# Safety of Using a Computerized Rounding and Sign-Out System to Reduce Resident Duty Hours

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## Abstract

### Purpose

To determine whether changing sign-out practices and decreasing the time spent in rounding and recopying patient data affect patient safety. Responding to limited resident duty hours, the University of Washington launched a computerized rounding and sign-out system ("UW Cores"). The system shortened duty hours by facilitating sign-out, decreasing rounding time, and sharply reducing the time spent in prerounds data recopying.

### Method

This 14-week, randomized, crossover study involved 14 inpatient resident teams (6 general surgery, 8 internal medicine) at two hospitals. The authors measured resident-reported deviations in expected care that occurred during cross-coverage, medical errors, and institutionally reported adverse drug events (ADEs).

### Results

The mean number of resident-reported deviations from expected care per 1,000 patient-days did not differ significantly between the control and UW Cores groups: 14.29 and 13.81, respectively ($P = .85$). The mean number of reported incidents involving errors was 6.33 per 1,000 patient-days for the control group and 5.61 per 1,000 patient-days for the UW Cores group ($P = .68$). The odds ratio of a reported overnight medical error under the UW Cores system was 1.01 (95% CI: 0.64, 1.60; $P = .96$). The odds ratio of an ADE while a resident is on an intervention team was 1.10 (95% CI: 0.69, 1.74; $P = .70$).

### Conclusions

Managing information for sign-out and rounding with the UW Cores system, to reduce time spent in recopying patient data and in rounding on patients, improved continuity and enhanced resident efficiency without weakening systemic defenses against error or jeopardizing patient safety.

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Management of in-depth patient information, especially the tradition of reviewing and assembling data before morning rounds ("prerounding"), is a historical part of medical training. The recent rapid expansion in the amount of inpatient data and the growing prevalence of electronic medical record (EMR) systems that provide automated summary reports are changing the traditional practice of prerounding. In addition, limited resident duty hours and greater distribution of patient-care duties among specialists, hospitalists, and midlevel practitioners demand more frequent handover of patient responsibility ("sign-out") and greater efficiency during patient-care activities.[1,2] The University of Washington (UW) approached these challenges by developing a computerized rounding and sign-out system ("UW Cores") to directly support efficient reduction of prerounding time and to promote dependable sign-out. The system generates printed rounding lists that are prepopulated with automatically collected information on vital signs, fluid in-and-out balances, and basic laboratory values. Clinicians can annotate each patient's entry with summary notes regarding problems and plans and with commentary that is important for sign-out.

We previously showed the UW Cores system's benefits for workflow efficiency and continuity of care.[3] The system also saves clinicians time formerly needed for information gathering and shortens the amount of time that housestaff spend rounding as a team on their patients.[4] These workflow changes improved duty hours compliance among residents, but they also raised two concerns. First, the system might actually jeopardize patient safety because residents no longer review patient data in detail by recopying for sign-out or before rounds. Second, residents were spending less time on rounds and, therefore, might have fewer opportunities for early discovery of problems and their correction. We hypothesized that the automation and the work and time savings provided by UW Cores represent either a helpful reduction

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in inefficiency or a harmful elimination of the current repeated handling of information that reduces errors.[5] Recent quality-improvement initiatives at our institution led to scrutiny of many systems used to pursue error-free care, and that scrutiny prompted us to resume the analysis of UW Cores safety impact data that had been collected at the time of the system's introduction (an analysis that had been sidelined by institutional evaluation of whether to adopt UW Cores as a permanent component of its information technology infrastructure). The purpose of this study was to ensure that the introduction of our computerized rounding and sign-out tool was not associated with an increase in medical errors.

