Residents' and Attending Physicians' Handoffs: A Systematic Review of the Literature

Lee Ann Riesenberg, PhD, RN, Jessica Leitzsch, Jaime L. Massucci, MD, Joseph Jaeger, MPH, Joel C. Rosenfeld, MD, MEd, FACS, Carl Patow, MD, MPH, MBA, Jamie S. Padmore, and Kelly P. Karpovich

Abstract

Purpose

Effective communication is central to patient safety. There is abundant evidence of negative consequences of poor communication and inadequate handoffs. The purpose of the current study was to conduct a systematic review of articles focused on physicians' handoffs, conduct a qualitative review of barriers and strategies, and identify features of structured handoffs that have been effective.

Method

The authors conducted a thorough, systematic review of English-language articles, indexed in PubMed, published between 1987 and June 2008, and focused on physicians' handoffs in the United States. The search strategy yielded 2,590 articles. After title review, 401 were obtained for further review by trained abstractors.

Results

Forty-six articles met inclusion criteria, 33 (71.7%) of which were published between 2005 and 2008. Content analysis yielded 91 handoffs barriers in eight major categories and 140 handoffs strategies in seven major categories. Eighteen articles involved research on handoffs. Quality assessment scores for research studies ranged from 1 to 13 (possible range 1–16). One third of the reviewed research studies obtained quality scores at or below 8, and only one achieved a score of 13. Only six studies included any measure of handoff effectiveness.

Conclusions

Despite the negative consequences of inadequate physicians' handoffs, very little research has been done to identify best practices. Many of the existing peer-reviewed studies had design or reporting flaws. There is remarkable consistency in the anecdotally suggested strategies; however, there remains a paucity of evidence to support these strategies. Overall, there is a great need for high-quality handoff outcomes studies focused on systems factors, human performance, and the effectiveness of structured protocols and interventions.

Acad Med. 2009; 84:1775–1787.

Effective communication is central to patient safety and quality. Inadequate communication consistently appears as a factor contributing to medical errors, across settings and practitioners. These span from an incident with a single patient[1] to broader communication issues between physicians and nurses.[2] In reviews of malpractice claims, communication problems were contributing factors in 26% to 31% of cases.[3–5] The Joint Commission has reviewed data from 6,244 sentinel events occurring between 1995 and June 30, 2009.[6] Communication problems have long been noted as a major contributing factor to these sentinel events. Sutcliffe et al[7] conducted semistructured interviews with residents, who recalled 70 recent medical mishaps, and indicated that 91% contained communication failures.

Handoffs, the transfer of patient care from one health care provider to another, are known to be vulnerable to communication failures[8] and have been called "remarkably haphazard."[9] As defined by the Joint Commission, handoff communication refers to a standardized process "in which information about patient/client/resident care is communicated in a consistent manner."[10]

Retrospective reviews of malpractice claims in the ambulatory setting[11] and emergency department[12] showed that handoffs were a contributing factor in 20% and 24% of medical errors, respectively. When looking specifically at malpractice cases with communication breakdowns, 43% involved handoffs.[13] A review of 146 surgical errors found that 41 (28%) involved handoffs.[14] Of residents and fellows who reported caring for a patient with an adverse event, 15% indicated the reason for the mistake was a problem with handoffs.[15]

Numerous surveys document health care staff concern. In an Agency for Healthcare Research and Quality 2008 survey, just over half (51%) of the 160,176 hospital staff respondents reported that "important patient care information is often lost during shift changes."[16] When 93 fourth-year medical students and 228 residents responded to a survey about patient safety, (70%) agreed that improved handoffs would reduce medical mishaps.[17]

Reduced resident duty hours were first introduced in New York State in 1989 and were mandated for all U.S. residency programs in 2003. Although reductions in duty hours may lead to less fatigue and improved well-being in residents, many have expressed concern about the resultant need for increased handoffs and reduced continuity of patient care.[18] As a

Please see the end of this article for information about the authors.

