

Assessing Provider-Generated Free-Text Quality in EHR-Integrated Handoff Notes

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Abstract

Handoff notes are increasingly integrated within electronic health record (EHR) systems and often contain data automatically generated from the EHR and free-text narratives. We examined the quality of data entered by providers in the free-text portion of our institutional EHR handoff tool. Overall, 65% of handoff notes contained at least one error (average 1.7 errors per note). Most errors were omissions in information around patient plan/management or assessment/diagnosis rather than entry of false data. Factors associated with increased error rate were increasing hospital day number; weekend note; medical (vs. surgical) service team; and authorship by a medical student, first or fourth year resident physician, or attending physician. Our findings suggest that errors are common in handoff notes, and while these errors are not completely false data, they may provide individuals caring for patients an inaccurate understanding of patient status.

Keywords:

Patient Handoff; Patient Transfer; Electronic Health Records;

Introduction

Within patient care, a handoff refers to the process by which clinicians transfer the care of patients from one clinician to another. This process occurs with the transfer of patients between clinical settings, such as from the Emergency Department to the inpatient unit, or when patients transfer between different care teams without necessarily changing physical location, such as when daytime care teams change to nighttime “on-call” teams. This latter type of care transfer between the primary daytime team to the “on-call” team is recognized to be an important source of preventable medical errors [1].

Handoff notes are cognitive aids that are created in order to aid in the transfer of patient care from one clinician (or team of clinicians) to another [2]. Increasingly, handoff notes are being integrated within the Electronic Health Record (EHR), rather than existing as stand-alone documents outside of the EHR [2-4]. EHR-integrated handoff notes may be completely populated with data automatically generated from the EHR, but more often contain both automatically generated data as well as free-text narrative data authored by members of the care team [4]. Patient summaries and management plans are two of the most important items within handoff notes, and almost always require direct free-text entry rather than automatic generation from data in other parts of the EHR [5].

The goal of this study was to assess the quality of free-text narrative data in handoff notes generated by physicians within an institutional EHR in an academic inpatient setting. First, we sought to learn which providers and medical teams at our tertiary-care institution (composed of medical students, resident physicians in training, attending physicians, and Advanced Practice Providers (APP)) were authoring handoff notes. Then, we evaluated the quality of data in these free-text narratives by analyzing their accuracy and completeness using daily progress notes and other data within the electronic chart as the gold standard. Finally, we attempted to identify patterns in the frequency and types of errors encountered, and to ascertain factors associated with errors in free-text data.

Methods

Introduction of an EHR-integrated Handoff Tool

In June 2016, our institution introduced an electronic handoff tool incorporated within our institutional EHR (Epic Systems, Verona, Wisconsin, USA). This tool was optimized and locally adapted to be more user friendly and legible by a team of eight physician informaticists and two information technology builders. The design was based on prior experience with the handoff tool at several other peer academic institutions and work with several inpatient-based provider groups. The handoff tool template included two free-text text boxes, labeled “Patient Summary” and “To-Do”. Authors could enter free-text within either box. The handoff tool could be accessed and viewed within the EHR by any member of the care team, including medical students, resident physicians, APPs, and attending physicians. A print option was also available, which included any free-text entered in either the “Patient Summary” or “To-Do” boxes as well as automatically generated patient information, including patient demographics, vital signs, and laboratory data.

Obtaining Physician-generated Handoff Notes

Free-text data was collected from handoff notes each evening from 7-9PM during a six week period. Patients included were on both surgical and medical service teams in general inpatient units. Patients in critical care settings were not included. Daily handoff note collection began on the day of admission and continued each day until the day of discharge. In addition to the content of the handoff “Patient Summary” and “To-Do” free-text text boxes, we also collected data on the date and time of data entry, the author’s specialty and level of training, as well as whether the note occurred on a weekday or weekend.

The free-text information in the handoff note was then compared to the information in the patient chart, including daily progress notes, laboratory data, imaging studies, and orders, to assess for accuracy. In addition to assessing the accuracy of the free-text information written by handoff note authors, physician-raters also assessed for missing information omitted from the handoff note.