## Method

### Intervention

UW Cores is a secure computer application that uses the Web and a database to deliver information to any authorized user on any Internet-connected workstation that is capable of secure authentication. This includes all hospital workstations and the computers in most residents' homes. Users log in through the hospital's secure Internet server. The system provides a centralized computer application whereby residents may create lists of their inpatients by designating which patients belong to which team. UW Cores then generates lists that are different for each team and that automatically include only that team's patients. Residents enter detailed sign-out information and create "to-do" lists for the care of these patients. UW Cores permits residents to add and edit patients on other team lists when cross-covering admitting or consulting duties or working a night-float shift. The system allows residents to enter and update comments outside of the official chart, writing in their own words about diagnoses, problems, allergies, and medications. It produces printed sign-out reports and rounding lists that organize patients by team, and it sorts them by location in the hospital. The system shows each resident's comments on the reports and frequently queries hospital data systems in order to automatically download and include on printed reports data on basic patient demographics, such as age, gender, hospital ward, and room number; recent vital signs, including intake and output volumes and ventilator settings; and basic laboratory values, such as the comprehensive metabolic panel, complete blood count, and coagulation profile; and allergies. When using this system, residents spend less time constructing lists of their team's patients, and almost no time hand-copying objective data before rounds. Members of our group described the planning and design of UW Cores in more detail elsewhere.[3]

The system had three goals. They were (1) to improve patient care by providing a flexible, centralized system for resident-entered patient information to enhance sign-out communication quality, (2) to facilitate the transition to an 80-hour workweek for residents by organizing patient information and downloading clinical data from hospital information systems to improve workflow efficiency, and (3) to change the nature of resident tasks to decrease the time spent in recopying patient data to notes and lists and to increase the time spent in direct patient-care activities.

### Participants

For this study, we selected two hospitals in the UW School of Medicine system: Hospital A (Harborview Medical Center) is a county-owned, 368-bed, level I adult and pediatric trauma center, and hospital B (UW Medical Center) is a 450-bed, tertiary care, university hospital. Both hospitals are located in Seattle. We implemented the UW Cores system at both hospitals simultaneously on June 23, 2003. All housestaff teams caring for inpatients were invited to use the system for a six-week run-in period. During that period, residents familiarized themselves with the system, and it was modified to better fit resident team needs. The system appeared to be intuitively usable for almost all residents; none of the residents requested training, and it was not offered to any of them.[3,6] We chose the sample size by convenience to include all resident-run inpatient internal medicine and general surgery teams at both hospitals. At hospital A, there were four general internal medicine teams, two general surgery/trauma teams, and one thoracic surgery/vascular surgery team; at hospital B, there were four general internal medicine teams, two general surgery teams, and one surgical oncology/vascular surgery team. At any one time, these teams comprised about 30 internal medicine residents and about 22 general surgery residents. Over the course of the entire study, because of resident rotation schedules, a total of 161 residents participated. At the time of this study, all teams used a cross-coverage model with a one-in-four schedule. None of the teams studied were covered by a night-float system.

### Randomization

The study used a randomized crossover study design (Figure 1) that the human subjects divisions at both hospitals approved. At each hospital, the study organizer used blind drawings to select teams to begin the study as either intervention or control teams. The study period began June 23, 2003, and ended November 17, 2003. This time span was divided into a six-week prerandomization run-in period and a 14-week randomized crossover study period. We deployed UW Cores as a prototype and made continuous system modifications in response to user feedback, using a process called rapid application development.[6] We did not collect data during the run-in period because the rapid application development process was still under way, and the functions and uses of UW Cores were changing too much for the system to provide reliable information. After randomization, half of the study teams retained the use of the UW Cores system (intervention group), and the other half of the teams stopped using the system (control group). Teams in the control group returned to their previous patient-list-management systems, which may have involved individual written lists or cards or a team-developed computerized spreadsheet. Seven weeks after randomization, we accomplished crossover by restoring UW Cores to those teams without it, which converted control group teams to intervention group teams, and by removing UW Cores from those previously using it, which converted intervention group teams to control group teams. On conclusion of the study, all residents regained the use of UW Cores.

