Organizing the transfer of patient care information: The development of a computerized resident sign-out system

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Background. *The problem of safe and efficient transfer of care has increased over the years as new and complex diagnostic tools and more complex treatment options became available. Traditionally, residents ensured continuity of care by working long hours and minimizing the transfer of significant diagnostic or therapeutic responsibilities to other providers. The new 80-hour workweek has curtailed that practice and increased the pressure on trainees for workflow efficiency. We report on a study of information-handling routines among residents for the separate tasks of transfer of care ("sign-out") and daily patient care work (ward work). Using these results, an institution-wide computerized system was developed to centralize information-handling tasks and facilitate the management and transfer of patient care information.*

Study design. *House staff from 31 resident-run inpatient and consult services at 2 teaching hospitals described current methods of maintaining patient information used during ward rounds and during sign-out. A subgroup of 28 residents then participated in the design of a computerized resident sign-out system to centralize patient information and produce lists for rounding and transferring care duties. Accuracy, flexibility, and portability were identified as key elements by the design team.*

Results. *Analysis of the type of information handled by residents caring for inpatients at our institution demonstrated common elements across many services. Most services used a paper patient list to manage both nightly sign-out and daily ward work, which required repeated recopying of patient data during the day. Utilizing medical information systems tools and rapid application development concepts, we constructed a computerized resident sign-out system ("UWCores"). This system combines the patient sign-out and daily ward work information in one central location. We believed this would improve the quality of information transferred during sign-out and enhance resident efficiency. During the design process, we identified rules that govern the type of clinical information that should be automatically versus manually updated. We observed an immediate acceptance by all residents and services that tried the system.*

Conclusions. *This study shows that by combining downloaded patient data from hospital systems with resident-entered patient details, a computerized resident sign-out system can be a feasible, powerful, and popular tool. While its effect on patient safety and resident efficiency await the results of further studies, our study shows that this tool rapidly captured the attention of resident physicians and became widely used as a valuable means to centralize and organize sign-out and daily ward work information.*
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THE TRANSFER OF PERTINENT CLINICAL INFORMATION from primary inpatient care providers to cross-covering colleagues (sign-out) is a key element in the successful outcome of care. Historically, the sign-out process has been a haphazard event with great variation in information content.[1] Lack of detailed knowledge about patients and poor communication of plans to cross-covering physicians are among the causes of decreased quality of care

associated with discontinuity.[2] New diagnostic and therapeutic methods, a greater volume of clinical information, and the increasing acuity of the inpatient population over the last 2 decades further complicate this process. Surgical specialties have traditionally dealt with it by decreasing the number of actual "transfer events," effectively having the same team care for patients throughout their hospital stay. Continuity of care was thus achieved at the expense of very long working hours.

Starting in July 2003, all residency programs had to comply with the new 80-hour workweek to maintain accreditation. With increasing frequency, residents spending fewer hours in the hospital were, by necessity, expected to turn over the care of their patients to cross-covering and night float house staff.[3,4] The discontinuity of care that accompanies such turn over had previously been shown to lengthen hospital stays, increase the amount of laboratory tests, and increase self-reported preventable adverse events.[2,5] In addition, the restriction on in-hospital time for residents places new emphasis on workflow efficiency. Others had previously proposed that information technology solutions might reduce the workload pressure on house staff.[6]

We decided to use the challenge posed by the 80-hour workweek, with its attendant increase in "transfer events" and workload pressure, to examine information-handling methods for resident temporary transfer of care (sign-out) and daily patient care work (ward work). Our goals were to develop a system intended to improve these processes using the limited experience reported by others[7] and techniques made possible by new information technology.

This paper discusses the characteristics of such a system and demonstrates important patient information-handling principles learned from its design. This system is now in place at our institution and has become widely accepted throughout. The next phase of this project will measure its effect on patient safety, resident efficiency, and user satisfaction. The purpose of this paper is to demonstrate that patient information elements critical to sign-out are similar to elements needed for daily ward work by residents, to show how this information can be more efficiently managed in a centralized computer system, and to propose design guidelines for such systems.

We believe the challenge of the 80-hour workweek presents a unique opportunity to develop tools and processes with the potential to transform what initially appeared to threaten patient care and jeopardize safety into an opportunity to work simultaneously toward increased safety and efficiency of care.