Correspondence should be addressed to Dr. Riesenberg, Academic Affairs, Christiana Care Health System, 4755 Ogletown-Stanton Road, MAP 2, Suite 2114, Newark, DE 19718; telephone: (302) 623-4488; fax: (302) 623-4485; e-mail: (Lriesenberg@christianacare.org).

result of reduced hours, patients can be seen by three different physicians in the first 24 hours of their care.[19] Seventy-six percent of 29 surgical residents in a New York study agreed that continuity of care had been negatively affected as a result of duty hours changes.[20]

Discontinuity in patient care, which can occur with cross-coverage and night float systems, has been found to lead to increased in-hospital complications,[21] preventable adverse events,[22] increased cost due to unnecessary tests being ordered by residents not familiar with the patient,[19] and diagnostic test delays.[21] In a study at one teaching hospital during a four-month period, the risk of a preventable adverse event was strongly associated (more than twice as likely) with coverage by a physician from another team.[22]

Night float systems, often implemented to ensure that residents do not exceed duty hours limits, have been noted to result in inadequate information transfer to the covering residents.[23] Nurses have expressed concern over these changes. Fifty-one percent of the 67 nurses who responded to a survey about a new resident night float system agreed that "residents don't know the patients as well as in the old system."[24]

Other issues surrounding attending physicians' and residents' handoffs have been documented. Gandhi[25] notes that inadequate handoffs can lead to diffused responsibility, which can be a major contributor to medical errors. In addition, Coiera[26] found that health care communications are prone to interruptions, with a third of communication events (30.6%) interrupted.[27] Many of these interruptions result in inefficiencies,[28] and interruptions during handoffs are likely to lead to failures of working memory,[29] which result in decreased recall accuracy.

In 2006, the average length of stay for all hospitalized patients was 4.8 days.[30] Assuming that patient care transfers between covering residents and/or attending physicians occur 1 to 2 times per day, the average patient will be handed off 5 to 10 times per admission. Each of these handoffs represents a risk for inadequate communication, which could result in reduced patient safety and increased medical errors.

In response to concerns about inadequate health care handoffs, a number of national patient safety organizations have highlighted the importance of communication, including the Institute for Healthcare Communication[31] and the National Quality Forum. In 2006, the Joint Commission created a new National Patient Safety Goal on handoffs.[32] In 2009, the goal remains virtually unchanged, requiring the organization to implement "a standardized approach to hand-off communications, including an opportunity to ask and respond to questions."[33]

As the preceding paragraphs suggest, there is abundant evidence of the negative consequences of poor communication and inadequate handoffs in health care. The purpose of the current study was to identify all English-language articles on resident and/or attending physicians' handoffs in the United States, conduct a systematic review of research studies, perform a qualitative review of barriers and strategies mentioned across all articles, and identify features of structured handoffs that have been shown to be effective. This review was conducted in conjunction with the Alliance of Independent Academic Medical Centers National Initiative: Improving Patient Care Through GME. The National Initiative was a collaborative formed in 2007 that linked residency programs in 19 teaching hospitals across the United States in efforts to integrate academics and quality through projects coordinated at a national level.

Method

National initiative work group

A work group of the National Initiative developed resources and wrote systematic reviews of the literature in support of the National Initiative's goals. We performed this study as one of a series of literature reviews initiated by that group. The methodology that we employed included regular, substantive discussions about manuscript concept and design, such as key questions, inclusion and exclusion criteria, and search strategies. There were critical interchanges among us about all important aspects of each systematic review written by this group, including those for this report, and we reached consensus on how to treat each systematic review. The specific subject, appropriate technique, and final presentation of this systematic review are the product of a progressive, iterative, and qualitative process of refinement.

Literature search

We conducted a thorough and systematic literature search of English-language articles published on handoffs from 1987 to June 4, 2008 using Ovid Medline, Medline In-Process & Other Non-Indexed Citations, CINAHL, HealthSTAR, and Christiana Care Full Text Journals@Ovid, followed by reference section review. The search terms used were *hand-off$, handoff$, signout$, sign out$, sign-out$, handover$, hand-over$, signover$,* and *sign-over$*. A total of 2,590 articles were identified. All titles were reviewed for possible inclusion, and 401 articles were obtained for further review (Figure 1). Reference sections of all 401 articles were reviewed for additional articles.

Inclusion criteria

Articles meeting the following criteria were eligible for review of barriers and strategies: English language, indexed in PubMed, published between 1987 and June 4, 2008, focused on health care handoffs in the United States, and including information about either resident or attending physicians' handoffs. Articles included in the systematic review had one of the following study designs: randomized controlled trial; nonrandomized trial, with control or comparison group; single-group pre- and posttest, cohort study; single-group cross-sectional research; single-group posttest only, or qualitative research.

