

A Conceptual Framework for Studying the Safety of Transitions in Emergency Care

Ravi Behara, Robert L. Wears, Shawna J. Perry,
Eric Eisenberg, Lexa Murphy, Mary Vanderhoef, Marc Shapiro,
Christopher Beach, Pat Croskerry, Karen Cosby

Abstract

In health care organizations, the division of labor and a need for continuous, 24-hour treatment subjects patients to multiple transitions in care. These transitions, or “handovers,” are potential points of failure that have seen very little study. We observed transitions of care in five hospital emergency departments as part of a larger study on safety in emergency care and found that in addition to many other differences in work patterns among the various hospitals, very different sorts of handovers occurred in different contexts, and these differences appeared to reflect a common structure. Using these observations, we have proposed a conceptual framework for characterizing handover events. The ability to characterize certain types of transitions may help to clarify future studies, while assisting in the development of interventions to better fit the context of clinical work.

Introduction

The need for 24-hour care and treatment requires health care workers to break each day into manageable shifts. This practice leads to transitions in the care of individual patients when the physicians or nurses who began a patient’s treatment transfer their charge to a new group of caregivers. Depending on the setting and the patient’s needs, these transitions may occur many times, once, or not at all. In addition, the complexity of health care requires a correspondingly complex division of labor, which leads to more transitions in care of a somewhat different kind, as patients move among different settings of care and professional specialties.

Efforts to increase safety through a reduction in work hours tend to increase the number of transitions in care.¹ This may affect safety in unexpected ways. Petersen reported that medication problems were more likely to occur when inpatients were being managed by a cross-covering physician, rather than their own doctor,² and later reported that a structured handover program appeared to reduce the frequency of such events.³ Similarly, although it has not yet reached the general awareness of practitioners, our group and others have reported that handovers can actually be mechanisms for recovering from failure—rather than merely sources of vulnerability.^{4–8} These unexpected findings suggest that handovers are much more complex than previously assumed, and that this complexity is not yet understood. In effect, handovers are “implicit processes” (personal communication, David Musson, University of Texas) that are not an

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE 2005		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE A Conceptual Framework for Studying the Safety of Transitions in Emergency Care				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Agency for Healthcare Research and Quality 540 Gaither Road, Suite 2000 Rockville, MD 20850				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 14	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

explicit function of the way work is done, but are implicitly present and necessary for the work to be completed successfully.

Shift change handovers in emergency departments provide a direct opportunity for studying transitions in care. These handovers are widely considered to be potential sources of failure.^{9, 10} Although the success of these transitions is critically important to the quality and safety of care,⁶ they have received little attention from the health care community. No prescriptive standards or guidelines exist for shift changes and, with rare exceptions, they have not been studied.^{11, 12} This is in sharp contrast to other high-hazard industries, where studies of shift change handovers are not uncommon.^{7, 13, 14} Although sporadic attempts have been made to improve handovers, they have been largely informal and unsuccessful (Croskerry, personal communication).

The problem of understanding how transitions contribute to the success or failure of care is compounded by the fact that handovers are extremely heterogeneous. While commonly viewed as exercises in communication, they also serve other important needs, including training, increasing team cohesion, and socialization.^{15, 16, 17} Additionally, they are highly variable in form and content. This paper will present a proposed conceptual framework for better understanding the heterogeneity of shift change handovers and transitions in care.

Methods

We performed ethnographic observations of caregiver transitions in five emergency departments (EDs) throughout the United States and Canada. Three of the EDs were large, inner-city, quasi-public institutions; another was a large, private tertiary referral center; and the fifth setting was a medium-sized community ED. All had academic affiliations; four were routinely staffed by residents-in-training under faculty supervision, and one was staffed solely by faculty physicians. Institutional review board approval was obtained prior to the start of the study at all participating sites.

Although the observations were directed primarily at shift changes involving physicians and nurses, there were opportunities to observe other transitions in care (e.g., from prehospital personnel to ED personnel, or from the ED to an inpatient service). The observations were supplemented by audiotaped transitions in four of the five institutions; these were later transcribed without personal or institutional identifiers. The observations were further supplemented by in-depth investigations of selected accidents or incidents involving handovers (either as a contributor to the failure, or as a contributor to the incipient failure recovery). Notes and cognitive artifacts created by the workers to assist them in managing the handover also were reviewed.