METHODS

The University of Washington Computerized Resident Sign-out System (UWCores) was created using the rapid application development process.[8] The development proceeded according to the following stages: (1) evaluation of existing systems; (2) analysis and prioritization of existing system content; (3) planning of the new system using a model database and user focus groups; (4) modifications of structure and function using iterative cycles of development, user testing, and feedback. The design team consisted of 2 clinical members: a General Surgery resident (E.G.V.) and a General Surgery faculty attending (K.D.H.); 2 biomedical informatics members: a physician informatics researcher (W.B.L.) and an informatics graduate student researcher; and a computer systems developer. Thirty-eight residents from 31 inpatient services participated in the evaluation and analysis stages by providing copies of sign-out lists or other patient management lists and by participating in surveys. Twenty-eight residents from 8 services participated in the planning and modification stages by conducting user testing and providing input about usability and functions. The design team met weekly during the development process to review the system design and make changes based on results from user-testing sessions.

RESULTS

1. Evaluation of existing systems. The evaluation of existing resident sign-out methods in use at the University of Washington during 2002 was achieved during resident meetings and educational activities. In addition, we held 6 focus group sessions in which residents discussed sign-out methods, continuity of care, and work hours. These discussions yielded 2 important concepts: First, patient sign-out methods are intimately related to maintaining an up-to-date patient rounding list ("rounding list management"). Second, sign-out tools should incorporate patient information sources used during daily morning collection of vital signs and laboratory data necessary for rounding ("prerounding"). In addition, residents identified a number of changes to the sign-out methods (Table I) that could improve patient care and recommended changes to daily prerounding (Table II) that could improve resident efficiency and accuracy.

Table I. Residents' suggestions for improving sign-out systems and patient continuity of care

1. The sign-out should be printed or written on paper for portability.
2. The patient list should be up-to-date at the time of sign-out.
3. A computerized system for maintaining sign-out information should be implemented.
4. Residents at each level should sign out to a corresponding level, face-to-face when possible.
5. Each patient on the list should be discussed.
6. Teams should sign out together when possible.
7. To-do lists should be put on paper and, preferably, computerized.
8. Overnight events and decisions by the cross-covering team should be recorded on the paper sign-out list and returned to the primary team the next day.

Table II. Residents' suggestions for improving rounding list management and prerounding

1. Cross-covering residents should be able to revise any team's patient list.
2. Hand copying of daily patient data should be replaced with a printout of current electronic data.
3. Where paper progress notes are used, preprinted notes with current data should be generated.
4. A computerized system for maintaining medication and problem lists should be included.
5. Access to team lists should be available at any hospital workstation and from home.

Two hospitals in the University of Washington (UW) Medicine system (composed of several owned, managed, integrated and/or affiliated hospitals, the School of Medicine, and the Practice Plans) were identified with the most prerounding work and sign-out complexity, according to resident interviews: the University of Washington Medical Center (UWMC), which is a 450-bed, tertiary care university hospital (owned and operated by UW Medicine), and Harborview Medical Center (HMC) which is a 368-bed level I adult and pediatric trauma center (owned by King County and fully managed and operated by UW Medicine). Data obtained from a survey of the 31 teams from both hospitals, including sign-out methods, techniques for rounding list management, and mechanisms and routines for prerounding were assembled into a matrix for analysis, a portion of which is reproduced in Figure 1.

2. Content and organization of existing systems. Twenty-three services used a computerized spreadsheet program (Microsoft Excel; Microsoft Corporation, Redmond, Wash) to perform rounding list management. Four services used a word-processing program list (Microsoft Word; Microsoft Corporation, Redmond, Wash); 3 services used a database program (Microsoft Access; Microsoft Corporation, Redmond, Wash). These lists were privately maintained by designated residents on each service and were accessible only on individual workstations. Forty-two different workstations in both hospitals used up to 2 of these different software programs for rounding list management. Residents on Internal Medicine services added the use of preformatted progress notes in the word-processing program that linked to their spreadsheets. This system imported the resident-entered problem lists, medications, and antibiotics directly to their daily notes. The departments of General Surgery and Neurosurgery, and residents in the Neonatal Intensive Care Unit (NICU) had separately developed patient database systems. These databases stored a centralized list of patients from all teams. Access to the database was available from a small group of computers in the departments' resident workrooms. Patient lists could be organized differently from this central database as needed. For example, each General Surgery team could generate a separate list and the General Surgery ICU resident could combine ICU patients from all teams.