Trained reviewers (J.L. and L.R.) deemed that 46 articles met inclusion criteria for the initial review of barriers and strategies. Using an iterative process, an abstraction form was developed to confirm eligibility for full review, assess article characteristics, and extract data relevant to the study questions. This iterative process started with an initial form, which was used by two reviewers (J.L. and L.R.) to independently abstract data from four articles. The reviewers then met to discuss the abstraction form for inclusion of all relevant data. A second, more detailed form was then

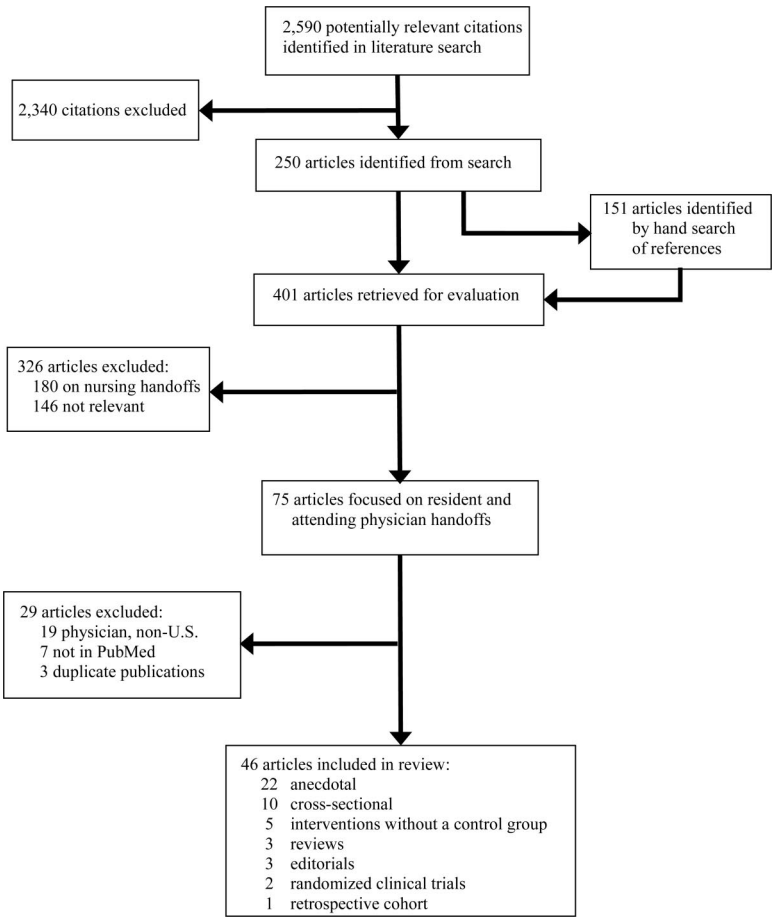

Figure 1 The process used by the authors to select appropriate published studies about residents' and attending physicians' handoffs.

created for abstraction. Reviewers (J.L. and J.M.) independently abstracted all data. Most abstraction disagreements were minor, and all disagreements were quickly resolved during discussion, when a consensus was reached on the abstracted data.

Quality scoring system

Downs and Black[34] created a valid and reliable checklist designed to assess both experimental and observational studies. Two systematic reviews[35,36] of published systems (scales and checklists) designed to assess study quality have ranked the scale developed by Downs and Black as one of the best. Both of these systematic reviews went on to suggest that some modifications might be useful, depending on the specific topic and study designs. Therefore, five of us (L.R., J.L., J.M., J.J., J.S.P.) developed a quality scoring form based on this approach, using four of the original items and eight modified items, which yielded scores ranging from 1 to 16, with 16 being the highest possible score (see Chart 1). This quality scoring form contained two items related to study type and sample size, five items related to reporting, and five items related to internal validity.

If a study included multiple assessment formats, such as interviews and a questionnaire, that resulted in different sample sizes, the largest sample was used as the sample size in the quality scoring form. There was no way to determine the number of independent study participants for each assessment method. Thus, to avoid counting the same study participant multiple times, we credited the study with the largest reported sample only.