The data were reviewed qualitatively by domain experts and behavioral scientists using content analysis and a grounded theory approach, supplemented by the affinity diagram technique.¹⁸ A series of meetings was held with the entire research team to review the results and develop a conceptual framework for

explaining the observations. Finally, as the framework took shape, a review of the original data was conducted to ensure that the elements of the framework could be unambiguously attributed to the data.

Results

Handovers differed substantially in their external characteristics. Some were dyadic, one-to-one exchanges, for example, while others involved exchanges among two groups. Some occurred in the workplace, while other handovers took place what might be referred to as a “backstage” area; a separate area where the handover activity was not easily visible or audible from the main care areas. Some directly involved the patient, while others did not. Some, but not all, handovers made routine use of external cognitive artifacts (e.g., a chart or whiteboard). In most cases, the party coming on-shift made notes, but there was little structure or standardization among individuals in this practice. The external characteristics of the transitions differed to such a great extent among the study institutions, it was impossible to use identical observational protocols at all of the sites; instead, the study procedures were customized as necessary to fit the local environment and practices.

Many of the aforementioned differences would appear to have implications for safety. There was acknowledgement at all of the sites of some potential safety problems with current handover practices, but these were viewed as tradeoffs (i.e., improving one aspect of the turnover, such as decreasing noise and interruptions by moving to a backstage area, would introduce new vulnerabilities because the oncoming workers would not see the patients being discussed). In addition, there had been very little history of experimentation with handovers at the various hospital sites, i.e., handovers were performed in a certain way because they had always been done that way.

In contrast to the external differences, there were several attributes of ED handovers that were nearly universal in our observations. First, the handovers were never unidirectional “data dumps,” but were instead dialogues or conversations with the oncoming party actively eliciting information, asking for clarification, or pointing out omissions, contradictions, and inconsistencies. The transition of care did not simply involve the sharing of information, but also included expectations for the future, plans based on those expectations, and assessments of those areas for which the information was incomplete or poorly understood. Thus, handovers are, in effect, joint constructions involving the offgoing and oncoming parties. Second, they included both specific exchanges referencing individual patients, and global exchanges about the status of the entire work unit, including supporting services. Third, they covered the patients being transitioned in a “standard order” to guard against omissions; typically this involved always starting and ending at the same bed locations to ensure that so all patients were reviewed. Fourth, the discussions generally were initiated and terminated by the oncoming party. Finally, the handovers were “accordion-like,” in that they expanded and contracted in relation to a variety of factors, including

the number of patients to be transferred, emergencies or other pressing situations needing immediate attention, and the degree of confidence and credibility in both parties.

In addition to the external difference in form, there were additional differences in the observed handovers that seemed to be related to deeper, underlying properties. These fundamental conditions form a conceptual framework with which handovers can be examined and compared, which may prove useful in explanation as well as the design of better processes.

Conceptual framework

The framework addresses four important attributes of a handover: (1) the type of process in which it occurs; (2) the primary content; (3) structural issues (e.g., the nature of the participants); and (4) dynamic issues (e.g., the position of a given case in a structuredness/continuity space).