Prior to initiation of data collection, two physician-raters met and formulated an initial schema to define quality issues in handoff notes. Missing information was defined as any data missing from key portions of the patient's diagnosis and subsequent clinical course or key elements of the management plan. History and Physical Exam notes written on the day of admission and subsequent daily progress notes were used as the standard against which to compare the free-text data in the handoff note. In the initial schema, data included in the Assessment and Plan portion of the admission History and Physical Exam note or daily progress notes that was omitted from either the free-text "Patient Summary" or "To-Do" portions of the handoff note were deemed missing information. Missing significant results of imaging studies or laboratory tests, as well as notes from consulting medical teams were also defined as missing information. Again, the daily progress note and subsequent data generated throughout the clinical work day constitute basic information that should be included in the free-text portions of the handoff note. After this schema was defined, physician-raters separately reviewed thirteen daily handoff notes and compared their individual assessments. Differences in assessment were discussed and agreed upon, and the final schema was adjusted to account for the variation in physician-rater assessment.

After six weeks, the physician-raters had collected free-text information from 368 handoff notes. The quality of these notes was assessed using the aforementioned schema and errors were recorded. We then sought to describe the nature of the errors uncovered from free-text data in handoff notes, using a schema originally described by Arora and colleagues for assessing medication-related errors in handoff notes [6]. We adjusted the schema to fit our broader goals of defining both medication and non-medication related errors in handoff notes. Errors were initially classified as either errors of commission or errors of omission. Errors of commission were defined as those errors committed by authors where incorrect information was entered into the handoff note. For instance, an author may have entered "patient receiving ciprofloxacin" but on review of the active orders in the patient chart, the patient may have been on an antibiotic other than ciprofloxacin. Entered information that was no longer relevant was also classified as an error of commission. For instance, if the handoff note states "patient to receive chest CT if respiratory status declines" and review of imaging studies show that a chest CT had already been completed that day, this would also be deemed an error of commission. Errors of omission were those where a piece of clinically relevant information related to the diagnosis/clinical course or management plan was omitted from the free-text data in the handoff note (Table 1).

In addition to assigning errors as either those of commission or omission, errors were also grouped according to whether they were an error in assessment/diagnosis or an error in plan/management. Errors were assigned this label based on whether the information would more likely be included in the Assessment or the Plan portion of a traditional SOAP (Subjective, Objective, Assessment, Plan)-style daily progress note. For instance, errors regarding surgical procedures that

had occurred during hospital admission or important clinical events, such as the development of Acute Kidney Injury, were errors of assessment/diagnosis. Errors such as omitting that Gastroenterology was consulted or listing the wrong antibiotic for treatment of pneumonia were considered errors in management/plan.

Finally, errors were assigned as either "New" or "Continued". Errors appearing for the first time in handoff notes for a hospitalization were defined as "New", whereas the same error included in a patient's subsequent handoff notes was considered "Continued". After the number and types of errors were determined for each handoff note, the overall percentage of notes with errors were compared across disciplines, levels of training, hospital day, as well as if the note was written on a weekday or weekend.

Table 1 – Examples of Handoff Note Errors

Error	Data in Handoff Note	Data in EHR (Gold Standard)
Commission in Assessment/Diagnosis	Patient is post-operative day 0	Patient is post-operative day 2
Commission in Management/Plan	Patient is on ciprofloxacin	Patient is on piperacillin
Omission in Assessment/Diagnosis	No mention of deep vein thrombosis (DVT)	DVT diagnosed on day 4
Omission in Management/Plan	No mention of heparin drip	Heparin drip started for DVT on day 4

Table 2 – Handoff Note Author Demographics and Other Variables

Variable	Number (%Total)
Author	
Medical Student	28 (8%)
PGY-1	188 (51%)
PGY-2	99 (27%)
PGY-3	19 (5%)
PGY-4	10 (3%)
Attending physician	17 (4%)
APP	8 (2%)
Day of Week	
Weekday	269 (73%)
Weekend	99 (27%)
Clinical Service Team	
Medical	181 (49%)
Surgical	187 (51%)
Total	368 (100%)

Results

Handoff Note Demographics

Overall, 368 handoff notes were collected and evaluated during the study period. Handoff note authors ranged in level of training from medical students, to resident physicians in post-graduate years (PGY) 1 through 4, APPs (Nurse Practitioners and Physician Assistants), and attending physicians. The majority of handoff notes were written by resident physicians in PGY-1 (51%) and PGY-2 (27%) (Table

2). There was a nearly even distribution in handoff notes written on patients on internal medicine (49%) and surgery service teams (51%). Surgery teams included General, Bariatric, Colorectal, Thoracic, Transplant, Gynecology, and Ear Nose and Throat (ENT) surgery. The majority of the handoff notes were written on Hospital Day (HD) 1 (27%) and HD2 (21%). Among those patients included in our study, length of stay ranged from 1-25 days.

