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Utilizing Information Technology to Mitigate the Handoff Risks Caused by Resident Work Hour Restrictions

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Abstract
Background Resident duty hours have been restricted to 80 per week, a limitation thought to increase patient safety by allowing adequate sleep. Yet decreasing work hours increases the number of patient exchanges (so-called "handoff") at the end of shifts.
Where are we now? A greater frequency of handoff leads to an increased risk of physician error. Information technology can be used to minimize that risk.
Where do we need to go? A computer-based expert system can alleviate the problems of data omissions and data overload and minimize asynchrony and asymmetry. A smart system can further prompt departing physicians for information that improves their understanding of the patient's condition. Likewise, such a system can take full advantage of multimedia; generate a study record for self-improvement; and strengthen the interaction between specialists jointly managing patients.
How do we get there? There are impediments to implementation, notably requirements of the Health Insurance Portability and Accountability Act; medical-legal ramifications, and computer programming costs. Nonetheless, the use of smart systems, not to supplant physicians' rational facilities but to supplement them, promises to mitigate the risks of frequent patient handoff and advance patient care. Thus, a concerted effort to promote such smart systems on the part of the Accreditation Council for Graduate Medical Education (the source of the duty hour restrictions) and the Association of American Medical Colleges (representing medical schools and teaching hospitals) may be effective. We propose that these organizations host a contest for the best smart handoff systems and vigorously promote the winners.

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Introduction

Where Are We Now?

The problem of physician fatigue—specifically house officer sleep deprivation—has garnered much attention in recent years [2, 8, 9, 21]. In general, people kept awake for 24 consecutive hours or more demonstrate cognitive and emotional dysfunction; and, in particular, the error rate increases for house officers working longer shifts [8, 25, 27]. For this reason, among others, in 2003 the

Accreditation Council for Graduate Medical Education (ACGME) limited resident work hours to 80 hours per week [20].

While many patient advocates have applauded these limits on duty hours, some academic physicians have argued the 80-hour work week may be harmful [1, 15]. These critics suggest that the benefits accrued from greater sleep are more than offset by the added harm of frequent transfers of primary responsibility for a patient between house officers, a process known as "handoff" (the term we will employ) or "sign-out" [5, 18]. Greater patient handoff necessitated by ACGME requirements is said to lead to increased opportunities for miscommunication and omission of vital patient information [15]. If this is true, then covering house officers (despite being well rested) may still make mistakes that their more fatigued colleague (having greater familiarity with the patient) would not have made, even in the latter's 30th duty hour [5, 6]. For example, a case-control study of 3146 patients over 4 months found those with adverse events were more likely at the time of the event to have been covered by a physician from another team [18].

Where Do We Need To Go?

The problems associated with an increased frequency of handoff are not a reason for rescinding the 80-hour restrictions, of course. For one thing, residents must get some rest [5]. Also, studies show decreased medical errors [5] as well as increased resident satisfaction and well-being with work hour restrictions [26]. As such some frequency of handoff is inevitable. The challenge, then, is to minimize the dangers associated with the transfer of responsibility between house officers. Information technology can limit the complications of handoff. That is, although the problems created by handoff are not solely informational—social, psychological, and cultural factors contribute, too—the core difficulty is information imbalance leading to discontinuity of care. Thus, with better informational tools in hand, this information disequilibrium can be minimized and the quality of care improved [8].

How Do We Get There?

To minimize the difficulties with frequent handoff, we advocate creating a computerized, multimedia system that can facilitate accurate and efficient transfer of patient care. Our proposed system can attend to the general problems of handoff—which we identify as distortion of original message, omission and excess of data, asynchrony of information, and the focus on individual competition in medicine—all the while addressing the "meta-issues" of an information technology solution, such as Health Insurance Portability and Accountability Act of 1996 (HIPAA) [11] regulations and Joint Commission standards. It can also specifically address problems unique to the specialties, such as the diversity of the inpatient population and the practice of house officers covering more than one facility while on call, issues confronted on many orthopaedic surgery services, for example.

Problems and Solutions

Distortion

The process of handoff has been likened to the children's game of "telephone," in which the repeated exchange of a message degrades the signal to the point where none of the original content remains [6]. In a similar manner, repeated handoffs can lead to great distortion of the original message. Patient handoff is additionally problematic because the original message—even before initial transmission—may represent a distorted view of reality, based on inadvertent omission of data [6], or an incomplete or incorrect understanding on the part of the departing physician, who may not even consider the patient his or her "own" [8].