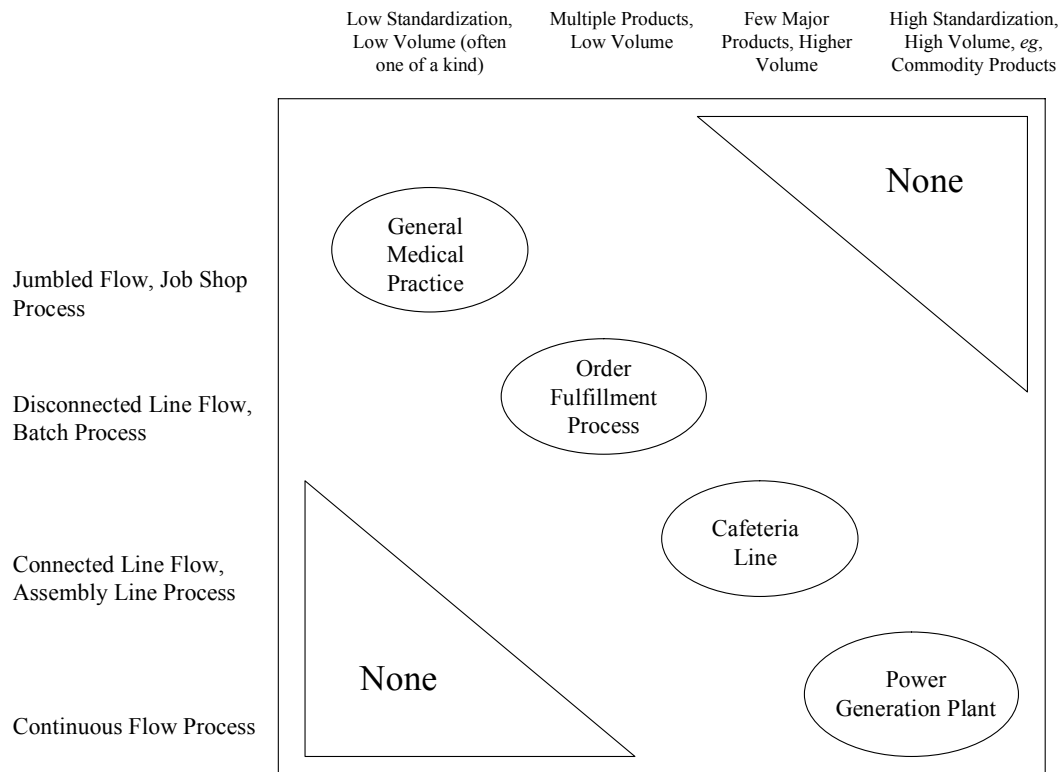
Type of process

For our purposes, a process is defined as the means by which an organization transforms its inputs into higher-valued outputs. The ED care process, for example, can be viewed as transforming patients with undifferentiated emergent conditions into those who are sufficiently stable for discharge or transfer to an inpatient service for more specific care. The product–process matrix¹⁹ relates the characteristics of the item(s) being produced with the type of flow process the work presents (Figure 1). Different types of transitions are characterized by different positions in the matrix. In EDs, standardization is very low with respect to patient types and needs, since they are unpredictable and typically one-of-a-kind. Furthermore, the patients flow in a “jumbled” fashion as they do not usually follow a predetermined or linear sequence of steps, and often interfere with one other.²⁰ Thus the job shop model appears best suited to EDs.

In job shop settings, resource utilizations cannot be maintained at 100 percent; workers have a wide range of skills, and each “product” or “job” moves through the production facility at a much slower rate than the actual number of hours required to complete the specific “job.” Flexibility is high in such settings, but so is unit cost. These characteristics fit the ED context well. Other types of handovers might occupy different positions in the matrix. Ward team signouts for cross-coverage involve less variability in the work and might be better viewed as batched processes, while some very tightly integrated services (e.g., cardiovascular surgery in some settings), might approach a production/assembly line model.

In the ED setting, pressures of increased work volume and/or calls for greater economic efficiency tend to advance the batch or assembly/production line model. This is not likely to be an effective operational strategy, however, since the unique nature of the “product” does not change. The differences in production process may account at least in part for the success of a structured signout system

Figure 1. Process–product matrix with archetypical examples



for cross-coverage on inpatient medical wards,³ and the failure of similar efforts in the ED.

Content

Primary content refers to the relative importance of three things that are transferred in any handover: information, authority, and responsibility. Focusing on handovers solely as a communications (i.e., information transfer) task ignores much of what is important and does not provide insight into certain types of failures. Most handovers include all three elements to some degree, and this tendency does not seem to vary within types of transitions. When handovers are extended in time or space, authority and responsibility are at risk of confusion. This can occur, for example, when an inpatient physician accepts a patient from the ED but cannot attend to the individual promptly, or when a patient’s care is transferred from one service to another, but the patient is not moved out of the original care area. Another setting where authority may be diffused is in cross-coverage situations, when the covering physician assumes a “caretaker” role, and tries not to make major changes in the patient’s care management.

Even when a narrow focus on communication is adopted, the information transfer task is much richer than the simple replication of facts in a new location. Moreover—and perhaps more important than the specific, isolated facts of a patient’s condition—handovers also transfer at least three additional components:

expectations for the near future; nascent plans for managing potential deviations from the desired course of care; and an idea of where current knowledge is reliable and where it is imperfect.