Quality scores were independently obtained from reviewer pairs (L.R. and J.L. or J.J.) for each study. The interrater reliability was assessed for all identified research studies (n = 18). Overall agreement was 97.7%, and Cohen's kappa for agreement between the two reviewers was $r = 0.96$, $P < .001$. All differences were resolved through discussion to yield a final quality score for each study.

Qualitative analysis of barriers and strategies

Conventional content analysis is a type of qualitative research used when there is limited or no existing theory on the phenomenon of interest.[37] This analysis involves an iterative process that allows themes to arise from data. Researchers immerse themselves in the content and allow categories to emerge.[37]

All barriers and strategies mentioned in the reviewed articles were identified and listed in phrase format in two continuous lists, one for strategies and another for barriers. Reviewers (J.L. and L.R.) met to compare lists and, through discussion, agreed on final comprehensive lists. Through an inductive iterative process, category labels were created and all phrases were moved to a category or subcategory. The final lists were reviewed by J.M. for coherence and consistency.

Results

Forty-six articles describing resident and/or attending physicians' handoffs were identified. Thirty-three (71.7%) were published between 2005 and 2008 (Figure 2). Content analysis yielded 91 barriers in eight major categories and 140 strategies in seven major categories (Table 1).

Twenty-two articles presented anecdotal data,[38–58] one of which had a physician handoffs case example and nursing handoffs research[59]; three provided circumscribed reviews,[60–62] and three were editorials.[63–65] The remaining 18 articles reported research on handoffs and were analyzed in depth (see the Appendix).[66–83] Only one[80] research study did not involve residents or have a graduate medical education focus. Quality assessment scores for the research studies ranged from 1 to 13 (possible range 1–16). Six studies obtained scores of 8 or less, eight had scores between 8.5 and 11.5, and four achieved quality scores of 12 to 13.

Only 6 of 18 (33.3%) research studies identified effective handoff features.[66,67,69,71,77,78] In studies comparing computerized handoff

Chart 1

Quality Scoring System for Evaluation of Handoff Research Studies*

Study quality indicator	Points	
Study type		
Single group cross-sectional, *or* single group post-test only, *or* qualitative study	1	
Single group pre- and post-test, *or* cohort	1.5	
Non-randomized trial (includes control or comparison group)	2	
Randomized controlled trial	3	
Total sample size		
Unclear	0.0	
≤ 10	0.5	
11-50	1.0	
51-100	1.5	
101-150	2.0	
151-200	2.5	
201 or more	3.0	
Reporting	Yes	No
Is the hypothesis/aim/objective/purpose of the study clearly described?	1	0
Are the participants clearly described? Number, rotation or clerkship name (e.g., pediatrics, medicine), and stage of training, if medical students; Number, residency type (e.g., internal medicine, surgery), and stage of training, if residents; number and discipline (e.g., internists, hospitalists, surgeons) if attending physicians.	1	0
Are the main outcomes to be measured clearly described in the Introduction or Methods section? (If the main outcomes were first mentioned in the Results section, this question was answered no. If the article does not have clearly marked sections for Introduction, Methods, Results, this question was answered no.)	1	0
Are the methods described with enough details to replicate the study (e.g., intervention, interview process, quality improvement process, measurement process and instrument) – given you had the resources, training, etc needed?	1	0
Are the main outcomes of the study clearly described in the Results? (Simple outcome data—including denominators and numerators—should be reported for all major findings so that the reader can check the major analyses and conclusions.)	1	0
Internal validity		
Did they use a previously validated or published instrument, questionnaire, interview script?	1	0
Did they conduct any validity assessment (e.g., analyze reliability, validity, inter-rater reliability)?	1	0
Did they use any method designed to enhance the quality of measurement (e.g., multiple observations; training of observers/interviewers; iterative process used to develop a tool, assessment instrument, or to conduct analysis for qualitative analysis or quality improvement process; pilot study; focus group; or Delphi process used to develop measurement tool)?	1	0
Did they report obtaining Institutional Review Board (IRB) approval?	1	0
Did the reported conclusions follow from the reported results?	1	0

* The quality scoring system in this chart was designed to assess both experimental and observational studies and was adapted from the Downs and Black[34] quality scoring system.