### Outcome measures

This study measured three outcomes. They were (1) resident-reported incidents: deviations in expected care (e.g., failure to complete a task, an incorrectly performed task, or a complication of care) that occurred during cross-coverage and that were identified on morning rounds by the primary resident team, (2) medical errors: the subset of resident-reported incidents that a clinician, who was blinded to treatment group, judged to expose patients to the risk of adverse outcomes because a

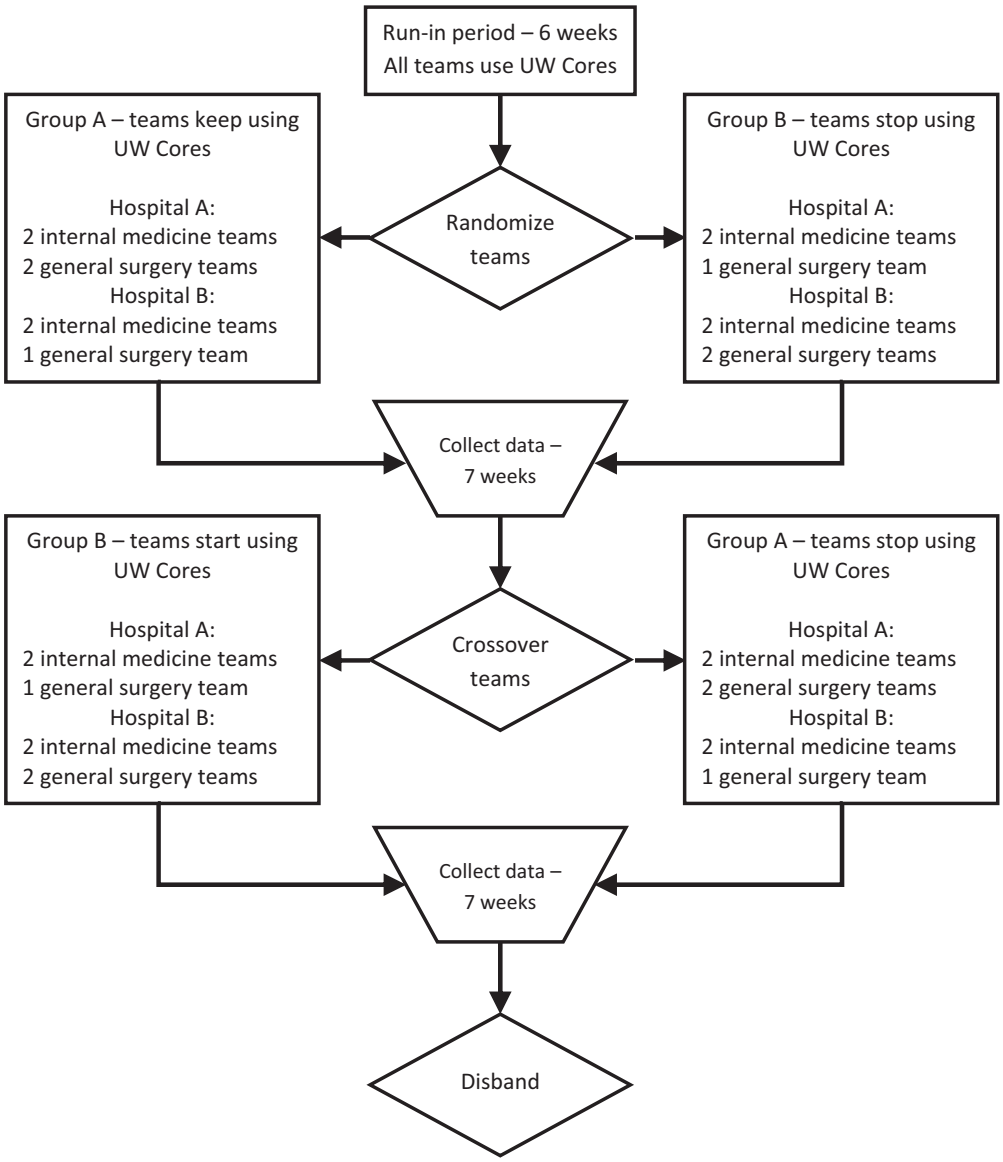


**Figure 1** The randomized crossover study design of the computerized rounding and sign-out system, developed at the University of Washington and called "UW Cores," that improved the rounding efficiency and the transfer of patient-care information among graduate medical trainees at the time of sign-out. In 2003, the system was studied by using a design that included a run-in period, team-level randomization, and a crossover design, as illustrated by the algorithm in this figure. A recent institutional decision at the University of Washington to integrate the UW Cores system with the electronic medical record prompted the completion of the analysis of the safety data collected in 2003 with the use of this study design.

planned action was not completed as intended or because the plan used to try to achieve an aim was not the right plan for that effort, and (3) adverse drug events (ADEs): patient injury or exposure to potential injury, attributable to the mismanagement of medications.

### Data collection

**Resident-reported incidents.** The study organizer telephoned the second-call resident on each study team every day, two to four hours after morning rounds. The residents reported the inpatient volume for that day, any deviations in expected care that a patient experienced overnight, and, if there were deviations, the perceived cause.

**Medical errors.** In the case of potential medical errors, references to UW Cores were removed from the residents' reports. A faculty clinician (K.M.) who was blinded to whether the team that cared for the involved patient was in an intervention or a control group reviewed the reports. The reviewer examined the patient's chart and made a determination for each incident regarding (1) whether the event involved medical error and, if so, (2) what category of error it was, according to the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) classification scheme.[7] See the Appendix, Supplemental Digital Content 1, http://links.lww.com/ACADMED/A17, for the classification scheme.

**ADEs.