team is developing a web-based shared care plan that will facilitate the medication reconciliation and cross-disciplinary communication considered to be necessary to avoid medication errors, and reduce readmissions.¹⁰ The objective of this study was to describe the prevalence of different types of discrepancies between the records of referring providers and HH agencies. We therefore examined the prevalence of these different types of discrepancies across and within our sample of patients. The information presented in this paper will serve as a baseline for future testing of the web-based shared care plan intervention.

Methods

We collected data from patients who had been referred to a large HH Agency with a significant rural practice between January 1, 2012 and January 1 2013 by providers at a large regional hospital. The resulting dataset of 770 patients included demographic data on the patients (age, sex, and number of active problems) and a pair of medication lists for each patient: one extracted from the hospital electronic health active medication list at time of referral and the second from the HH agency's plan of care.

Medication discrepancies between the provider and HH lists are of different types and may occur for different reasons. For example, a medication may be on one list but not the other, or there may be differences in dose, frequency, form or route for the same medication between the two lists. We therefore developed an automated algorithm, implemented in the Ruby programming language, to compare the lists and determine for each medication whether there was a discrepancy and if so the type. This algorithm required three algorithmic phases: medication list alignment (i.e. pairing medications in the HH list with the referring provider list), concept extraction (i.e. finding and normalizing mentions of doses, frequencies, route), and detection of discrepancies between the concepts extracted from medication pairs.

The medication list alignment algorithm was created specifically for use with this study's HH referral data. The concept extraction and discrepancy detection algorithms used in this study have been evaluated previously using a corpus of outpatient prescription data from Partners Healthcare¹¹ in which they were found to identify errors in dosage with 90.3% precision and errors in frequency with 96.6% precision.

Phase 1: Medication list alignment.

Medications were aligned across the two lists for each patient based on the name field. A greedy matching algorithm¹² was used, finding the best single match for each referred medication (if one could be found), and removing the match from further consideration, resulting in a strict one-to-one mapping with some items potentially left over on one or both lists. Matches were based on various string similarity criteria and also semantic analysis using the RxNorm ontology.¹³

Phase 2: Concept extraction.

We used the MedAttrib Ruby library to extract and normalize mentions of the *Name*, *Dosage*, *Frequency*, and *Delivery Method* fields of each medication list entry. MedAttrib uses regular expression searches as well as terminology lists from public knowledge bases to identify these concept mentions¹⁴. For example, mentions of “2x daily” and “twice a day” would both be extracted from surrounding text and labeled with the normalized label *BID*. The original text data was annotated with the normalized labels for further analysis.

Phase 3: Discrepancy detection.

Once the medication lists were aligned and concepts were extracted, detection of discrepancies was a simple task. For each medication pair, and for each text field under consideration (*Name*, *Dosage*, *Frequency*, and *Delivery Method*), the extracted concept was compared. When there was a mismatch in the concepts, the algorithm recorded a discrepancy for the field in which the mismatch occurred for each medication pair.

To evaluate the accuracy of our algorithms in this dataset, we ran them on the medication lists from 30 randomly selected patients (681 total medication records) and manually inspected the output for accuracy.

Analysis

We used R statistical computing software for all analyses.¹⁵ To examine the patient demographics we calculated the median, range, and standard deviations of subject age, and number of active medical problems and also calculated the proportion of subjects who were male, racial and ethnic makeup, and who were living in geographically highly rural, rural, or urban areas.

We examined the prevalence of discrepancies across records as the proportion of paired patient medication lists with at least one of each type of discrepancy. The discrepancies we assessed included: medications on one list but not the other (on the referral list but not the HH, and vice versa) as well as differences in dose, frequency, form or route for the same medication between the two lists. For the purposes of this study discrepancies are defined as differences between the lists. Potential reasons for these differences and their significance are examined in the discussion section.

To examine the distribution of different types of discrepancies within patients, we calculated the median and range for the number of each type of discrepancy within the lists for individual patients. These numbers might be considered to represent the unadjusted risk that

such a discrepancy might occur when an individual patient is referred for HH services. We chose these statistics (rather than mean and standard deviation) because the number of discrepancies per patient was clearly not normally distributed; a small number of patients had very high numbers of discrepancies, leading to a distribution that was skewed to the right.