systems with other methods, such as personal handwritten notes, the computerized or electronic system performed better. Residents were more likely to have all patients on their list,[67] to report that they received all important information,[78] to have increased satisfaction with the handoff system,[67] to spend less time in prerounding and rounding activities,[67] and to self-report decreased adverse events related to handoffs.[77] Others have noted that resident-maintained lists in a database, such as a Microsoft Word file or Excel database, contain content and medication errors.[69,71] However, interns using standardized, self-maintained sign-out cards reported fewer poor sign-outs and were more likely to record code status, patient age, and allergies.[66]

Discussion

As stated earlier, we identified 46 articles describing residents' and attending physicians' handoffs in the United States. Eighteen were research studies (39.1%), only two of which were randomized controlled trials. The majority (71.7%) of articles were published in recent years, which is not surprising, given the Joint Commission's National Patient Safety Goal on handoffs issued in 2006. However, as demonstrated by our quality assessment scores (see the Appendix), there is a remarkable lack of high-quality outcomes studies. It is notable that one third of the reviewed research studies obtained quality scores at or below 8 (out of a possible 16), and only one study achieved a score of 13.

One purpose of the current study was to identify features of physicians' handoffs that have been shown to be effective. Unfortunately, only 6 of the 18 (33.3%) research studies included measures of effectiveness. Of the three studies using computerized handoff systems, one was a stand-alone system,[78] and the other two had some linkage with the hospital computer system.[67,77] While these all provided a structured template, they also relied to varying degrees on residents to enter information, which introduces an opportunity for errors to occur.[69,71] Most of the studies assessing effectiveness used self-reported data, with a few exceptions. Van Eaton and colleagues[67] looked at the number of patients missed on resident rounds and showed a decrease from 5 to 2.5 patients/team/month ($P = .0001$) when using a computerized handoff system. Two other studies assessed errors on resident-maintained handoff forms when compared with the medical record[69,71] (a surrogate for actual medical errors) and, not surprisingly, found errors on the resident lists.

Of note, two survey studies documented a lack of formal handoffs instruction during residency, with 60% to 74.4% (internal medicine[72] and emergency

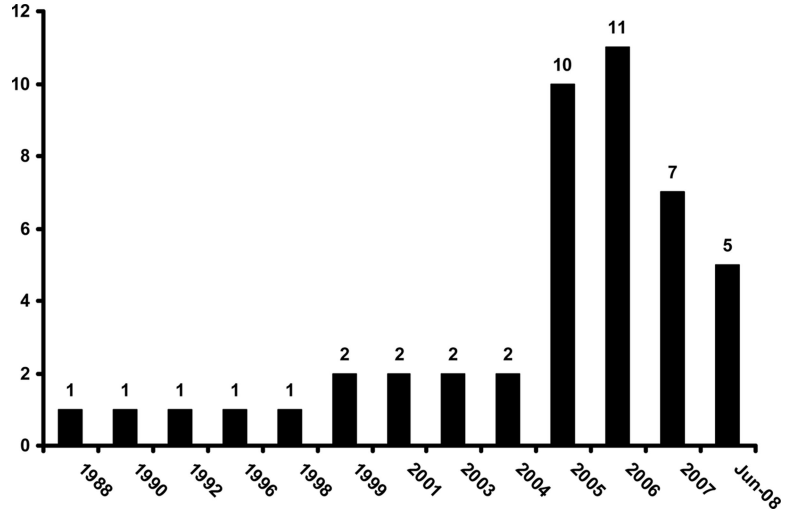

Figure 2 Years of publication of 46 English-language articles focused on residents' and attending physicians' handoffs in the United States, 1987 to June 2008.

medicine,[73] respectively) reporting that they have no lectures or workshops on the topic. Although 72.3% of the 185 emergency medicine residency/fellowship program directors studied agreed that standardized handoffs would reduce medical errors,[73] the majority did not have a uniform policy or procedure regarding handoffs. Only one of the studies reviewed here included the development, implementation, and assessment of a formal, structured handoffs curriculum.[75] Horwitz and colleagues[75] provide a comprehensive curricular template for others to use; however, they relied on postsession evaluations of perceived comfort and importance of handoffs. We commend their plan to conduct observation of handoff skills and look forward to their future publications.

