HOSPITAL MEDICINE

Medication Discrepancies in Resident Sign-Outs and Their Potential to Harm

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BACKGROUND: The accuracy of information transferred during hand-offs is uncertain.

OBJECTIVE: To describe the frequency, types, and harm potential of medication discrepancies in resident-written sign-outs.

DESIGN: Retrospective cohort study.

PARTICIPANTS: Internal Medicine interns and their patients at a single hospital in January 2006.

MEASUREMENTS: Daily written sign-outs were compared to daily medication lists in patient charts (gold standard). Medication discrepancies were labeled *omissions* (medication in chart, but not on sign-out) or *commissions* (medication on sign-out, but not in chart). Discrepancies were also classified as *index errors* (the first time an error was made) and the proportion of index errors that persisted on subsequent days. Using a modified classification scheme, discrepancies were rated as having minimal, moderate, or severe potential to harm.

RESULTS: One hundred eighty-six of 247 (75%) patients and 10 of 10(100%) interns consented. In the 165 (89%) patients' charts abstracted and compared with the sign-out, there were 1,876 of 6,942 (27%) medication chart entries that were discrepant with the sign-out with 80% (1,490/1,876) labeled omissions. These discrepancies originated from 758 index errors, of which 63% (481) persisted past the first day. Omissions were more likely to persist than commissions (68% [382 of 580] vs 53% [99 of 188], $p < .001$). Greater than half (54%) of index discrepancies were moderate or severely harmful. Although omissions were more frequent, commissions were more likely to be severely harmful (38% [72 of 188] vs 11% [65 of 580], $p < .0001$).

CONCLUSIONS: Written sign-outs contain potentially harmful medication discrepancies. Whereas linking sign-outs to electronic medical records can address this problem, current efforts should also emphasize the importance of vigilant updating in the many hospitals without this technology.

KEY WORDS: medication discrepancy; sign-out; hand-off; transition.

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BACKGROUND

Inaccurate documentation or unclear communication between physicians often leads to uncertainty in patient care decisions and may compromise patient safety. This is especially true with respect to maintaining an accurate medication list during times of transition, especially during the transfer of clinical responsibility for hospitalized patients from 1 inpatient physician to another. This process, also known as sign-out (pass-off, hand-off, etc.) in academic teaching hospitals, embodies the written and verbal transfer of patient information.¹ Residents often prepare and use sign-out documents to summarize clinical information about their patients to aid in the hand-off process. These documents are then given to covering physicians who may use them as a reference to aid in patient care as medical issues arise during their coverage. Despite the importance of these documents, studies suggest that these written sign-outs often suffer from omitted or inaccurate information.^{1,2} Although sign-out is a nearly universal practice in academic medical centers, the best way to synchronize this auxiliary repository of clinical information with the medical record remains an open question.

Little is known regarding the frequency and types of medication discrepancies that occur during hand-offs. Therefore, we aim to assess the frequency of medication discrepancies during the hand-off process by comparing the medications listed on a resident sign-out to those the patient is currently taking, as noted in their chart. We also aim to describe the types of medication discrepancies and determine whether these medication discrepancies are clinically significant, i.e., having the potential to harm patients.

METHODS

Study Design and Subject Selection

We conducted a retrospective study to characterize the frequency, type, and potential impact of medication discrepancies between patient charts and resident sign-outs. All inpatient general medicine interns and the patients that they cared for

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at a single academic teaching hospital from January 1 to 29, 2006 were eligible for inclusion in this study. Patients were approached for consent to perform a chart review examining quality of care and resource allocation as part of a larger ongoing research protocol.³ Eligible patients were treated by 5 attending-led inpatient general medicine teams consisting of 1 resident and 2 interns who were on-call every fifth night. During call periods, the resident and interns admitted new patients and provided cross-coverage for the patients of the other 4 teams after interns received a hand-off, which included the receipt of a written sign-out from the interns from the other teams.⁴ We excluded patients who were treated by a nonresident team (i.e., nonteaching Hospitalist service) or were admitted for less than 1 day because a resident may not generate a sign-out for a patient that they do not expect to hand off. To avoid a Hawthorne effect, first year resident physicians were asked to provide oral consent after the completion of their rotation to abstract the medications for those consented patients listed on their daily sign-outs, which had been automatically archived daily on a hospital electronic server.⁵ This study protocol has been approved by the University of Chicago Institutional Review Board.