Structure

There are three structural elements that characterize transitions. The first is the nature of the participants (the oncoming and offgoing parties, and the patients themselves). The second is the number of patients involved (typically one, but sometimes a few or many). And the third characteristic is the probability that the receiving party will have to interact with the same patients in the future. The participants can be like (ED physician to ED physician), or unlike (paramedic to ED nurse, or ED physician to surgeon). Transitions between like participants typically involve many patients (e.g., at shift changes), while handovers between unlike participants typically involve only one patient. Failures arising from interaction effects are more likely in the former, as are shared misunderstandings (i.e., where both parties fail together). Differential misunderstandings are more likely to occur in handovers involving unlike participants. Finally, the probability that the receiving party will have subsequent interaction with the patients being transferred can be either high or low. Transitions where the probability of future interaction is low (e.g., a ward team's signout to a night coverage team) can be thought of as "just in case" information. This type of handover may be more amenable to structured, information technology interventions.³

If we dichotomize each of the three structural dimensions into its extremes (like versus unlike, few versus many, high probability versus low), there are eight potential combinations of attributes (Table 1). In our observations, however, only three of the eight potential combinations occurred with any frequency. The first common combination was typified by ED shift changes or nursing shift changes (Table 1, first row). The participants were like (nurse-to-nurse or doctor-to-doctor); many patients were handed over; and the likelihood of future interaction with the transitioned patients was high (typically 100 percent). The second most common combination was ward coverage handovers (Table 1, second row). Here the participants are like (doctor-to-doctor); many patients are transitioned; but the likelihood of future interaction with any one particular patient is low (since the covering physician may never be called about many of the transitioned patients). The third common combination is typified by transfers of patients between disparate services (e.g., from an ambulance to the ED, from the ED to the ICU, or from internal medicine to surgery [Table 1, row 7]). Here the participants are unlike in some way; either they are from different professions (e.g., paramedic-to-doctor), or if not, they are from different specialties (e.g., emergency physician-to-internist, or internist-to-surgeon). The number of patients involved is small (typically one), and the probability of future interaction is high (typically 100 percent).

One notable aspect of the participants' nature pertained to joint handovers (i.e., involving both physicians and nurses), which almost never occurred in our observations. When they did occur, they were extremely limited; for example, a

charge nurse might take part in physician handovers. A variety of reasons were offered for this behavior. Physicians sometimes asserted that nursing handovers concerned “softer” social issues that were of less interest to the physicians, but our observations did not support that. The content of nursing handovers was largely related to technical work, as was the content of physician handovers. The nature of the technical work discussed did vary between the two groups, however, reflecting their different work content. Nurse-to-physician teams were not well established in some hospital settings, so different pairs of nurses and physicians were made responsible for different patients, making joint handovers somewhat more difficult. In the two settings that did use nurse-physician teams, however, handovers still occurred separately. A final reason offered for the separation was that handovers remove caregivers from direct patient contact for some period of time, so conducting them separately permits at least one set of caregivers to work, making them available to watch and care for the patients. Again, experience with alternative scenarios was scant.

Table 1. Structural characteristics of handovers and prototypical examples*

Participant	Volume	Probability	Example
Like	Many	High	ED shift change, nursing shift change
Like	Many	Low	Ward team signout
Like	Few	High	
Like	Few	Low	
Unlike	Many	High	
Unlike	Many	Low	
Unlike	Few	High	Admission to ED from ambulance, admission from ED to hospital, transfer to another service
Unlike	Few	Low	

*Only three of the eight possible combinations were commonly observed; examples of these three are listed.