Twenty-seven lists were organized by patient in the order of floor and room number; 3 lists were in alphabetical order. All lists included at least 1 of the following elements: plans, to-do list, current clinical condition, or comments. Twenty-eight lists included extra space between patient entries for handwritten notes. Typically, a junior resident would arrive at the hospital 30 to 90 minutes before work rounds to hand-copy vital signs, laboratory values, and other clinical information for each patient into this space on the paper rounding list. This prerounding session also included the rounding list management tasks of investigating whether overnight admissions or transfers required adding entries to or reordering the list. At various times throughout the day, the designated resident would typically recopy or update the list as new clinical information became available. At the end of the day, the resident would add notes intended to assist cross-covering or night float residents with overnight decision-making.

3. Planning the new computerized resident sign-out system. A proof of concept database constructed by the first author was the basis for development. At design and appearance planning sessions, house staff identified the core functions of

UWMC	Name, Age, Gender, Location	Attending	Resident	Hospital Day	Admit Diagnosis	Code Status	Hospital Course	Problem List	Procedures	Medications and Allergies	Tubes, Lines, Drains	Diet	Mobilization Precautions	Pathology	Plans or To-Do List	Condition Summary or Comments	Discharge Disposition
Gynecologic Oncology	X	X			X			X		X	X	X		X	X		
Internal Medicine	X				X	X		X		X					X	X	
Orthopedic Surgery	X	X			X				X				X		X		
Pulmonary/Critical Care	X				X	X		X		X	X				X		
HMC																	
Burns/Plastic Surgery	X	X		X	X				X	X						X	
General Surgery	X	X	X	X	X				X	X	X	X	X				
Infectious Disease	X		X				X								X		
Rehabilitation Medicine	X				X		X	X	X	X		X	X		X	X	X

Fig 1. A representative sample of data elements included in a subset of submitted rounding lists or sign-out lists by the hospital and service departments.

Table III. Residents' suggestions for core functions of a computerized resident sign-out system

1. Maintain a current census of inpatients in a central location that is accessible from many computers throughout the medical centers and, possibly, from home.
2. Associate with each patient a set of common data elements, and allow easy editing of that information.
3. Allow different services to maintain an independent information set about a single patient when more than 1 team is consulting on that patient.
4. Produce paper rounding reports or rounding notes prepopulated with the common data elements and the patient's recent vital signs and laboratory values.

a computerized resident sign-out system (Table III). Volunteer residents from 8 services (Burns/Plastic Surgery, Cardiology, Cardiothoracic Surgery, General Surgery, Internal Medicine, Neurology, Neurosurgery, Rehabilitation Medicine) evaluated the concept database at regularly scheduled house staff meetings, at which they voted on design and appearance aspects.

4. Structure and function of the new computerized resident sign-out system. UWCores is a single system housing separate databases for each hospital: UWMC and HMC. The application is Web based and available through any secure Internet connection. Users can add, edit, and remove patient profiles anywhere in the hospital: on the wards, in the emergency department, in resident workrooms, and in computer-equipped operating rooms. The system is also available to users at home via the same secure Internet portal.

Table IV. Common data elements shared among house staff rounding lists and sign-out lists at the University of Washington

Name*
Medical record number*
Primary service and team
Attending physician*
Location (unit or ward name and room number)*
Date of admission and hospital day number*
Age*
Date of birth*
Gender*
Admission diagnosis
Problem list
Code status
Medication allergies*
Diet
Medication list
Antibiotic list
Sign-out information/patient plan/to do list
Tubes/lines/drains
Procedure list
Culture results
Study results

*In UWCores, these data elements are updated by the hospital's clinical information system.