Data Collection and Analysis

For those patients and residents who consented, daily medication lists were abstracted from both resident sign-outs and patient charts. Daily sign-out files (Microsoft Word, Seattle, WA) from first year resident physicians (interns) on resident teams (A-E) were accessed from an electronic archive maintained on a hospital server. Patient charts contain a daily medication administration record (MAR), which is a computer-generated daily list of what the patient is taking. The MAR is then annotated daily by nurses to confirm that medications were given at the appropriate time and to reflect any changes (medications held, discontinued). MARs were abstracted from charts of patients who consented to medical record review. Medication information (name, dose, unit, route, frequency, prn, hold, etc.) from sign-outs and charts, as well as the date, day in the resident call cycle (pre-call, on-call, etc.) and additional comments were abstracted into a Microsoft Excel file. We defined a medication discrepancy as any difference between the sign-out and chart (e.g., omissions, commissions, incorrect drug name, dose, frequency, or route). Descriptive statistics were performed, and error rates in medications for omission (medication listed in chart, but not on sign-out) and commission (medication listed on sign-out, but not in chart) were calculated. Because we compared sign-outs that were

electronically archived to an annotated medication list (MAR) in the chart, it is possible that medication changes in the chart were recorded by hand on the sign-out (by a primary or covering physician) and therefore not listed in the sign-out we used in the electronic archive. Therefore, we calculated discrepancy rates after providing a 24-hour grace period to account for the potential to update the sign-out. Because certain medications listed in the chart may have been annotated during that day as "held" for a one-time dose but not discontinued, medications on-hold were not included in the discrepancy rate. Day of discharge and interns' call day were excluded as interns may not expend effort to update their sign-out if the patient was being discharged or if they were the on-call physician. Lastly, because some discrepancies may have been caused by the use of generic drug names in the MAR with interns using corresponding trade names, a manual review of all discrepancies was performed to account for this problem.

Discrepancies were then recoded to identify index errors (the first time an error was made) and the proportion of index errors that persisted on subsequent days. A classification scheme, based on an earlier study of medication discrepancies at hospital admission, was generated for to categorized discrepancies into 3 levels of potential harm (minimal, moderate, or severe potential to harm).⁶ The discrepancies were coded in the context of a cross-coverage call to a physician who is likely unfamiliar with the patient and using the sign-out as the sole source of information to initially manage medical issues. This assumption was made as interns on-call may receive pages while admitting or evaluating a new patient in the emergency department, writing orders, looking up labs, or retrieving previous medical histories from the electronic data repository. Whereas it is possible that an intern may delay a clinical decision to first locate the chart and examine the medication record for a patient, the overwhelming majority of cross-coverage pages to an intern are initially managed over the phone using the sign-out as the sole source of information. Examples of the varying degrees of harm in clinical context are provided in Table 1.

For 29 patients (15%) of the sample, discrepancies were independently examined by 2 physician investigators (DL, VA) to apply the classification scheme. The purpose of this initial manual application of the classification scheme to a subset of the patients was to examine if the classification captured all possible types of discrepancies and if there were any other issues that needed to be taken into account (other medications or dosage issues). Any discrepancies that could not be classified were then examined by the reviewers, and the scheme was revised to incorporate capturing that type of

Table 1. Classes of Harm for Medication Discrepancies

Class of harm	Description	Examples
1	Unlikely to cause patient discomfort or clinical deterioration	Vitamins, laxatives or stool softeners, acetaminophen, stress ulcer prophylaxis
2	Potential to cause moderate discomfort or clinical deterioration	Oral antibiotics, oral antihypertensives, oral hypoglycemic agents, oral analgesics except narcotics, oral neurologic agents (antipsychotics, antidepressants), sliding scale insulin, prophylactic dose anticoagulants
3	Potential to result in severe discomfort or clinical deterioration	Intravenous antibiotics, intravenous antihypertensives, intravenous analgesics and oral narcotics, intravenous neurologic agents (antipsychotics, antidepressants), standing dose insulin, full dose anticoagulants (any route), oral or intravenous immunosuppressants

discrepancy. The final classification scheme was based on a combination of factors including drug class, drug name, and route. For example, omission of intravenous antibiotics was rated with potential to cause severe harm, whereas omission or commission of a po antibiotic was rated with potential to be moderately harmful.

The remainder of the data was classified using an automated program, which identified discrepancies and assigned the harm classification based on the medication name, drug class, and route. All harm classifications were then manually reviewed by 2 physician investigators together to ensure that the program correctly classified the discrepancy. Demographic characteristics of patients were also summarized using descriptive statistics. All statistical tests were done using Intercooled STATA 8.0 (College Station, TX, USA) with statistical significance defined as $p < .05$.