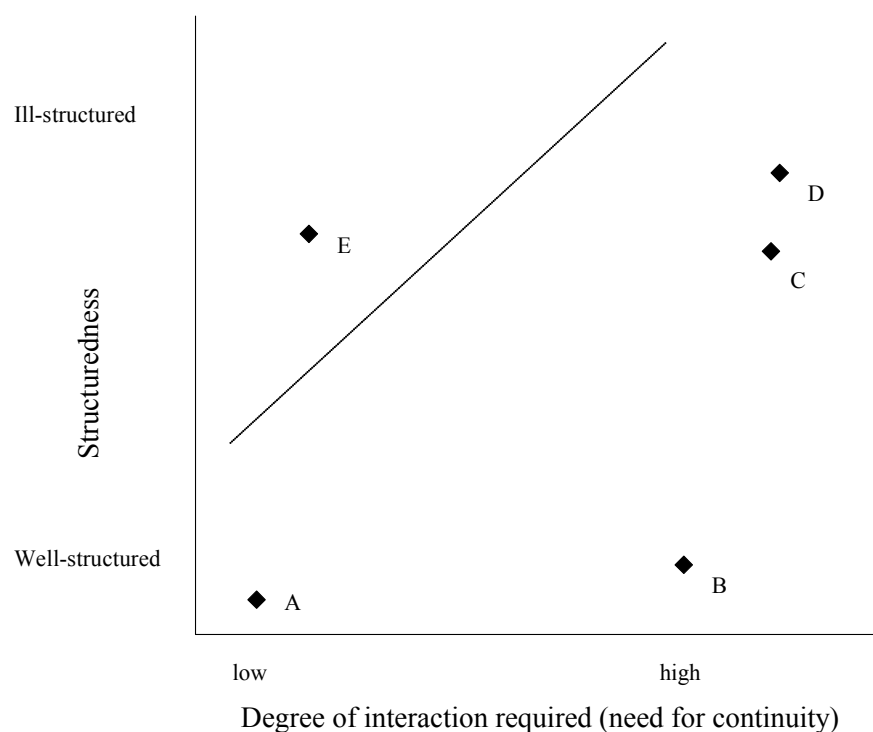
Dynamic

The dynamic component of the framework refers to a contextually sensitive, “on the fly” adjustment of the volume, detail, and style of the conversation about a given patient. Handovers involving many patients typically were internally heterogeneous, with different sorts of discussions involving different patients—even when their cases were nominally similar. Participants in the handovers appeared to switch fluidly between several communication modes, which we will call *genres*, with apparent ease.^{21, 22} Yates and Orlikowski define genres as “socially recognized types of communicative action habitually enacted by members of a community to realize particular communicative and collaborative purposes.”²³ Obvious examples of communications genres include business letters, memos, face-to-face meetings, reports, and announcements. These genres are easily recognized because of their socially identifiable purpose and shared form. Yoshioka and Herman point out that communities use genres for

coordinating information.²² A genre is socially recognized by members of a community and invoked in typical situations, such as ED handovers. In our observations, communications genres were used to implicitly convey information regarding the nature of a specific patient’s handover.

These handover genres can be characterized by their locations on a 2-dimensional plane (Figure 2). The x-axis represents the amount of interaction required from the oncoming worker (which can be viewed as a need for continuity) from low to high, and the y-axis represents the degree of uncertainty or unstructuredness of the patient’s problem from well-structured, (high certainty), to ill-structured (high uncertainty).

Figure 2. Relationships among handover genres



Point A represents a case “all wrapped up and tied with a bow”: an extremely well-structured problem with very little future interaction needed (e.g., ED patient waiting for a plastic surgeon to arrive and repair a laceration). The opposite extreme is represented at Point D, which could be a patient who arrived in the ED just prior to shift change but has not been assessed. Point C represents a “work in progress”—a patient whose assessment has started, but whose problem cannot be adequately characterized at the time of the transition; and Point B typifies a patient with well-structured problems requiring prolonged observation before an informed decision can be made, (e.g., an apparently unvenomated snakebite victim). Point B also could typify a patient whose problem is well understood, but the remaining work they require is distributed unequally among physicians and nurses. For instance, a hip fracture patient being admitted to an orthopedic

surgeon might be represented by Point A for physicians, but by Point B for nurses. Virtually all ED transitions occur beneath the angled line. Some transitions in other settings, however, could be characterized by Point E; for example, a ward team signout to a night coverage team. Here, the likely need for interaction continuity for any specific patient is low, but should the need arise, the problem is likely to be a new and ill-defined one.

The choice of communication genre for the handover appears to be important in the co-construction of a mental model for the patient whose care is being transferred. Orlikowski has proposed that communication genres are used by workgroups to serve as an organizing structure for the social and professional interactions of the group.²¹ In the ED, a given genre conveys information implicitly about the state of knowledge for a patient, the certainty of that knowledge, and the likely future course. The importance of the genre to the handover is particularly notable when a mismatch is detected. If the selected genre did not sufficiently represent the picture being constructed by the oncoming party, there was always an attempt to renegotiate the choice. If the negotiation was successful, the handover proceeded—either using a new genre or with an agreement that the original choice of genre was suitable. The renegotiation effort, however, was quite brief. If it was not immediately successful, the oncoming party adopted a strategy of resignation, conceptually placing the patient in question at Point D, and, (in the oncoming party's view) no further time was wasted in a futile attempt to achieve a better understanding.