** To determine the incidence of medication errors for each team during the study period, one of the authors (E.G.V.) reviewed the hospital-maintained quality assurance database of ADEs and compared identified cases to each study team's list of inpatients. Anyone can file these reports; at both hospitals, ADEs are typically identified

and reported by nursing and pharmacy staff and only rarely by residents. These reports are anonymous, and thus we could not discern whether ADEs were related to decisions by the primary team or by cross-covering residents.

### Statistical methods

The numbers of resident-reported incidents and ADEs were first evaluated at the team level. The numbers of incidents were summed for each of the sets of daily reports, and then the numbers of ADEs were summed for each of the sets of daily reports. We used *t* tests for comparative evaluation and Wilcoxon rank sum test to confirm whether outlying data points had an undue influence on the *t* tests. We used these data for power calculations because the values they estimate are most closely associated with the clinical outcomes of interest. Rates of resident-reported events and errors were compared across study groups. The observed differences in error rates provided the variance estimate for power calculations. Given the fixed sample size of 14 teams, our methodology has 21% power to detect a one-event average increase in the error rate, 63% power for a two-event average increase, and 93% power for a three-event average increase in the number of reported errors per team.

Because data were collected on a daily basis, we used logistic regression to analyze the association between being on UW Cores and the incidence of resident-reported incidents. The within-team correlation was very low, and therefore no special methods were used to adjust for it. The error prevalence is also very low, and, therefore, odds ratios from the logistic regression model can be interpreted as relative risks. All regression models controlled for team service type, hospital, and patient volume, because those factors were considered potential confounding factors.

Because crossover studies are sometimes prone to carry-forward effects, we plotted resident-reported incidents against time to evaluate such an effect. We did not use control–control or intervention–intervention groups. We could not evaluate carry-forward from the run-in period because data were not collected from that period. As discussed below, in the Results section, temporal trends in the data are more consistent with seasonal variability than with a carry-forward effect. Seasonal variability is an expected finding because patient load, responsibilities, and team capabilities vary over time in quite noticeable ways, whereas any carry-forward effect would be much smaller.