Handoff Errors

Overall, 635 errors were discovered in 368 handoff notes, an average of 1.7 errors per handoff note. In 65% of handoff notes, at least one error was found. The vast majority of errors were rated as either plan/management omission (54%) or assessment/diagnosis omission (32%). There were far fewer errors of commission in both plan/management (12%) or assessment/diagnosis (2%). Of the omissions in plan/management, nearly half (48%) were rated as “New” errors. Only 32% of omissions in assessment/diagnosis were rated as “New” errors, with the majority (68%) being rated as “Continued” errors. Over half of the errors of commission in plan/management (59%) and assessment/diagnosis (60%) were rated as “New” errors (Table 3).

Table 3 – Errors in Handoff Notes

Type of Error	Number (%Total)	New Errors (%)
Omission in Plan/Management	343 (54%)	165 (48%)
Omission in Assessment/Diagnosis	201 (32%)	65 (32%)
Commission in Plan/Management	76 (12%)	45 (59%)
Commission in Assessment/Diagnosis	15 (2%)	9 (60%)
Total	635 (100%)	284 (45%)

Error Rate and Type by Hospital Day

The rate of having at least one error detected in a handoff note and the average number of errors per note increased with each subsequent day in the hospital. Forty-seven percent of handoff notes written on HD1 had at least one error detected with an average of 0.9 errors per note. This increased to 57% on HD2, with 1.19 average number of errors per note. A subsequent increase was noted on HD3, 4, and 5 as well, where 65%, 74%, and 78% of notes, respectively, had at least one error detected (Table 4). Average number of errors per note also increased, with 1.69, 1.91, and 2.26 errors respectively. Handoff notes written on HD6 or later had the highest rate of errors (86%), and the highest average number of errors per note (2.95) (Table 4).

The types of errors also changed with increasing hospital day. On HD1, 61% of errors were omissions in plan/management and 22% were related to omissions in assessment/diagnosis. Only 6% were errors of commission in plan/management and 2% errors of commission in assessment/diagnosis. This distribution of types of errors stayed relatively consistent for HD2-5 (Table 5). However, for handoff notes written on HD6 and beyond, omissions in plan/management decreased (42%

of total errors) while omissions in assessment/diagnosis increased (44% of total errors) (Table 5).

The percentage of errors that were rated as “New” versus “Continued” also changed with increasing hospital day. On HD2, 76% of omissions in plan/management and 55% of omissions in assessment/diagnosis were rated as “New.” By HD6 and beyond, only 17% of omissions in plan/management and 13% of omissions in assessment/diagnosis were rated as “New” (Table 5).

Table 4 – Errors by Hospital Day, Day of Week, Clinical Service and Provider Level

Variable	Total Number of Errors	Percentage of Notes with Error	Average Number of Errors per Note
Hospital Day			
1	88	47%	0.90
2	92	57%	1.19
3	91	65%	1.69
4	67	74%	1.91
5	52	78%	2.26
6+	245	86%	2.95
Day of Week			
Weekday	457	62%	1.70
Weekend	245	86%	2.95
Clinical Service			
Medical	374	72%	2.07
Surgical	259	55%	1.39
Provider			
Medical Student	62	85%	2.38
PGY-1	310	68%	1.65
PGY-2	137	54%	1.38
PGY-3	19	47%	1.0
PGY-4	14	70%	1.40
APP	7	38%	0.88
Attending Physician	72	82%	4.24
Overall	368	65%	1.7

Error Rate and Type by Weekday versus Weekend

Handoff notes written on a weekend had a higher rate of having at least one error detected (73%) and higher average error (1.8) versus those notes composed on a weekday (62% error rate and 1.7 average errors) (Table 4).