Most of the studied sites had coded language to express the genres being used, e.g. “work in progress” and “all wrapped up and tied with a bow.” This encoding allowed the oncoming party to efficiently grasp the state of knowledge, its certainty, and the expected course of action, while establishing clear expectations for the discussion that followed.

Discussion

Because it is never possible to transfer a complete picture of a patient's condition from the mind of one caregiver to another and because the handover time is necessarily limited, clinicians must make judgments about the relevance and importance of what goes into the co-construction of the picture. Cook has used the “spinning up” metaphor to describe this phenomenon (personal communication, Richard Cook, University of Chicago). In his view, the goal of the handover is optimization. Given the limited co-presence of the participants, the handover provides just enough of the relevant picture so that the oncoming caregiver can “spin up” to operational speed quickly, should the need arise.²⁴ Thus, the shared expectation of this need guides the volume and detail of each handover conversation, and explains some of the postulated differences between, for example, ED handovers and ward team handovers.

In her study of handovers in four different high-hazard industries, Patterson noted 21 strategies that workers employed in order to improve either the efficiency or the effectiveness of handoffs.⁷ In our observations, we found that

eight of these strategies were used consistently in ED handovers, another four strategies were used sometimes or in some institutions, and the remaining nine were used infrequently or never at all (Table 2). This work suggests several potential avenues for improving handovers. Some of the more promising strategies include: limiting interruptions during a handover; using “readback” practices to ensure both parties share the same mental model; including practitioners in the handover beyond the one being replaced; and cross-monitoring the handovers of others.

Table 2. ED use of 21 strategies identified by Patterson, et al.⁷ to improve handovers

Strategies used consistently	Strategies used occasionally	Strategies never used
Face-to-face verbal update with interactive questioning	Offgoing oversees oncoming's work following update	Limited interruptions during handover
Delay handover when concerned about status or stability of process	Unambiguous transfer of responsibility	Offgoing writes summary before handover
Topics initiated by oncoming as well as offgoing	Overhear others' updates	Incoming scans historical data before handover
Limit initiation of actions during update (with critical exceptions)	Additional update from practitioners other than the offgoing	Incoming reviews captured sensor-derived data before handover
Incoming assesses current status		Intermittent monitoring of systems status while “off”
Updates provided in consistent order every time		Incoming receives primary access to most up-to-date information
Offgoing has knowledge of previous shift activities		Incoming receives paperwork including handwritten annotations
Handover includes offgoing's contingency plans, stance towards changes in plans		Readback to ensure understanding
		Others are clear about which party is responsible for which duties at a given time

Uncertainty in system input is a unique characteristic of EDs. In a study of the relationship among input uncertainty, means of coordination, and hospital ED organizational effectiveness,²⁵ Argote noted two categories of coordination methods: programmed and non-programmed. Programmed means of coordination involve plans, specific policies, and relationships previously specified by the organization; non-programmed means involve general ED policies and the autonomy and flexibility of the workforce. Her results indicated that EDs are most effective when they use programmed means of coordination, when faced with low input uncertainty, and when they switch to non-programmed means of coordination in those situations involving high input uncertainty. It was interesting to note that there was little evidence to indicate that EDs actually use

the level of input uncertainty to choose their methods of coordination. This contrasts with other service industries, where input uncertainty is associated more strongly with the function and structure of production processes.²⁶

The current emphasis on information systems as solutions to safety problems, and the success of Petersen's intervention for ward cross-coverage,³ makes technological solutions to handover-related failures at least superficially attractive. Technical solutions are mixed blessings, however, and their role (if any) in facilitating the effective transfer of information, authority, and responsibility in the ED setting is unclear. Ash, et al have pointed out studies showing that in a shared context, concise and informal, unstructured communication is most effective for coordinating work around a complex task,²⁷⁻²⁹ and argued that attempts to impose structure upon such processes comes at a cost and can prove counterproductive. Lardner reviewed the literature on transitions in industry and concluded face-to-face, interactive, verbal handovers were preferable to more restricted modalities.¹⁴ Berg has raised similar, more generalized arguments, while Coiera has emphasized the immense size and complexity of the communication/interaction space in health care organizations.^{30, 31} Our results and these critiques all suggest that truly useful informational aids are more likely to be based upon a detailed understanding of the context, manner, and social setting of the way technical work is performed, than designs derived from formal information systems principles.