We evaluated the numbers of resident reports over the entire study period by hospital, service, and starting study group. The number of reports varies by hospital and service in a way that seems to correlate with differences in patient load. The number of reports does not vary significantly by starting study group, which suggests that there was little, if any, difference in patient loads across the study group for both periods of the study.

## Results

### Characteristics of study groups

The study period was 103 days; during that time, 1,365 (94.7%) of a possible 1,442 team-days of data were complete, including patient volumes and a conversation about resident-reported incidents. Including rounds on the same patient on serial days, teams rounded on patients a total of 15,587 times during the study. Therefore, we used that value in calculations for the total number of patient-days for this study. Table 1 shows the characteristics of the study teams by hospital and service.

### Resident-reported incidents

The resident teams made a total of 1,452 reports, of which 1,276 were reports of no unexpected activity, and 176 were reports of unexpected overnight incidents. Of those 176 incidents, 84 (48%) were reported by the control group, and 92 (52%) were reported by the intervention group. The mean number of incidents per team was 6.0 for the control group and 6.6 for the intervention group ($P = .66$). To account for differences in patient volumes across resident teams, we compared the number of reported overnight incidents per 1,000 patient-days among the control and intervention groups: We found 14.29 incidents for the control group and 13.81 for the intervention group ($P = .85$; Table 2).

### Medical errors

The blinded clinician judged 76 (43%) of the resident-reported overnight incidents to involve a medical error. Of those errors, 37 (49%) were reported by the control group, and 39 (51%) were reported by the intervention group. The mean number of errors per team during the entire study

Table 1

**Characteristics of Two University of Washington Hospitals, Resident Teams, and Study Groups During a 14-Week Study in 2003 of a Computerized Rounding and Sign-Out Application to Support Patient Handovers and Resident Efficiency**

| Variable | Both hospitals | Hospital A | Hospital B |
|---|---|---|---|
| **Number of teams** | 14 | 7 | 7 |
| Medicine | 8 | 4 | 4 |
| Surgery | 6 | 3 | 3 |
| **Number of patients rounded on** | 15,587 | 10,224 | 5,363 |
| Medicine | 6,567 | 3,652 | 2,915 |
| Surgery | 9,020 | 6,572 | 2,448 |
| **Average daily team census** | 11 | 14 | 7 |
| Medicine | 8 | 9 | 7 |
| Surgery | 15 | 21 | 8 |
| | **Both groups** | **Intervention group** | **Control group** |
| **Number of patients seen on daily rounds*** | 15,587 | 8,018 | 7,579 |
| Medicine | 6,567 | 3,393 | 3,174 |
| Surgery | 9,020 | 4,625 | 4,395 |
| **Average daily team census** | 11 | 13 | 10 |
| Medicine | 8 | 9 | 8 |
| Surgery | 15 | 17 | 13 |

* These values are equivalent to patient-days and are used as such in calculations.

Table 2

**Comparison by *t* Test of Resident Groups Managing Daily Patient Information and Handovers by Using the Computerized Rounding and Sign-Out System Developed at the University of Washington (UW Cores) With Residents Not Using the System, 2003***

| Variable | Total reported incidents | Incidents per 1,000 patient-days | Total reported errors | Reported errors per 1,000 patient-days |
|---|---|---|---|---|
| Control, mean (SD) | 6.00 (3.59) | 14.29 (9.96) | 2.64 (2.21) | 6.33 (5.51) |
| UW Cores, mean (SD) | 6.57 (2.79) | 13.81 (7.53) | 2.79 (1.67) | 5.61 (4.12) |
| Difference, mean (SD) | 0.57 (4.80) | −0.49 (9.72) | 0.14 (3.03) | −0.71 (6.34) |
| *P* value | .66 | .85 | .86 | .68 |

* These data are corrected for each resident group's patient volume. Incidents are any overnight patient events that were unexpected by the primary clinician team. Errors expose a patient to risk by failure of a planned action to be completed as intended or because the plan used to try to achieve an aim was not the right plan for that effort.