Omissions in plan/management accounted for 56% of errors in handoff notes written on weekdays, and 48% of errors in notes written on weekends. Omissions in assessment/diagnosis accounted for 32% of errors in both weekday handoff notes and weekend handoff notes. Sixteen percent of errors in handoff notes were related to errors of commission in plan/management on weekends, versus only 11% of errors on weekdays.

Error Rate and Type by Service Team

The percentage of notes with at least one error detected and average number of errors detected per handoff note varied by service team. Fifty-five percent of handoff notes written by authors on surgical service teams had at least one error detected, and an average of 1.39 errors per note. In contrast, 72% of handoff notes written by authors on medical service

teams had at least one error detected, with an average of 2.07 errors per note (Table 4).

Sixty-six percent of errors in handoff notes on medical service teams were omissions in plan/management, while only 37% of errors on surgical service teams were omissions in plan/management. Conversely, on surgical service teams 44% of errors were omissions in assessment/diagnosis while on medical service teams omissions in assessment/diagnosis accounted for only 23% of errors.

Table 5 – Distribution of Error Types by Hospital Day

HD	Plan/Management Omission (%New)	Assessment/Diagnosis Omission (%New)	Plan/Management Commission (%New)	Assessment/Diagnosis Commission (%New)
1	61% (100%)	22% (100%)	6% (100%)	2% (100%)
2	59% (76%)	22% (55%)	17% (94%)	2% (100%)
3	56% (35%)	27% (56%)	13% (67%)	3% (67%)
4	64% (42%)	24% (25%)	7% (75%)	4% (33%)
5	62% (38%)	23% (17%)	15% (50%)	0
6+	42% (17%)	44% (13%)	12% (31%)	2% (40%)

Error Rate and Type by Training Level of Author

The majority of handoff notes were written by resident physicians in PGY-1 or PGY-2. Sixty-eight percent of handoff notes written by PGY-1 physicians had at least one error detected, just slightly above the overall rate of 65% for all training levels. Fifty-four percent of handoff notes written by PGY-2 physicians had at least one error detected. PGY-1 physicians had an average of 1.65 errors per handoff note and PGY-2 physicians had an average of 1.38 errors per note. Overall, there were an average of 1.73 errors per handoff note for all authors (Table 4).

Nearly half of errors in handoff notes (49%) written by PGY-1 physicians were omissions in plan/management, while well over half (60%) of errors in notes written by PGY-2 physicians were omissions in plan/management. Thirty-three percent of errors were omissions in assessment/diagnosis for PGY-1 physician-generated notes, and 20% of errors were omissions in assessment/diagnosis for PGY-2 physician-generated notes.

Only 8% of handoff notes were written by medical students, with an average of 2.38 errors per note. Of these notes, 85% had at least one error detected. PGY-3 and PGY-4 physicians authored 5% and 2.7% of notes, respectively. Forty-seven percent of handoff notes authored by PGY-3 physicians and 70% of notes authored by PGY-4 physicians had at least one error detected.

Few notes were authored by attending physicians or APPs. Eighty-two percent of handoff notes authored by attending physicians had at least one error detected, with an average of 4.24 errors per note. Thirty-eight percent of handoff notes written by APPs had at least one error detected, with an average of 0.88 errors per note.

Discussion

In the present study, we analyzed free-text data within a series of handoff notes written using an EHR-integrated handoff tool. The majority of authors were PGY-1 or PGY-2 physicians. Over half of the errors encountered were omissions in plan/management and nearly one third were omissions in assessment/diagnosis, reflecting a lack of completeness, rather than gross inaccuracies, as the major source of error. When examining the errors of commission in plan/management that had been entered into handoff notes, 63% (47 out of 75) were due to failure to update a previously accurate plan that had since changed. Again, this shows that a major contributor to false information was the failure to update previously true information, rather than the direct entry of erroneous data. This points to a deficiency in effort on the part of handoff note authors, rather than a deficiency in knowledge, as a major cause of inaccurate and incomplete data in handoff notes.