Limitations

This schematic framework arose from our efforts to better understand and manage the complexity and heterogeneity of our observations on transitions. It is limited by the lack of an underlying theoretical construct (such as the abstraction/decomposition framework), although it might be adapted to such a method.³² In addition, our intensive observational effort was focused on ED shift change handovers; other important transitions also were observed, but they were not the primary focus of our efforts. We feel it is both useful and informative, however, to relate the ED shift change transitions to other transitions in care via this framework.

Conclusions

Shift change handovers are much more than simple exercises in communication. Authority, responsibility, and information are transferred through a process of co-construction in which both the oncoming and offgoing parties are active participants; they are, in essence, exercises in building distributed cognition.^{11, 33} Handovers are highly heterogeneous in their external attributes and in their internal structure, and some of this heterogeneity may explain differences in the success of efforts to improve them. Participants in handovers use information genres²¹ as an efficient means of implicitly conveying contextual information about the handover. Attempts to improve handovers—at least in EDs—have generally failed. These failures may be due in part to the absence of a

deep understanding of the multidimensional nature of transitions, resulting in one-size-fits-all interventions that do not support technical work.³⁴ A better understanding of the nature of handovers in health care may prove key to better interventions in the future.

Acknowledgments

The authors are participants in the Center for Safety in Emergency Care, a research consortium funded in part by Agency for Healthcare Research and Quality (P20-HS11592). Additional funding for this and related work has been provided by the National Patient Safety Foundation and the Commonwealth Fund.

Author affiliations

College of Medicine, University of Florida (RLW, SJP), College of Business, Florida Atlantic University (RB), Department of Communication, University of South Florida (EE), Department of Communication, DePaul University (LM), College of Nursing, University of Florida (MV), Brown University (MS), Northwestern University (CB), Dalhousie University (PC), Rush Medical College (KC).

Address correspondence to: Robert L. Wears, M.D.; University of Florida Health Science Center, 655 West Eighth Street, Jacksonville, FL 32209. Phone: 904-244-4124; e-mail: wears@ufl.edu.

References

1. Barden CB, Specht MC, McCarter MD, et al. Effects of limited work hours on surgical training. *J Am Coll Surg* 2002;195(4):531–8.
2. Petersen LA, Brennan TA, O’Neil AC, et al. Does housestaff discontinuity of care increase the risk for preventable adverse events? *Ann Intern Med* 1994;121(11):866–72.
3. Petersen LA, Orav EJ, Teich JM, et al. Using a computerized sign-out program to improve continuity of inpatient care and prevent adverse events. *Jt Comm J Qual Improv* 1998;24(2):77–87.
4. Cooper JB, Long CD, Newbower RS, et al. Critical incidents associated with intraoperative exchanges of anesthesia personnel. *Anesthesiology* 1982;56(6):456–61.
5. Cooper JB. Do short breaks increase or decrease anesthetic risk? *J Clin Anesth* 1989;1(3):228–31.
6. Wears RL, Perry SJ, Shapiro M, et al. Shift changes among emergency physicians: best of times, worst of times. In: *Proceedings of the Human Factors and Ergonomics Society 47th Annual Meeting*. Denver, CO: Human Factors and Ergonomics Society; 2003 pp.1420–3.
7. Patterson ES, Roth EM, Woods DD, et al. Handoff strategies in settings with high consequences for failure: lessons for health care operations. *Int J Qual Health Care* 2004;16(2):125–32.
8. Feldman JA. Medical errors and emergency medicine: will the difficult questions be asked, and answered? (letter). *Acad Emerg Med* 2003;10(8):910–11.
9. Joseph AJ. Acute coronary syndromes. *Foresight: Risk Management For Emergency Physicians* 2002 June;54:1–7.
10. Cook RI, Woods DD, Miller C. A tale of two stories: contrasting views of patient safety. <http://www.npsf.org/exec/toc.html>. (Accessed 2002 Sept.)
11. Brandwijk M, Nemeth C, O’Connor M, et al. Distributing cognition: ICU handoffs conform to Grice’s maxims. <http://www.ctlab.org/properties/pdf%20files/SCCM%20Poster%201.27.03.pdf>. (Accessed 2003 Jan.)
12. Matthews AL, Harvey CM, Schuster RJ, et al. Emergency physician to admitting physician handovers: an exploratory study. In: *Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting*. Baltimore, MD: Human Factors and Ergonomics Society 2002. pp.1511–15.
13. Patterson ES, Woods DD. Shift changes, updates, and the on-call architecture in space shuttle mission control. *Computer Supported Cooperative Work* 2001;10(3):317–46.