period was 2.6 for the control group and 2.8 for the intervention group ($P = .85$). To account for differences in patient volume, we compared the number of errors per 1,000 patient-days in the control and intervention groups: We found 6.33 errors for the control group and 5.61 errors for the intervention group ($P = .68$; Table 2). We used logistic regression to evaluate the association between UW Cores status and reported errors, after control for the variables of daily patient volume, hospital, and service. Table 3 shows the numbers of resident reports and the descriptive statistics of those variables, stratified by whether the observation had a reported error. The odds ratio of the occurrence of an reported overnight medical error under the UW Cores system, as compared with such an occurrence when the UW Cores system is not being used, was 1.01 (95% CI: 0.64, 1.60; $P = .96$).

### ADEs

A total of 84 ADEs related to study team patients were documented in the quality assurance databases of both hospitals during the study period. Control group patients experienced 39 (46%) ADEs, and intervention group patients experienced 45 (54%). The odds ratio of a patient's experiencing an ADE while being cared for by a UW Cores-using team was 1.10, after control for the number of patients rounded on, the hospital, and the service (95% CI: 0.69, 1.74; $P = .70$). We compared the study groups for risk of ADEs that ranked in NCC MERP category "C" (i.e., the event reached the patient but did not cause harm) or worse. There were 43 such errors reported. The control group patients were involved in 23 (53%) of these 43, and the intervention group patients were involved in 20 (47%). We used logistic regression to evaluate the association between UW Cores status and ADEs, again after control for daily patient volume, hospital, and service. The odds ratio estimated from that model for an ADE involving a UW Cores-using team compared with control was 0.87 (95% CI: 0.47, 1.62; $P = .66$).

Table 3

**Comparison of Medical Errors by the Use of a Computerized Rounding and Sign-Out System (UW Cores), by Hospital, and by Medical or Surgical Service at the University of Washington, 2003***

| Variable | No reported error | Reported error |
|---|---|---|
| **UW Cores, no.** | | |
| Control | 688 | 37 |
| Cores | 688 | 39 |
| **Hospital, no.** | | |
| Hospital A | 587 | 40 |
| Hospital B | 789 | 36 |
| **Service, no.** | | |
| Surgery | 695 | 30 |
| Medicine | 681 | 46 |
| **Census, mean (SD)** | 11.39 (7.82) | 12.45 (9.20) |

* The UW Cores safety study used these values as logistic regression model covariates. UW indicates University of Washington.

### Effect of carry-forward

We plotted the numbers of reports per day against the time period of the study for each of the starting groups. We followed these original groups past the study crossover and to the end of the study. Carry-forward should cause a trajectory change in these plots at the time of crossover: The group starting with UW Cores should maintain its trajectory, while the control group should change. As shown in Figure 2, however, neither of these expected trends occurred. The group starting with UW Cores had a flattened trajectory for about a month after crossover, whereas the control group continued on its previous trajectory, also for about a month. Team rotations did not occur on the day of study crossover.

## Discussion

This multihospital, randomized, crossover trial shows that the previously described reduction in rounding time and information handling by residents using the UW Cores computerized rounding and sign-out system does not increase the incidence of deviations from expected care, resident-reported overnight medical errors, or ADEs. This finding is important because the daily time savings and resident-reported benefits to continuity made the UW Cores system extremely popular at our institution, and its use has spread to almost all residents and many