To address the first form of distortion—message degradation—a computer program to facilitate the process of handing off patients by the departing physician can be used. Studies show that use of a standardized, computer-based handoff system helps preserve accurate patient care [25, 26], and systematized forms have been used at various academic institutions over the past decade [19, 24]. But, to our knowledge, none of these approaches have availed themselves of current technology's full potential to mitigate the second form of distortion by ensuring that the best possible message is used initially. Accordingly, the fundamental feature of our proposed system is that it will query the departing physician for information and not simply accept it passively.

The request for information can begin simply. For instance, the program can note whether laboratory tests have been ordered on a given patient earlier in the day and then ask the departing physician if the receiving house officer is to check these laboratory values later that evening. Additional focus can be introduced by generating a task list based on the patient's diagnosis. For example, if a patient is admitted with a tibia fracture, the evening work assignment could, without human intervention, include the task "assess for compartment syndrome" (Fig. 1A–B)—a known complication of tibia fractures, whose prevention requires vigilance.

Fig. 1A–B Radiographs and extremity photograph of a patient with a tibia fracture are shown. (**A**) Although the bony injury here is obvious, (**B**) the soft tissues are fairly unremarkable and lack any clue, per se, to suggest an incipient compartment syndrome (a condition commonly associated with tibia fractures and indeed present in this particular patient). That is, the only clue is the diagnosis itself. A sign-out system that automatically alerts receiving physicians to assess for a compartment syndrome based on the bony injury may be helpful accordingly.

At a higher level of sophistication, a rule-based expert system can note trends in studies or laboratory values and suggest areas of concern. By asking the departing physician questions related to the case, the program minimizes the opportunity for distortion before the first transmission.

Data Omissions and Data Excess

The information disequilibrium associated with handoff is driven not only by faulty comprehension of the patient's condition but also by a lack of raw data. In one detailed analytic study, the overwhelmingly most common source of handoff-related error was a failure to transmit information [4]. Yet that is not to say the handoff message must be voluminous: to the contrary, brevity ensures that the signal-to-noise ratio stays appropriately high. Indeed, when the entire electronic medical record (EMR) is pasted verbatim, there is so much dross included that, in effect, no information is transferred.

Both of these problems—data surfeit and data scarcity—can be eliminated with a handoff program that links electronically to the EMR. The problem of dropped data is less likely, as the information would be readily available when the receiving physician requests it. On the other hand, by only linking to the data—and not allowing the cutting and pasting of it—the program will not inundate the receiving physician with distracting information. Receiving physicians can avail themselves of the stream of data without being drowned by it. And as suggested by Van Eaton et al. [24], a paperless system—even one simpler than the proposed smart system—is apt to help the typical house office save at least several hours per week otherwise wasted by transcribing information.

Asynchrony

In conventional modes of transfer, the receiving physician must be receptive at the same time the departing physician wishes to initiate handoff and vice versa. A smart system can help avoid this problem: departing physicians can execute the handoff to the computer system when they are ready to do so, and the tasks and information can be collected by receiving physicians when they are ready to accept them.

A related benefit of the computerized handoff program is that the departing physician can handoff patients incrementally during the day at the precise time the patients' situations change. For instance, if the departing physician orders a blood transfusion at 2 pm, the receiving physician might be asked to check a post-transfusion hematocrit that evening. The charge to the receiving physician is initiated, conceptually speaking, at 2 pm (when the transfusion is ordered). There is no reason articulating that request should be deferred to the evening, but for the fact that handoff itself does not occur until the evening; and indeed that delay invites the opportunity of omission. Optimally, the request to check the post-transfusion hematocrit should be contained within the order for the transfusion itself.

Competition versus Cooperation

The medical school admission process does not generally select students based on their talents for cooperation. One gets into medical school, and thrives within it, by the demonstration of individual merit in a Darwinian system of outcompeting one's peers. Unfortunately this emphasis of individual attainment hinders effective handoff, which is inherently a collaborative, team-oriented undertaking.