Data elements common to all services were defined (Table IV) by using the information from the patient list management matrix (Fig 1). These elements became the basic sign-out system profile for each patient (Fig 2). Additional data elements not common to all services were added if they were used by a large number of residents or if they were felt to be of high importance to a small number of residents (eg, "next hemodialysis day" or "mobilization precautions"). From the patient list management matrix, the sections "patient plan," "to do" and "comments" were combined into a single section "sign-out/plans." Two data elements, "hospital course" and "disposition" were removed by the group after the services that used them said they would instead convey that information in the problem list and sign-out/plans sections. When multiple services are seeing a single patient, each service maintains a separate profile about that patient.

Supplying patient data to the computerized resident sign-out system. UWCores obtains its information from 2 sources: (1) data automatically downloaded from the electronic health record and (2) data entered by residents.

1. Data provided by the electronic health record: Both hospitals are served by an electronic health record system that operates independently of UWCores. The clinical information system (CIS) for in-

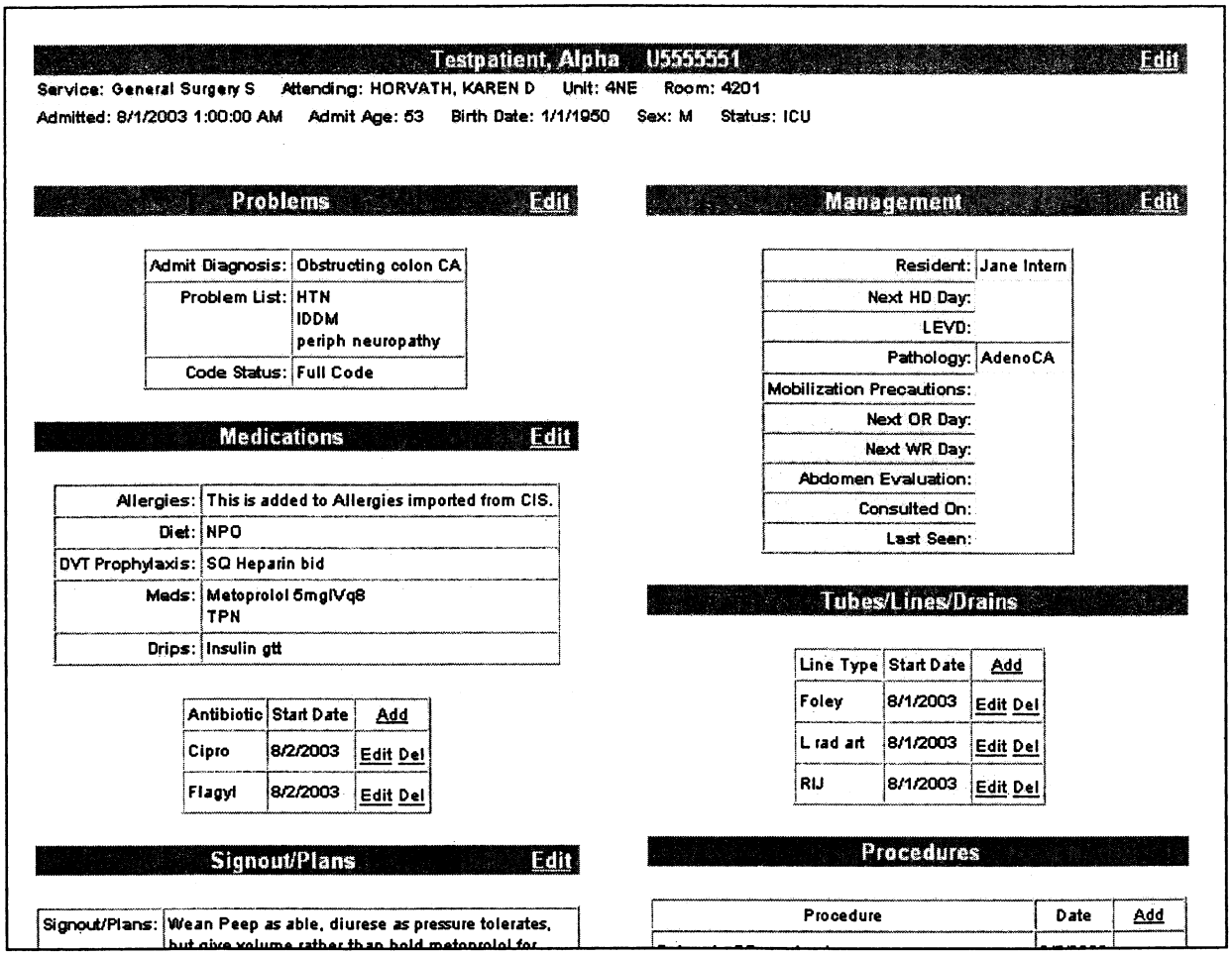
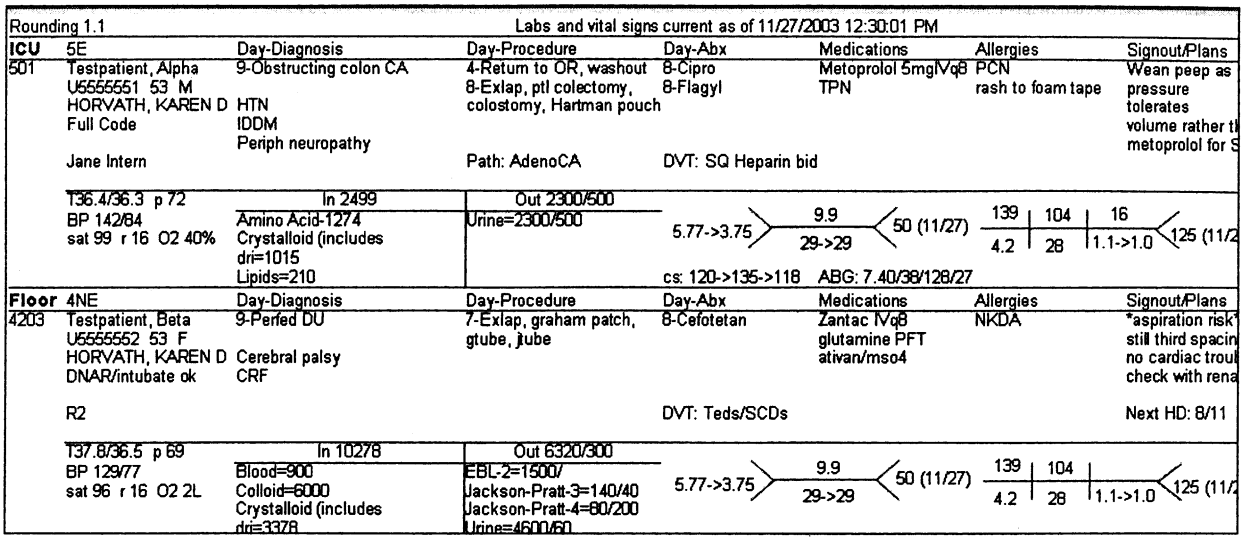