Results

To verify the accuracy of our medication alignment and discrepancy detection algorithms, we ran the algorithms on the medication lists from 30 randomly selected patients (681 medication records) and manually inspected the output for accuracy. We found that the alignment algorithm achieved 5.3% false negative rate, 0% false positive rate, 91.1% recall, and 100% precision. Similarly the discrepancy detection had a 3.7% false negative rate, 4.5% false positive rate, 95.5% recall and 80.9% precision. Upon completing the validation process, we performed our analysis on the full dataset.

The patient population in this sample (See Table 1) was overwhelmingly male (96.2%) older (median 71, SD 13.1), white (94.5%) and had multiple medical problems (median 16 average problems, SD 10.4). They were taking a median of 15 medications (SD 10.6). In this sample, we found a high rate of discrepancies of most types (See Table 2). Overall, 90.1% of patients had at least 1 medication that was not on the HH list but was on the provider list with a median of 4 medications prescribed but missing from the home health list. Similarly, 92.1% of patients had at least 1 medication that was on the HH list but not the provider list, with a median number of 4. There were also a significant number of discrepancies between the dosing (present in 89.8% of cases) and frequency (present in 71.0% of cases) of medications between the HH list and provider list; but relatively few discrepancies in route of administration (present in 0.8% of cases).

Discussion

In this study we examined the prevalence of medication discrepancies between HH referrals and HH plans of care through the use of an automatic discrepancy detection algorithm. To our knowledge, this is the first study to use an automated process in this setting, and our algorithm showed exceptional sensitivity and specificity, which increases its potential for use in clinical applications versus manual review. We defined medication discrepancies as any difference between the referring provider's medication list and the medication list included in the HH plan of care. Based on prior discussion with referring physicians we expected to find significant discrepancies; however, we were surprised that *every* patient record had some type of discrepancy. The most frequent discrepancies that we identified were medications that were on one list but not the other, followed by differences in dosage or frequency. These findings largely echo work performed by Corbett et al that found 94% of individuals in their sample of 101 patients discharged from a hospital to home health had a discrepancy,³ however, the depth and breadth of discrepancies was greater than Corbett previously reported and in a larger sample. Moreover, in that case they used a time intensive process of research nurses hand coding discrepancies, a process that is not practical in daily practice.

Many patients do not adhere rigidly to their prescribed medication regimen and may substitute, ration or otherwise change their medication list without provider approval.¹⁶ Additionally, a large proportion of patients enter HH from hospital discharge in which case the referring provider is not the primary care provider. During these transitions, there are often significant changes to the patient's medication regimen that the primary care provider may be unaware of, even if the primary care provider is aware of the hospitalization itself.¹⁷ Furthermore, many patients take over the counter medications and supplements that are often not accounted for in provider records^{18,19} but are on the HH list as the HH nurse has access to everything a patient is taking at home because they are physically in the home. Given this complexity, and the fact that homebound elderly generally have significant illness and multi-morbidity, understanding whether there are medication discrepancies, if they are being optimally medically managed, and if they are adherent has significant potential implications for both patient care and the healthcare system.^{2,20-22} It is this holistic view, focusing on all aspects of the care transition, shared care management and communication between the provider and HH agency that is key; medication reconciliation is but only one component.

Technology has not been previously used in HH to assist healthcare providers in understanding discrepancies or adherence between what is actually occurring in the home through report of the HH nurse and what the provider believes is occurring. This provides a significant opening for improving quality of care. Requiring providers to manually reconcile two lists is time intensive and often not performed. One study found a mean reconciliation by pharmacist taking 21.2 minutes (SD 13.2).⁵ By integrating electronic tools, such as this algorithm into care systems, providers can potentially better manage their time, resolve discrepancies, address adherence issues, and improve provider satisfaction.¹⁰

Future work

The prevalence and origins of medication discrepancies discussed above accentuate the need for clear and efficient communication between referring physicians and HH, to support care coordination and optimal medical management.