Although a medical school admissions process favoring team-oriented individuals may be most helpful in the long run, a more immediate payoff is obtained if physicians were simply encouraged to collaborate better. In our view, that encouragement requires no more than informing physicians their achievements in the realm of collaboration will be evaluated, given a defining characteristic of successful medical students is the ability to perform well on tasks under evaluation. A computer-based handoff program can help foster that system of incentives, precisely because it creates an audit trail. The quality of the handoff task list can be assessed by a supervisor; likewise, the receiving physician's rate of successful follow through can also be marked.

A related issue is that students and residents are, with rare exceptions, inadequately taught handoff skills, with few receiving formal instruction or even informal feedback [3]. A handoff program therefore could be an invaluable adjunct to train students and residents with real-world examples, and the system could easily be adjusted to serve as a simulator for practice.

Added Value From Images (or "One Picture is Worth a Thousand Words")

Conversational modes of handoff offer certain advantages such as nuance of speech and the ability to at least ask if the message was received; written lists also offer their rewards. Yet both, of course, have limits. For example, if the task at hand is to monitor a patient with cellulitis and to make sure the region of erythema retreats with antibiotics, the best mode of handoff is neither a conversation nor a written list: it is a picture (Fig. 2). The ideal handoff system, therefore, would support a multimedia approach such that pictures, trend graphs, radiographs, and the like can be shared efficiently.

Impediments

The primary impediment to the creation of a smart handoff system is financial. First, integrated computer systems necessary to support such a handoff technology are present in at most 10% of United States hospitals and probably fewer [3, 7]. It is therefore likely that not only building such a system will be expensive but building necessary infrastructures will be as well. Furthermore, the benefits of such a system, manifested as improvements in the quality of care, are reaped by all, and are difficult to capture by the investor distinctly. This creates a so-called Free Rider problem: when the costs are focal but the benefits diffuse, there is an understandable reluctance by any single individual or entity to bear these costs. And no matter how powerful the program may be, at present it can serve only as an adjunct: the Joint Commission has decreed handoff must include a conversation between house officers [23].

Fig. 2 A photograph shows cellulitis of the great toe. If a covering house officer is charged to note progression/regression of the infection, a photograph can be more helpful than a verbal description.

There are also problems unique to the medical specialties. In orthopaedic surgery, for example, receiving house officers typically cover a highly diverse population of patients. Because of the lack of patient homogeneity on the orthopaedic surgery service—e.g., the issues for a postoperative arthroplasty patient and a recent trauma admission are distinct (Table 1)—no template is apt to succinctly yet completely match every patient.

Moreover, orthopaedic surgery cross-coverage may involve more than one hospital. Especially if residents are covering multiple hospitals with distinct computer networks, the best implementation of the handoff program would be a browser-based system, accessible by personal digital assistant or smartphone. This creates challenges with regard to the Privacy [13] and Security [14] Rules established by HIPAA [11].

Additionally, in the medical-legal domain, concerns that the program may increase vulnerability to medical malpractice suits may impede adoption. House officers may worry the system will leave evidence for medical malpractice attorneys eager to document violations of the standard of care. As a result, they may fear the program's potential to harm them in future litigation and shun it, even if it improves their efficiency otherwise.

HIPAA does not pose insurmountable problems. While the general impression is that HIPAA was primarily designed to protect the privacy of the patient by restricting what information can be disseminated, this is not quite the case. The "P" in HIPAA in fact stands for "Portability," not "Privacy" [11], and the Act was designed to facilitate communication among providers, payors and other relevant actors in the health care system. And while Title II of HIPAA, "Administrative Simplification," promulgated a set of rules designed to protect patient privacy by restricting unauthorized use and disclosure of protected health information [12], such compliance should not be difficult. As long as patients have received a copy of the hospital's "Notice of Privacy Practices," consent is not required for disclosures between

Table 1. Differences in typical sign-out tasks and other patient features, contrasting orthopaedic trauma and adult reconstruction patients