Fig 2. Part of the on-screen view of the basic patient profile Web page, which was designed using elements from the patient list management matrix (Fig 1).

patients includes demographics, allergies, vital signs, laboratory values, nursing and some physician notes (Sunrise Clinical Systems; Eclipsys Corp, Boca Raton, Fla). At HMC, the primary clinical information system also functions as the medication administration record. A second application (MINDscape; University of Washington Information Technology Services, Seattle, Wash) is used for both inpatient and outpatient encounters and includes laboratory values, transcribed documents, radiology and other procedural reports, and provider relationship information.

UWCores receives selected patient data from CIS hourly for inclusion in its printed reports. Data elements populated by CIS are shown in Table IV. Vital sign ranges are shown for the past 24 hours. Laboratory values and their dates are shown for the past 48 hours and include trends for white blood cell count, hematocrit, creatinine, and international normalized ratio. The time elapsed since the last update from CIS appears on the UWCores Web site and is included on any printed report. CIS also updates patient demographic information in UWCores, including patient location, allowing the system to automatically sort team lists by patient location and to adjust the list order appropriately when patients are transferred to a different location within the institution.

2. Data provided by the resident: Except for the elements in Table IV designated as being provided by CIS, the majority of the data elements in each patient's profile are filled in as needed by the resident primarily responsible for, or consulting on, that patient. The system provides some automation to the resident-entered information to improve communication and efficiency. For example, house staff can enter antibiotic names and associate them with start dates so that printed list and note reports will provide the antibiotic day number. The same feature is provided for procedures, lines, and drains. The data entered by residents to this system are not forwarded to CIS or MINDscape, and are



Rounding 1.1			Labs and vital signs current as of 11/27/2003 12:30:01 PM				
ICU	5E	Day-Diagnosis	Day-Procedure	Day-Abx	Medications	Allergies	Signout/Plans
501	Testpatient, Alpha U5555551 53 M HORVATH, KAREN D Full Code Jane Intern	9-Obstructing colon CA HTN IDDM Periph neuropathy	4-Return to OR, washout 8-Exlap, ptl colectomy, colostomy, Hartman pouch Path: AdenoCA	8-Cipro 8-Flagyl DVT: SQ Heparin bid	Metoprolol 5mgIVq8 TPN	PCN rash to foam tape	Wean peep as pressure tolerates volume rather th metoprolol for S
	T36.4/36.3 p 72 BP 142/84 sat 99 r 16 O2 40%	In 2499 Amino Acid-1274 Crystalloid (includes dri=1015 Lipids=210	Out 2300/500 Urine=2300/500	5.77->3.75 9.9 29->29 50 (11/27) cs: 120->135->118	139 | 104 | 16 4.2 | 28 | 1.1->1.0 125 (11/2 ABG: 7.40/38/128/27		
Floor	4NE	Day-Diagnosis	Day-Procedure	Day-Abx	Medications	Allergies	Signout/Plans
4203	Testpatient, Beta U5555552 53 F HORVATH, KAREN D DNAR/intubate ok R2	9-Perfed DU Cerebral palsy CRF	7-Exlap, graham patch, gtube, jtube	8-Cefotetan DVT: Teds/SCDs	Zantac IVq8 glutamine PFT ativan/mso4	NKDA	*aspiration risk* still third spacin no cardiac troul check with rena Next HD: 8/11
	T37.8/36.5 p 69 BP 129/77 sat 96 r 16 O2 2L	In 10278 Blood=900 Colloid=6000 Crystalloid (includes dri=3378	Out 6320/300 EBL-2=1500/ Jackson-Pratt-3=140/40 Jackson-Pratt-4=80/200 Urine=4600/60	5.77->3.75 9.9 29->29 50 (11/27)	139 | 104 4.2 | 28 | 1.1->1.0 125 (11/		

Fig 3. Part of an sample printed rounding list report. Vital signs and laboratory values are imported from the hospital's electronic clinical information system.

therefore not part of the patient's medical record unless the system is used to print a progress note report. This aspect is intended to allow residents to use UWCores much like a handwritten sign-out list, where doctor-to-doctor notes and abbreviations that might not be appropriate for inclusion in the official record are allowed.

UWCores report functions. The system produces 7 reports: 1 sign-out list report, 4 styles of rounding list reports based on common examples of lists in use at the beginning of the project (see example, Fig 3), and 2 styles of progress note reports based on current hospital note templates. Both kinds of progress note reports and 2 of the rounding list reports include current vital signs and laboratory values.

Adoption of UWCores by residents. The UWCores system permits tracking of the volume of patients managed by the system and the number of reports generated by its house staff users. Analysis of these logs shows that during the first month after the system was introduced, residents had used it to manage information on 3613 patients and had printed 6705 reports. At 6 months, the number of patients added per month had risen to 4606, and residents were generating 10,398 printed lists or notes per month. At the end of the first 6 months of use, the number of patients active in the system at a given time point was 66% of the combined total inpatient capacity of the 2 hospitals where the system is available. In addition, an average of 5 services were added to the system in each of the 6 months after its introduction. Approximately one third of these additions represent consult services and fellow-run services at both hospitals.

DISCUSSION

The advent of the 80-hour workweek and the anticipated increase in turnover rate in the care of patients provided the stimulus for us to thoroughly review sign-out systems and resident workflow processes at our institution. Working with resident teams from different disciplines, we obtained information that proved invaluable in establishing the goals of our system. For example, residents said it is important that centralized sign-out information be (1) regularly and easily updated, (2) available from many locations including home, and (3) accurate. At the same time, they felt it vital that the system have some degree of flexibility to account for differences among users. We therefore designed a Web-based system that is automatically updated hourly with selected information captured by other hospital information systems, and that allows residents to enter additional information in their own way to achieve the flexibility needed. We found that the residents rapidly embraced the system. Residents have anecdotally reported that by automatically importing laboratory data and current vital signs, the system shortened the time spent by junior residents on particular prerounding tasks. We are currently in the process of determining this effect using a prospective, randomized crossover study of resident inpatient teams that compares use