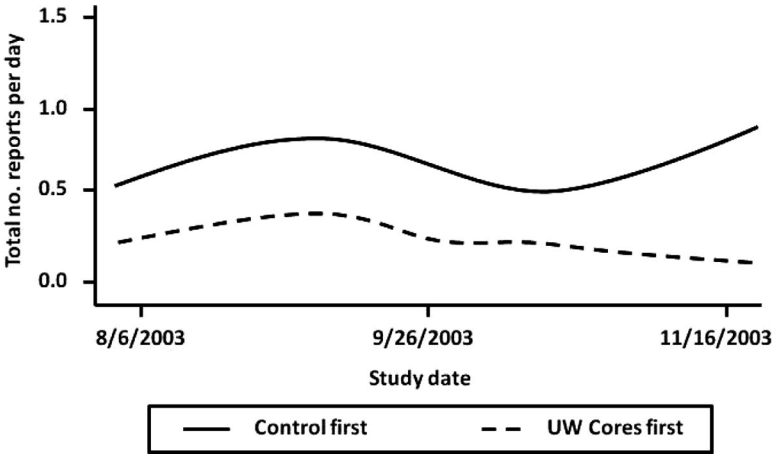


**Figure 2** The effect of carry-forward on the results of a study of a computerized rounding and sign-out system that improved the rounding efficiency and the transfer of patient-care information among graduate medical trainees at the time of sign-out. This system was developed at the University of Washington, is called "UW Cores," and was studied at the University of Washington in 2003. The effect of carry-forward on the study's results was evaluated by plotting rates of resident-reported incidents, separated by starting study group (control or UW Cores) over the time of the study. Carry-forward should cause a trajectory change in these plots at the time of crossover: The group starting with UW Cores should maintain its trajectory, while the trajectory of the control group should change. The fact that neither such trend is seen in the figure suggests that seasonal variation (e.g., residents becoming more experienced as the year progresses) better explains temporal trends in the data.

attending physicians at the two hospitals where it is available. In addition to the objective efficiency gains we previously reported, residents using the UW Cores system describe spending 30 to 45 fewer minutes per day in managing patient information and generating sign-out materials for colleagues.[4] It can be posited, however, that those 30 to 45 minutes per day that residents had been spending in copying and recopying patient information onto rounding lists, progress notes, and sign-out sheets provided an important, but invisible, protective system redundancy in the handling of patient information that acted to reveal trends, to help residents detect errors, and to prevent patient harm. Therefore, we felt obligated to show that eliminating that redundancy in an effort to improve efficiency is safe for patients.

Other studies have shown that a system designed to support sign-out communication can improve the quality of the information transferred[4,8] and can help reduce the risk of adverse events associated with overnight cross-coverage.[9] In fact, both improved communication among providers and their improved access to information are commonly included in discussions about hospital adverse events and medical errors.[9–12] UW Cores is designed to improve communication by providing a standardized report for sign-out that includes resident-entered notes about patient-care tasks and plans. Standardizing sign-out is increasingly cited[13,14] as a needed, but lacking, aspect of student and resident training.[15,16] A safe method for the handing over of patient care is not formally taught to medical students or residents; by tradition, this process is unstructured[8] and is historically suited only for brief overnight periods of cross-coverage.[17] Before the Accreditation Council for Graduate Medical Education's introduction of duty hours limits,[18] poor communication during handovers of patient care was already cited as a problem.[19] Now, more than ever, sign-outs are critical opportunities to prevent errors in communication and decision making and avoid disruptions to patient-care plans.[20,21]

Our study did not show a reduction in the incidence of deviations from expected care, resident-reported overnight medical errors, or ADEs. We observed that, in the absence of the UW Cores system, the control teams produced paper sign-out reports with hand-written details that likely were just as comprehensive as those generated automatically by UW Cores. However, the more traditional method is time-consuming, and it poses a challenge to duty hours compliance.