Task	Orthopaedic trauma	Adult reconstruction
Need to address weightbearing status	Often (dependent on injury pattern and attending preferences)	Rare
Need to make preoperative plans or initiate clearance while in hospital	Often (many patients return to the operating room during index admission)	Rare
Need to address anticoagulation orders and status	Variable (ranges from nothing to various pharmaceuticals to Greenfield filters)	Always
Need to obtain medicine consultation (versus need to address primary medical problems directly)	Variable (based on age and comorbidities)	Almost always
Need to monitor hemoglobin	Variable	Almost always
Need to obtain inpatient radiology services	Frequent, highly variable	Rare, beyond first postoperative film
Need to request durable medical goods	Highly variable (injury pattern and treatment dictate needs)	Many (eg, continuous passive motion machine, walker, bedside commode), but almost always anticipated by protocol
Age range	16–90 years old	60–80 years old
Primary service	Usually "general trauma" service	Usually orthopaedics
Comorbidities	Unknown; not controlled	Frequent, controlled
Complications	Many, variable	Well defined

treaters of information related to treatment and healthcare operations. Indeed, the HIPAA Security Rule [14] expressly allows systems such as the one proposed. Still, the Security Rule requirement to implement technical safeguards to ensure that privacy is not compromised—safeguards such as data encryption, two-factor authentication, secure layer protocols, personal firewall software, and session time-out procedures—may create barriers to execution by virtue of added cost alone.

The concerns about malpractice are more challenging. In our view, worry that the handoff program may increase vulnerability to medical malpractice suits represents a mistaken view of the malpractice system and the vulnerabilities of physicians. For one thing, written records (with explicit, real-time documentation of care) tend to exonerate careful physicians in lawsuits, supporting their contention that proper standards of care have been followed [10]. It is also likely the handoff program, by proactively guiding house officers to check test results, for instance, will prevent the very errors that lead to malpractice suits in the first place. And although one pilot project indicates that resident satisfaction with handoff increased with the introduction of a simple database (FileMaker® Pro, FileMaker, Inc., Santa Clara, CA) handoff system [26], the mistaken perception that a more comprehensive smart handoff system is potentially harmful may cause enough resistance to scuttle the system. Still, remedying that perception may therefore require tearing down the entire "culture of blame" [16, 22] currently characterizing medicine—a formidable task indeed.

Discussion

Resident duty hours have been restricted in order to increase patient safety, yet critics say that decreasing work hours compromises patient safety by increasing the risk for mistakes by covering doctors unfamiliar with their patients' needs. While it may be easy to dismiss critics of the 80-hour work week, handoff is indeed potentially dangerous [5, 18]. Nevertheless, the correct response is not to outlaw handoff in general but to minimize its costs and to improve the quality of care. As shown, this goal can be attained through the better use of informational technology [8]. The methods employed to improve overnight handoff among house officers, moreover, can be the springboard for improving collaboration among specialists sharing responsibility for a complex inpatients or between hospitalists and outpatient practitioners for more routine cases.

To help build this computerized smart system—especially in the face of formidable impediments—we can turn to the Accreditation Council for Graduate Medical Education (the source of the duty hour restrictions) and the Association of American Medical Colleges (representing medical schools and teaching hospitals). We propose that these organizations sponsor a tournament for the best smart handoff systems, similar to the Netflix Prize competition that was organized for the purpose of improving rating prediction algorithms in ordering DVDs by mail [17].

In this ACGME/AAMC smart system tournament, programs can be graded not only in terms of ease of use and other features, but with direct comparative measurements of efficacy: teams of doctors can be enrolled in an experiment similar to the Turing test of artificial intelligence [28], and asked to manage hypothetical patients using information gleaned from one of two sources: a phone call to the departing physician or the smart system itself (which received handoff from this same departing physician). If the performance of the experimental physician is no worse using the smart system then perfect handoff can be said to have been attained.

In turn, the ACGME and AAMC can agree to promote the winners of the tournament, thereby ensuring not only that the best systems are used, but also that developers can expect to be rewarded for their efforts.

Without a doubt, even the most robust handoff system will not prevent every potential error by receiving physicians. Certain risks are inherent to the role, including the difficulties caring for large cohorts of patients, an inability to accept complete personal responsibilities for "somebody else's patients," and the circadian rhythm problems associated with working deep into the night. Yet a reasonably robust handoff system will prevent at least some errors. Hence, building such a system should be no less required than utilizing technology for ordering medications, laboratory testing, or diagnostic imaging.

Within the reach of all physicians, and in need of their faith, is the embrace of smart technology systems, not to supplant their rational facilities but to supplement them. It is in this role as a guide that the proposed smart-system, computerized handoff program promises to advance patient care.

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