Almost all of the research articles (17 of 18; 94%) were conducted within a residency program. Graduate medical education has taken the lead in conducting handoffs research, which is one demonstration of the value added to health care by medical education.

Handoff barriers

We identified 91 barriers to effective handoffs that could be organized into eight major categories. Of barrier categories, communication issues were reported most frequently (30.8%), with general communication barriers ranging from not listening to inadequate communication. Because effective communication is an essential component of handoffs, this was an expected finding. However, hierarchy and social barriers constituted a less intuitive group. Here, we found things such as relational communication barriers and residents not being likely to hand off work to more senior residents, because of a rigid reliance on hierarchical norms that prohibit such behavior. Thus, adequately addressing handoff issues will require more than protocols, structure, and training. Understanding the complex social structures and hierarchies in which residents and attending physicians work, as well as the unwritten rules that govern the handoff of patient responsibilities, will be required.

Handoff strategies

We identified 140 strategies that could be organized into seven major categories. Strategies for standardization were noted most frequently (44.3%), with technological solutions (16.4%), such as computerized handoff systems, next. Interestingly, whereas communication issues constituted approximately one third of barriers, improving communication skills was noted much less frequently (11.4%) as a strategy. Standardization would address some communication issues, but not all, such as language differences. Providing training or education (10%), evaluating the process (7.1%), and addressing environmental issues (5.7%), such as lighting and limiting interruptions and noise, make intuitive sense. However, a less obvious strategy was insuring the recognition that a transfer of responsibility/accountability (5.0%) had occurred.

Limitations and strengths

Handoffs in a variety of environments were studied, which makes it difficult to use our findings to formulate barriers and strategies for use in every handoff situation. For example, some techniques may be better applied to inpatient medicine as opposed to the emergency department. In addition, we abstracted barriers and strategies from all sections of the articles studied, including the introduction. This may have resulted in overemphasis of some barriers or strategies, depending on the author's views and on repetition. However, we only counted the same barrier or strategy multiple times if the wording was significantly different in subsequent use and if the two instances could stand alone as different aspects of the same category.

Another potential limitation is that the barriers and strategies we identified (Table 1) represent the opinions of the authors of the reviewed studies. Further, we identified the barriers and strategies through a qualitative process. Although they seem intuitively relevant, they were not derived from research studies designed to identify handoff barriers and strategies.

The current study is limited by the Ovid search strategy used. Specifically, the selected search terms may not have included all relevant terms. We strengthened the possibility of identifying all articles that met inclusion criteria by reviewing the reference sections of all obtained articles. Although this strategy minimizes the risk of missing germane studies, it does not eliminate the possibility.

Publication bias refers to the possibility that high-quality studies with negative results may not have been published. Others have noted that many quality improvement (QI) projects are not published.[84] In addition, it has been our observation that some QI projects are published in newsletters, with the authors never submitting them to peer-reviewed journals. Thus, there may be outcomes studies of handoffs that are not in the peer-reviewed literature. However, the explicit search strategy, clear inclusion criteria, and systematic process used to

Table 1

Barriers and Strategies Identified in Articles on U.S. Residents' and Attending Physicians' Handoffs in the English-Language Literature, 1987 to June 2008