In addition to improving efficiency, the UW Cores system is intended to provide cross-covering clinicians with a better ability to act as an integral part of the care team and to make overnight decisions that resemble as closely as possible the decisions that would have been made by the other primary team members, had they been there. Helping cross-covering physicians make decisions about patient care on the basis of the same understanding of plans as the primary team is an important undertaking; covering clinicians are increasingly called on to manage and advance the plans made by others, not only to respond to unexpected new issues until the primary team returns. In addition, as the care of inpatients becomes more complex, and as that care is delivered by a growing number of subspecialty providers, the opportunity for all of these professionals to act in a coordinated fashion often is missed. Part of the reason for this lack of coordination is that the traditional medical record is inadequate as a means of communication among providers working in teams. Today's EMR systems merely mimic the appearance of paper records, complete with daily progress notes that repeat (sometimes in a misleading way) data already available elsewhere in the record.[22] Most of these systems do not currently generate patient lists that contain multiple summaries per page and that include informal physician commentaries; nor, typically, do they effectively leverage the power of their underlying databases and integration capabilities to summarize patient information in a mobile format.[23] The consequence is an interrupted workflow and wasteful, repetitive effort.[24]

UW Cores is an information-handling system that addresses these shortcomings of today's EMR systems and that supports the flow of summarized inpatient data from hospital EMR systems, paired with provider commentaries regarding plans or concerns. It provides these summaries at the team level and does not require that individual clinicians form database relationships with specific patients. This important difference from many EMR systems permits any clinician to assume a team role in UW Cores and instantly access the correct summarized patient data.

This study had several potential limitations. The baseline probability of an error was very low (0.051 errors/day), and the unit of randomization was the resident team, which was composed of several rotating individuals who joined and left study teams during the investigation. We were unable to control for resident experience, although the study was kept brief to prevent

confounding by the growth of resident knowledge and skill. Whereas some residents rotated among study teams, almost all remained within the same study arm. Two residents switched study arms because of rotations: one from a UW Cores group to a non-UW Cores group, and vice versa for the other; both changes took place before crossover. It is possible that a carry-forward effect from the run-in period influenced the performance of teams initially assigned to the control group, but that possibility cannot be measured because data were not collected during the run-in period. In addition, this intervention is completely unblinded, which may change the behavior of either group on the study from their performance under typical conditions.

It is encouraging that our study found the baseline error rate to be so low; however, we captured only overnight incidents that were noticed by residents on rounds the next day, rather than capturing any error noticed by any provider at any time. Benchmark figures for the incidence of adverse events range from 3.7% of hospitalizations in the Harvard Medical Practice Study[25] to 36% of admitted patients reported by Steel and colleagues.[26] Had we sought more comprehensive reporting of adverse events, we might have captured sufficient event volume to detect an impact. We felt we would be unable to capture sufficient event volume because UW Cores is perceived to affect only sign-out and rounding and not other aspects of patient care, such as nursing processes or medication-ordering and -delivery processes.

The process of gathering detailed information about overnight incidents and about the ways in which residents manage and share patient data may have brought unusual scrutiny to patient information management and patient safety. Such a focus may have had, in itself, an independent effect on overnight events and medical errors. However, this effect ought to be the same in both arms of the study and should have little effect on our measured differences. The implementation of a computerized rounding and sign-out system that fits the unique workflow of resident teams can help reduce inefficient information management, improve communication, and safely permit residents to allocate more of their time to educational and direct patient-care activities.

## Conclusions

The UW Cores computerized rounding and sign-out system reduced rounding time and decreased repetitive information-handling tasks by residents at two hospitals. Shortening rounds and diverting resident time away from recopying patient information do not increase the incidence of deviations from expected care; do not increase resident-reported overnight medical errors; and do not affect reported adverse drug events. Residents at both hospitals found the system intuitive. They began using the system to manage their lists of patients with no formal training in the system. Its use has now spread to almost all residents and many attending physicians at both hospitals. The success of the UW Cores system stems from its ability to efficiently combine data from multiple places such as the medical record, the inpatient census list, and the resident's own "to-do list" and comments. Systems like UW Cores should inform the next generation of EMR tools for team-based care delivery.

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*Other disclosures:* After acceptance of this manuscript, the University of Washington began to commercially license a version of the UW Cores system. The University now receives royalties from sales of these licenses.

*Ethical approval:* The University of Washington human subjects division gave approval for both hospitals involved in the study.

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