The Role of Hospital Day and Information Decay

A major contributor to the amount of errors detected in handoff notes was the length of hospital stay, with increasing days correlating with increasing errors. Forty-seven percent of handoff notes had at least one error detected on HD1. By HD6 or beyond, 86% of handoff notes had at least one error detected. Increased length of hospital stay correlated with an increased risk of errors as new clinical information is gained, along with a higher probability of propagating previous errors. Arora et al noticed this in their study of medication discrepancies, noting that 63% of errors persisted beyond their index case (6). This corresponds to our data, where 24% of omissions in plan/management and 45% of omissions in assessment/diagnosis were rated as “Continued” on HD2, yet by HD6 and beyond, 83% of omissions in plan/management and 87% of omissions in assessment/diagnosis were rated as “Continued.” Interestingly, the majority of errors initially were omissions in plan/management, but by HD6 and beyond, there were nearly equal omissions in assessment/diagnosis. This reflects the fact that while authors were relatively accurate at recording initial diagnoses and clinical events, accuracy waned as hospital day, and presumably clinical complexity, increased.

Weekday versus Weekend Handoff Notes

Handoff notes from weekends were more likely to have at least one error (73% vs 62%) and had a higher average number of errors per note (1.80 vs 1.70) compared to notes written on weekdays. Other clinical phenomena have been associated with weekend care. Admissions and surgical interventions on weekends have previously been associated with higher mortality [7], length of stay [8] and hospital-acquired conditions [9]. These associations could be due to decreased numbers of physicians on weekend care teams. With fewer physicians present to aid in clinical work, those physicians who are present may prioritize other clinical activities at the expense of updating handoff notes.

The Role of Clinical Service Team and Author Training Level

To our knowledge, this is the first study to compare rates of errors in handoff notes by specialty. Handoff notes for patients on medical service teams were more likely to contain at least one error (72% vs 55%) and had a higher average number of errors per note (2.07 vs 1.39) compared to surgical

service teams. One possible explanation is the level of training of the authors. All attending physicians, who had the highest rates of errors, were on medical service teams while the vast majority of APPs, who had the lowest rates of errors, were on surgical service teams. Notably, medical service teams were more likely to omit items from plan/management while surgical teams were more likely to omit items from assessment/diagnosis, possibly reflecting differences in handoff data prioritization between specialties.

The percent of handoff notes with at least one error detected, as well as average number of errors per note, varied by author level of training. Increased training initially correlated with improvements in error rate, with PGY-2 and PGY-3 physicians having fewer errors than medical students or PGY-1 physicians. The benefits of increased training, knowledge, and clinical acumen could account partially for the improvement in handoff note errors. However, increased training beyond PGY-3 (PGY-4 and attending physicians) was associated with a higher error rate. This could reflect that more experienced physicians (beyond PGY-3) rely less on the handoff note as a comprehensive summary of the patient's clinical course and management plan and thus require a less granular version to serve its purpose as a cognitive aid [10]. This also suggests that physicians-in-training interface with the EHR in a qualitatively different way as training progresses and attending-level status is reached [11].

Study Limitations

While the handoff note represents an important cognitive artifact, there are other verbal aspects of the handoff process that we could not evaluate in this study. Further studies might include a focus on both the verbal and written aspects of handoff. Studying handoff notes at different timepoints throughout the year may also show a difference in error rates, especially at teaching institutions where physicians-in-training progress in their clinical acumen throughout the year.

Finally, this study utilized a schema we devised to determine what information was important for inclusion in the handoff note. Decisions about the accuracy and completeness of handoff notes were based on information recorded in the remainder of the electronic chart. Further work might include a larger body of physician-raters from various specialties and training levels to further validate the present methods.

Conclusions

Increasingly, handoff notes are being integrated within the EHR. We found free-text data in EHR-integrated handoff notes frequently contain errors. The majority of these errors are related to the omission of information regarding both plan/management and assessment/diagnosis. Far fewer errors are directly related to the entry of erroneous information. Further work should focus on efforts to increase the ease with which accurate handoff notes can be generated. This will rely on efforts from clinicians, members of the health IT community, and experts in human factors to ease the process of generating high-quality handoff notes, rather than simply increasing the amount of automatically generated data in the handoff note. It will also involve improvements in clinician training, emphasizing the importance of high-quality handoff notes and recognizing the relevance of these notes in providing high-quality patient care.

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