Our planned web-based shared care plan is intended to address this need. Use of the tool will begin with the referring provider creating a referral (including their medication list for the patient). As they perform an initial patient assessment HH clinicians will have electronic access to the referrer's medication list so that as they enter medications, discrepancies can be identified and an explanation provided as needed. For example, when a registered nurse finds a medication in the home that has been prescribed by another provider, the nurse could provide the name of the provider as well as other prescription data. Similarly, if prescriptions from the referrer are not found in the home the registered nurse would be able to note the missing medication and expedite a refill or renewal as needed. Patient concerns on adherence to dose and frequency can also be noted and communicated. When the HH medication list is electronically compared to the referring providers' list the discrepancies can be automatically highlighted and made salient. When the provider views the electronic comparison results the discrepancies are easily identified, and explanatory text could be viewed. This would support the provider in making a more informed decision on how to

proceed, ideally including an efficient method of communicating across providers to clarify and resolve discrepancies.¹⁰

Strengths and Limitations

This study has a number of strengths. First, this is one of few studies to examine the discrepancies between HH referrals and plans of care. Second, we used a validated electronic algorithm to measure these discrepancies, thus allowing for the replication of this work in other settings and for the application of the same algorithm to our web-based shared care plan. On the other hand, the limitations in this study primarily relate to its scope. Because of limitations in the patient-level data, we were not able address the clinical importance of the discrepancies that we counted or why the discrepancies occurred. In addition, the records for this study were drawn from a single referring healthcare facility and comparisons were performed using records from a single HH agency. Additionally, the patient population was largely demographically and regionally homogenous, and may limit generalizability. While these limitations suggest the need for further work, the input we have gathered both from physicians and HH registered nurses indicate that the problem of medication discrepancies is not a local problem and requires an efficient and scalable solution. Finally, while the sensitivity and specificity were quite high utilizing this algorithm, they are not high enough for use without clinician review. In developing a medication reconciliation module for HH we have therefore required HH clinicians to manually enter and reconcile portions of the medication record to ensure patient safety.¹⁰

Conclusions

We have estimated the prevalence of discrepancies between the medication lists of referring providers and HH agencies. Our results suggest that this is an extremely common *potential* risk to patient safety. Given the significant attention currently being paid to value based purchasing, effective care coordination and transitions, and reducing risk for rehospitalization, this study raises ample concern to require both further study and solutions. We are therefore in the process of developing an electronic intervention intended to address this problem, reducing potential risk from poor medication reconciliation and adherence.

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Table 1

Patient Demographics (N=770)

Descriptor	
Male Gender	745 (96.2%)
Age	Median 71 (22–94 (range))
Race	
White	726 (94.5%)
Black	20 (2.6%)
Asian	2 (0.3%)
American Indian	6 (0.8%)
Unknown	16 (2.1%)
Hispanic	
Yes	36 (4.7%)
No	728 (94.5%)
Unknown	6 (0.8%)
# of Medications	Median 15 (1–93(range))
# of Active medical problems	Median 16 (0–73(range))
Population Density in home	
Highly Rural	114 (14.8%)
Rural	189 (24.5%)
Urban	467 (60.6%)

Table 2

Medication Discrepancy Rates Between Referring Provider List and HH CMS 485 Certification Form

Descriptor	
HH does not include medication(s) on provider list N (%)	694 (90.1%)
Median number not on HH list N (range)	4 (0–41)
HH contains medication(s) not on provider list N (%)	709 (92.1%)
Median number not on provider list N (range)	4 (0–41)
Differences between lists in:	
Dosing N (%)	692 (89.8%)
Dosing Median number N (range)	1 (0–16)
Frequency N (%)	547 (71.0%)
Frequency Median number N (range)	2 (0–18)
Route N (%)	5 (0.8%)
Route Median number N (range)	0 (0–1)
Median number of medications having naming discrepancies between same medication between lists (e.g. trade vs generic name) N (range)	5 (range 0–28)