Categories	Frequency
Barrier categories	
Communication barriers (hierarchy, language, general communication)	
General communication problems[49,51,53,58,60–62,64,67,70,81*]	14
Hierarchy/social barriers[38,51,56,59,61,62,80,82]	8
Language/ethnic barriers[56,59,62]	3
Communication style[38,56,59]	3
Lack of standard system/requirement (no tool, no requirements, no system)	
No standardization or structure[42,51,57,59,61,65,75]	8
No requirements[52,59,61,80]	5
Lack of a tool/protocol[54,73]	2
Lack of training (training, education)	
Lack of education[62,65,70,75,81]	7
Lack of training[44,47,57,60,75]	6
Missing information (omitted information, incorrect information)	
Incomplete/missing information[41,42,49,60,65,69,71,80,83]	9
Errors in information[43,65,71,80]	4
Physical barriers (lighting, location, noise, interruptions)	
Interruptions/distractions[43,47,62,83]	5
Chaotic environment[47,53,80]	3
Lack of time	
Time-consuming processes[48,52,62,69]	4
Time constraints[38,47,83]	3
Difficulties due to complexity/high numbers	
Complexity[51,81]	3
Large number of patients[52,64]	2
Cross-coverage[53,60]	2
Strategy categories	
Standardization	
Standardized process[47,62,65,73]	4
Specific techniques[45,47,51,56,57,61,79,81,83]	15
Preparation[47,51,60,61,69,79]	9
Face-to-face communication[44,47,51,60,62]	5
Read-back[47,57]	2
Standardized content/template[41,42,44,51,56,57,61,65,66,72,81]	14
Mnemonics[38,40,44,56,57,59,60,63,75,80,81]	13
Technology[45–48,50,52,55,57,62,64,69,71,72,74,76–79,81,83]	23
Communication skills (hierarchy, language, general communication)	
General communication skills[38,45,49,51,57,62,80]	13
Limit hierarchy[38,79,82]	3
Training/education[41,44,45,57,60–62,69,70,73,75,80,81]	14
Evaluate the process[40,42,45,61,65,80,81]	10
Physical environment (lighting, location, noise, interruptions)	
Location[57,61,62]	3
Limit interruptions[47,83]	2
Address physical environment[38,83]	3
Recognize transfer of responsibility/accountability[45,56,58,60]	7

* Note: Some articles mentioned a barrier or strategy more than once in different sections of the article, using different descriptions. When these seemed to fit the same category but expressed a different aspect of the category, they were counted as separate barriers or strategies. Thus, some frequencies are greater than the number of references.

identify and evaluate articles strengthen the quality of this review.

Although our quality scoring system was based on a validated methodology developed to assess experimental and observational studies together, our system has not been validated across multiple settings and investigators. The relative weightings may require refinement, and there may prove to be additional relevant categories. The system did have a high internal reliability, and reviewers of various educational backgrounds and experience found it straightforward and easy to use. Further, the quality scoring system provides a reproducible template for the assessment of handoffs articles.

Recommendations

Numerous authors have noted the dearth of research focused on handoffs.[45,57,70,83,85,86] In addition, there are risks involved in implementing interventions without evidence supporting their effectiveness.[87] Winters and colleagues[87(p1,647)] noted that "[n]ational efforts to improve patient safety should be supported by sufficiently strong evidence to warrant such a commitment of resources."

Evidence-based practice is informed by high-quality research. Recent publication guidelines for patient safety and quality initiatives have established a framework for standardized reporting.[88,89] We recommend that future handoffs studies use the Standards for Quality Improvement Reporting Excellence (SQUIRE) guidelines.[89] Many of the studies reviewed here would have been improved by doing so.

Others have noted that it may be unreasonable to expect patient safety and quality studies to follow the design rigors of randomized controlled trials.[87] However, the RAND/UCLA Appropriateness Method provides a structured, rigorous method to synthesize data from other clinical study types with expert opinion to provide the best available guidelines.[90] Unfortunately, the literature on handoffs identified here is not of sufficient quality and quantity to synthesize into evidence-based recommendations.

Although the Joint Commission is calling for structured handoffs, we identified

List 1

Useful Research Questions About Physicians' Handoffs, Organized by the Content Domains of Knowledge, Attitudes, Skills, Process Outcomes, and Clinical Outcomes*

Knowledge
- Document accuracy of describing the handoff protocol
- Document accuracy of providing an example of the use of the protocol

Attitude
- Report satisfaction with handoff system
- Report comfort using the handoff system
- Report satisfaction with handoffs received

Skill
- Demonstrate ability to use the handoff system
- Document accuracy of information provided during handoff
- Document extent to which the handoff contained all needed information
- Document recall accuracy of handoff content

Process outcomes
- Record use of handoff system
- Describe details of handoff
- Document accuracy of information (content and quality)
- Answer "What are the best educational and implementation strategies?" using process outcomes

Clinical outcomes
- Describe errors related to handoffs (rates and types of errors)
- Document reduction of handoffs-related errors as surrogate for increased safety
- Define the elements of handoffs that lead to the best patient outcomes
- Compare different protocols, educational strategies, and/or implementation strategies to determine which are most effective in which settings (e.g., discipline, departments)

* The authors' review of U.S. physician handoffs literature led them to develop this list of research questions, organized by content domains. The list could provide guidance for future investigators of physician handoffs.

very little evidence to support the use of any specific structure, protocol, or method. However, direct observation of handoffs in other settings (i.e., NASA mission control, nuclear power, railroad, and ambulance dispatch) with high consequences for error, yielded 21 common strategies,[91] which could offer a starting point in the development of health care handoffs research. Our review of the U.S. physicians' handoffs literature has led us to develop a list of research questions, organized by the content domains of knowledge, attitudes, skills, process outcomes, and clinical outcomes (see List 1).