RESULTS

During the month of January 2006, 497 patients were hospitalized on the inpatient general medicine service. Of the 403 (81%) patients approached for consent, 281 (70%) were on resident teams. Ten (100%) intern physicians rotating on the inpatient general medicine service and 242 (86%) patients that these interns were caring for agreed to participate in this study. One hundred eighty-six (77%) consented patients had both medical charts and patient sign-outs available for review for a total of 576 patient-days reviewed. The patients had a mean age of 57 years, were predominantly female (61%), and African-American (56%). For the 186 patients that we reviewed, 6,942 medication entries (medications on the chart) were abstracted. On average, patients had 56 medication entries during their length of stay with an average of 13 medications per patient per day. A medication entry in this study is defined as 1 medication taken for 1 day.

After accounting for a 24-hour grace period to update sign-outs, 1,876 (27%) of entries contained a major medication discrepancy, either an omission or a commission. The vast majority (80% [1,490 of 1,876]) of these discrepancies were omissions. When performing analyses for each patient-day, an average of 21% (95%CI=19.5–22.2) of medications from the chart

Table 2. Frequency and Persistence of Medication Omissions and Commissions

Type of error	Total	Omission, n (%)	Commission, n (%)	p value
Discrepancy*	1,876	1,490 (79)	386 (21)	.0001
Index error*	776	588 (76)	188 (24)	.0001
Persistent error†	496	397 (68)	99 (53)	.0002

*Errors classified as omissions (medication in chart, not on sign-out) or commissions (medication on sign-out, not in chart). Percentages of discrepancies and index errors are reported out of total number of discrepancies and index errors, respectively.

†Discrepancies recoded to identify index errors (the first time an error was made), and the proportion of index errors that persisted on subsequent days. Percentage of persistent errors is reported as the percentage of index errors that persist after 24 hours.

‡p values reported for 2 sample tests of proportions comparing rates of omissions to commissions.

Table 3. Medication Index Errors and Potential to Harm

Potential to harm*	Total	Omission, n (%)	Commission, n (%)	p value
Minimally harmful	365	292 (49)	73 (39)	<.001
Moderately harmful	274	231 (35)	43 (23)	<.001
Very harmful	137	65 (11)	72 (38)	<.001
Total	776	588	188	

*Potential to harm rated by 2 physician investigators using prior classification scheme.

†p values reported for 2 sample tests of proportions comparing rates of omissions to commissions.

were omitted from a patients' daily sign-out and 5% (95%CI=4.4–5.9) of medications listed on the patients' daily sign-out were committed. In fact, 80% of daily sign-outs for a patient contained at least 1 omission and greater than a third (37%) of daily patient sign-outs contained at least 1 commission.

These discrepancies originated from 776 index errors of which nearly two-thirds (63% [496]) persisted past the first day. Of note, omissions were more likely to persist than commissions (68% [397 of 588] vs 53% [99 of 188], $p < .001$; Table 2). Greater than half (54%) of index discrepancies was potentially harmful (potential to cause moderate or severe harm). Although index omissions were more frequent, index commissions were more likely to be severely harmful (38% [72 of 188] vs 11% [65 of 588], $p < .0001$; Table 3). Omissions were also more likely to persist (397 of 588 [68%] vs 99 of 188 [53%], $p < .0001$). However, a greater fraction of persistent commissions were very harmful (35 of 99 [35%] persistent commission vs 31 of 197 [8%] persistent omissions). In fact, very harmful omissions were less likely to persist than less harmful omissions (31 of 65 [48%] very harmful persist vs 366 of 523 [70%] less than very harmful persist, $p = .004$). In contrast, there was no association between harm of commissions and their likelihood of persisting (35 of 72 [49%] very harmful persist vs 62 of 112 [55%] less than very harmful persist, $p = .473$).

Whereas not the primary aim of this analysis, roughly 50% of medication entries listed had an omission in dose, frequency, or route with the bulk of these being omissions in route. Incorrect dose, frequency, or route in sign-out medications was much less of a problem, occurring roughly 12% for all medications listed. Whereas rates of index omissions and commissions did vary by intern, these differences were not statistically significant.

DISCUSSION

To our knowledge, this is the first study to quantitatively report the frequency, type, and harm potential of medication discrepancies between patient charts and resident-written sign-outs on the general medicine service at an academic hospital. Medication discrepancies are common with medication omissions more frequent than commissions. Although medication omissions are more likely to persist, a higher proportion of both index and persistent commissions has the potential to be very harmful. More than half of all discrepancies had the potential to cause significant harm to patients. These results suggest the urgent need to improve current methods of information transfer during patient hand-offs.