of UWCores to existing methods of handling patient information, such as preprinted sign-out cards or handwritten lists. We acknowledge that the process of gathering detailed information about how residents collect, manage, and share patient data brought unusual scrutiny to the areas of patient care continuity and ward work efficiency. Such focus may have had, by itself, an independent effect on workflow and as such may have colored the observations reported in this paper, as well as the user feedback employed to assess the feasibility and efficiency of this system. In addition, this effect may impose similar limitations on the study of continuity and efficiency outcomes related to use of this system.

Combining rounding list management and sign-out. An essential concept identified by this study is the overlap between rounding list management tasks early in the day and the generation of sign-out lists at the end of the day. Our investigation of existing sign-out tools at our institution demonstrated that house staff had already adopted computerized methods of managing both in a single application. We propose that systems developed for computerized resident s*ign-out* be combined, when possible, with processes used by house staff for rounding *list management* for daily workflow. The information used and updated on rounding lists is so heavily shared by sign-out lists that a system to improve 1 function easily accommodates improvements to both. This provides the distinct advantage of increasing resident efficiency by allowing residents to simultaneously update information used in 2 different tasks. Incorporating patient information imported from hospital clinical information systems reduces the iterative recopying of data throughout the day, which may improve resident efficiency and offer time savings. Automating the list order by patient floor and room number permits residents to maintain an organized rounding flow in large facilities where patients may be distributed among several floors; this method reduces backtracking and minimizes the chance of inadvertently skipping a patient on rounds.

UWCores acts much like the index cards, handwritten lists, computer spreadsheets, or databases it replaces—it provides a central location for storing the clinical information deemed important by the resident. The resident condenses a patient's history, problem list, medications, clinical condition, and other information into the appropriate fields in the system, which safely stores those notes, makes them securely available throughout the hospital, and makes them portable in the form of printed sign-out list or rounding list reports.

Use of computer workstations vs the personal digital assistant. In choosing a network-based, workstation platform for this application as opposed to a hand-held, personal digital assistant (PDA) platform, we considered the following: (1) There are published data regarding the utility and outcomes of workstation-based systems for resident sign-out[9] whereas none are yet published that measure PDA sign-out outcomes. (2) In our hospital system, there is pervasive access to workstations in all clinical locations, while there is wide variation in PDA ownership and operating system compatibility. (3) Imported data are updated automatically by the workstation system, whereas PDA systems rely on user-initiated synchronization, either through physical connection ("docking") or through a secure wireless infrastructure. (4) No additional hardware cost is incurred by the hospitals or residents to deploy a workstation system to all users in contrast to the deployment of PDA devices, which involves the purchase of the devices and a widespread capability for physical or wireless synchronization. (6) Access to the system from home was a user requirement and was easily accomplished through a secure Internet interface, whereas updating patient data on a PDA outside of the hospital is problematic. (7) Unless data on a PDA are encrypted, a lost PDA may result in a breach of patient information privacy.

Linking computerized resident sign-out to clinical information systems. Links to data from the hospital clinical information system and methods by which computerized resident sign-out systems handle that data must be developed with care. We propose the following 4 criteria be used to determine whether hospital clinical information system data should be imported to computerized resident sign-out systems and how it should be handled: (1) Are the imported data correct? At our institution, residents often note that CIS incorrectly reports the admitting service or the attending physician's name. We developed UWCores to import the service and attending information contained in CIS, but allow residents to edit it. (2) Will editing of imported data introduce the risk of error? Residents may have more recent allergy information than CIS, but allowing residents to alter the UWCores representation of medical allergies from CIS could introduce error. We developed a method that reproduces in UWCores the allergy list as charted in CIS with editing prohibited; that list is then linked to a space for residents to write an addendum. This method