14. Lardner R. Effective Shift Handover. <http://www.hse.gov.uk/research/otopdf/1996/oto96003.pdf>. (Accessed 2004 Jan.)
15. Sherlock C. The patient handover: a study of its form, function and efficiency. *Nurs Stand* 1995;9(52):33–6.
16. Lally S. An investigation into the functions of nurses' communication at the inter-shift handover. *J Nurs Manag* 1999;7(1):29–36.
17. Wolf ZR. Nursing rituals. *Can J Nurs Res* 1988;20(3):59–69.
18. Pope C, Ziebland S, Mays N. Analysing qualitative data. In: Pope C, Mays N, editors. *Qualitative Research in Health Care*. London, UK: BMJ Books; 2000.
19. Hayes RH, Wheelwright SC. Linking manufacturing process and product lift cycle. *Harv Bus Rev* 1979;57:2–9.
20. Boutros F, Redelmeier DA. Effects of trauma cases on the care of patients who have chest pain in an emergency department. *J Trauma* 2000;48(4):649–53.
21. Orlikowski W, Yates J. *Genre Systems: Structuring interaction through communicative norms*. Cambridge, MA: MIT Sloan School of Management Center for Coordination Science; CCS Working Paper 205; 1998. <http://ccs.mit.edu/papers/CCSWP205/>. (Accessed 2003 May.)
22. Yoshioka T, Herman G. *Coordinating information using genres*. Cambridge, MA: MIT Sloan School of Management Center for Coordination Science; CCS Working Paper 214; 2000. <http://ccs.mit.edu/papers/pdf/wp214.pdf>. (Accessed 2003 May.)
23. Yates JF, Orlikowski W. Genres of organizational communication: a structural approach to studying communication and media. *Acad Manage Rev* 1992;17:299–362.
24. Durso FT, Crutchfield J, Harvey CM. Human factors in transitions of care. In: Carayon P, editor. *Handbook of Human Factors and Ergonomics in Healthcare and Patient Safety*. Mahwah, NJ: Lawrence Erlbaum Associates; 2005 (in press).
25. Argote L. Input uncertainty and organizational coordination in hospital emergency units. *Adm Sci Q* 1982;27(3):420–34.
26. Skaggs BC, Huffman TR. A customer interaction approach to strategy and production complexity alignment in service firms. *Acad Manage J* 2003;46(6):775–86.
27. Ash JS, Berg M, Coiera E. Some unintended consequences of information technology in health care: the nature of patient care information system-related errors. *J Am Med Inform Assoc* 2004;11(2):104–12.
28. Patel VL, Kushniruk AW. Understanding, navigating and communicating knowledge: issues and challenges. *Methods Inf Med* 1998;37(4–5):460–70.
29. Garrod S. How groups coordinate their concepts and terminology: implications for medical informatics. *Methods Inf Med* 1998;37(4–5):471–6.
30. Berg M. *Rationalizing medical work*. Cambridge, MA: MIT Press; 1997.
31. Coiera E. When conversation is better than computation. *J Am Med Inform Assoc* 2000;7(3):277–86.
32. Vicente KJ. *Cognitive work analysis*. Mahwah, NJ: Lawrence Erlbaum Associates; 1999.
33. Hutchins E. *Cognition in the wild*. Cambridge, MA: MIT Press; 1996.
34. Cook RI. Wrong level disc surgery, site marks, work details, and safety. <http://listserv.npsf.org/SCRIPTS/WA-NPSF.EXE?A2=ind0406&L=patientsafety-l&F=P&S=&P=23132>. (Accessed 2004 June.)