However, before improvements can be made, it is important to consider how and why such errors occur, and what their significance is. First, transfers of clinical responsibility occur frequently in hospitals, making it difficult for physicians, including residents, to keep their sign-outs up-to-date on a daily basis. In addition to daily progress notes that physicians write in the medical chart, sign-out is a parallel record that requires daily updates and maintenance. Furthermore, the majority of these index omissions and commissions persist on subsequent days, suggesting that vigilant efforts are not being made to keep the sign-out updated. One possible explanation for the high rate of persistent errors is that residents consider certain medications less important to keep track of, choosing to omit them. This likely explains the finding that persistent errors in omissions were less harmful than those that did not persist. In contrast, it is hard to imagine an intentional commission, which may explain why commissions, when present, are more likely to be serious than omissions.

It is also worth considering these findings and their implications in the context of a broader model of medical information. Whereas technological solutions will likely address medication discrepancies by linking to certain fields such as medications, allergies, and code status from medical records, certain fields which require human input such as pertinent historical data (recent problems, surgeries, recommendations, overnight events, etc.) will still depend on physician updating. This is of critical importance given the ease with which erroneous medical information can persist that is suggested by our findings. Furthermore, a major problem noted with the implementation of medical records is the ease of "cut-and-paste", suggesting how erroneous outdated clinical information can be perpetuated.⁷ This discussion highlights the burden that multiple updates impose on clinicians and the difficulty of manually synchronizing different information repositories. Improving the accuracy of sign-out will depend, to a substantial degree, on the ability to consolidate information stores in a single repository and the avoidance of solutions that require manual updates. To that end, encouraging residents to keep a meticulous perfect phantom record of medications on their sign-outs may not be the best use of their time as this information is available in the chart and this process is inherently prone to transcribing errors. It may be a more effective for residents to spend their time updating information that is not readily available elsewhere such as contingency planning, pending test results or consultant recommendations, or tasks to be completed.

This study has several limitations. First, it examines the transfer of clinical responsibility using resident sign-outs at 1 teaching hospital. However, most Internal Medicine residency programs use a similar "low tech" process for generating sign-outs, such that any results from this study would also prove insightful for other locations.¹² It is possible that at other institutions, interns use the chart or consult other sources before making initial decisions. At least one other major institution describes that because of the volume of patients being covered and the number of pages received (anywhere from 5 to 20 per hour), interns are making decisions without consulting the chart or directly evaluating patients.⁸ It was also a sample of 10 interns for 1 month at an academic teaching hospital. However, there was a large sample of medication entries for each intern and patient in which the results do consistently show that there are many medication

errors on the sign-out, some of which are potentially harmful. Third, because only the medication list was examined as a measure of sign-out accuracy, it is possible that there were additional details on other parts of the sign-out that were not abstracted. Lastly, the classification scheme does not distinguish between omissions and commissions when rating potential for patient harm, only the routes and classes of medications involved. This may not be a valid approach for this because omissions of a drug (antibiotic) may be more or less serious than a commission of a drug (antihypertensive).

Despite these limitations, it is important to note that the majority of medication omissions and commissions were not trivial, but instead had the "potential to cause moderate discomfort or clinical deterioration". Because of the large number of omissions and commissions present on the sign-out, this level of potential harm is unacceptable and represents a patient safety threat that needs to be addressed. Focus needs to be placed on system improvements in communication and information transfer. A major systems-level improvement that has already been shown to reduce medication discrepancies is the use of a computerized sign-out system, which can integrate with an electronic medical record.⁹⁻¹² However, given that this type of technology is not yet available in many hospitals, and evidence suggests that electronic solutions have the potential to increase the rate of medication errors in the short-term,^{13,14} education and monitoring needs to be a high priority.^{15,16}

CONCLUSION

This study demonstrates that there are a significant number of medication discrepancies between the resident sign-out and patient chart. Because these discrepancies appear to have the potential to harm, further studies of patient outcomes are warranted. Whereas linking sign-outs to electronic medical records can address this problem, current efforts should also emphasize the importance of vigilant updating in the many hospitals without this technology. However, given the potential for human error and the added work of manually updating written sign-outs, elimination of multiple information sources and the development of automatic updating capabilities is more likely to be a reliable long-term solution.

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