could be used, for example, to allow a resident to note that while CIS reports the patient is allergic to penicillin, cephalosporins had been used in the past with no reaction. (3) Will importing the data be technically difficult or disproportionately increase system complexity? The clinical information systems at our institution include such data as Foley catheter insertion date, but linking UWCores to the software mechanisms used to store and update that information would significantly increase system complexity and maintenance needs with little time savings for residents. (4) Does the information consume too much space on rounding lists with little added benefit, or does the information need to be edited by a resident to become useful? For example, the appearance of microbial culture results from CIS would contain such a phrase as "Final 01012003. Direct Observation. Subclavian Line Left. Special Request: None. Accession Number S0123456. Catheter Tip Triplelumen. No growth 3 days." Such a culture results list is too unwieldy to be useful to residents—many of whom reported a preference to re-enter such data in a more concise format or in a particular order that is meaningful to them and their colleagues, but that is not available automatically from CIS.

Essential elements in computerized resident sign-out design. Existing systems developed earlier by residents at the University of Washington used data elements similar to those described in other computerized resident sign-out systems.[9,10] This study identified the following elements that should be incorporated into such a system: (1) demographic information that includes name, age, gender, and location; (2) medication information that includes medication allergies and a current medication list, including antibiotic therapy with start dates; (3) current medical condition information that includes admission diagnosis, current active problem list, recent procedures, and code status; (4) recent vital sign and laboratory test results; (5) a summary of the primary service's intended treatment plan and a list of tasks to be completed by the cross-covering service. We found these 5 elements to be conserved in systems developed independently by many house staff services at our institution and others.[7] In addition to these common elements, a computerized resident sign-out system should include the ability to print reports on paper so that cross-covering residents can (1) take additional notes during face-to-face sign-out,[9] (2) keep a record of patient changes and decisions made overnight, (3) have ready access to key information when called by nursing staff without having to find a computer and access the system. It is noted elsewhere that having sign-out information in both paper and electronic forms might allow house staff to more accurately assess risk for adverse events.[9]

Care quality concerns and the role of computerized resident sign-out systems. Currently, the Joint Commission on Accreditation of Healthcare Organizations is investing considerable effort to improve patient care by analyzing and improving work processes to avoid poor communication and to reduce service handoffs, delays, rework and redundancy.[11] An important risk factor for potentially preventable adverse events is cross-coverage of patients by physicians who are less familiar with the patients.[2] In 1991, one hospital estimated that 30% of the hospital stay of a medical patient was under the care of night float or cross-covering house staff.[9] Residents self-report feeling less comfortable and less confident in managing patients admitted and evaluated by other residents.[3,5] This attitude is reinforced by findings that increased turnover of patient care duties from primary teams to cross-covering teams increases the potential for errors in communication, decision making, and disruptions to patient plans.[12] In fact, before the introduction of the 80-hour workweek, inadequate communication between teams when handing off patient care duties was already cited as a problem in some teaching hospitals.[5] The use of a computerized resident sign-out system reduced the rate of confidential, self-reported, preventable adverse events in the 1 study done to date.[9] In summary, we have demonstrated that computerized resident sign-out is a feasible tool that can efficiently combine the tasks of handling patient information needed for both sign-out and daily ward work. The system should permit portability and flexibility in the information it manages; it should combine common resident tasks that involve handling and maintaining patient information;[13] it should be linked to other hospital sources of patient data; and it should contain the essential information elements we have described above.

CONCLUSION

This new era of limited resident work hours introduces many opportunities to improve old systems. Indeed, we found the leadership of the UW School of Medicine and the hospitals eager to help us review, streamline, and improve the processes for patient care. An increasing body of knowledge suggests that long-standing, traditional methods of gathering patient data, organizing it, and communicating it among primary team

members and cross-covering physicians may not support high patient care standards under a system of shorter work hours, which consequently increased distribution of care among clinicians. Using the widespread support for this project from the UW School of Medicine, hospital administration, faculty, and house staff, we moved from the idea stage to production, using rapid application development,[8] in about 4 months at a cost of less than $15,000. Thus, what began as a partnership out of necessity to deal with a perceived threat to patient care resulted in the creation of a tool that is feasible and rapidly embraced by users, and that reflects house staff practice at our institution. With further study, we hope to characterize the project's impact on safety, quality, and efficiency—and hope ultimately to benefit not only residents, faculty, and institutions but, most importantly, our patients.

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