Across the United States, hospitals are implementing structured handoff protocols in an effort to comply with Joint Commission requirements. High-quality outcomes studies that focus on systems factors, human performance, and the effectiveness of protocols and interventions are urgently needed. These studies should address the barriers and strategies identified here. In addition, handoffs in different disciplines are likely to have different requirements and issues. For instance, an emergency department handoff will need to have different content than one for inpatient medicine or pediatrics. Therefore, researchers should conduct discipline-specific handoff studies.

We call for rigorous outcomes studies designed to (1) assess the effectiveness of handoffs, (2) determine the elements of handoffs that lead to improved patient outcomes, and (3) identify the best implementation strategies. Finally, these studies should be reported using the SQUIRE guidelines. Without these studies, hospitals across the United States are destined to waste time, resources, and effort on flawed handoff practices.

Dr. Riesenberg is director of medical education research and outcomes, Academic Affairs, Christiana Care Health System, Newark, Delaware, and research assistant professor, Jefferson School of Population Health, Thomas Jefferson University, Philadelphia, Pennsylvania.

Ms. Leitzsch is research assistant, Academic Affairs, Christiana Care Health System, Newark, Delaware.

Dr. Massucci is an emergency medicine administrative fellow, Christiana Care Health System, Newark, Delaware.

Mr. Jaeger is associate vice president, Academic Affairs, Monmouth Medical Center, Long Branch, New Jersey, and associate dean, Academic Affairs, Monmouth Programs, Drexel University College of Medicine, Philadelphia, Pennsylvania.

Dr. Rosenfeld is chief academic officer, St. Luke's Hospital and Health Network, Bethlehem, Pennsylvania, and associate dean, Temple University School of Medicine, Philadelphia, Pennsylvania.

Dr. Patow is executive director, HealthPartners Institute for Medical Education, and associate dean for faculty affairs, Regions Hospital, University of Minnesota Medical School, Minneapolis, Minnesota.

Ms. Padmore is assistant vice president, Academic Affairs, MedStar Health, Columbia, Maryland.

Ms. Karpovich is director, Medical Education-Baltimore, MedStar Health, Columbia, Maryland.

Acknowledgments

Special thanks to Ellen M. Justice, MLIS, AHIP, medical librarian of the Lewis B. Flinn Medical Library, Christiana Care Health System, for conducting literature searches; Dolores Ann Moran, medical library assistant II, and Janice Evans, medical library assistant II, for their assistance in locating articles; and Donald Riesenberg, MD, for feedback on the manuscript.

References

1 Chassin MR, Becher EC. The wrong patient. Ann Intern Med. 2002;136:826–833.
2 Donchin Y, Gopher D, Olin M, et al. A look into the nature and causes of human errors in the intensive care unit. Qual Saf Health Care. 2003;12:143–148.
3 Beckman HB, Markakis KM, Suchman AL, Frankel RM. The doctor–patient relationship and malpractice: Lessons from plaintiff depositions. Arch Intern Med. 1994;154:1365–1370.
4 White AA, Wright SW, Blanco R, et al. Cause-and-effect analysis of risk management files to assess patient care in the emergency department. Acad Emerg Med. 2004;11:1035–1041.
5 White AA, Pichert JW, Bledsoe SH, Irwin C, Entman SS. Cause and effect analysis of closed claims in obstetrics and gynecology. Obstet Gynecol. 2005;105:1031–1038.
6 Joint Commission sentinel event statistics as of: June 30, 2009. Available at: http://www.jointcommission.org/NR/rdonlyres/241CD6F3-6EF0–4E9C–90AD-7FEAE5EDCEA5/0/SE_Stats_03_08.pdf. Accessed August 18, 2009.
7 Sutcliffe KM, Lewton E, Rosenthal MM. Communication failures: An insidious contributor to medical mishaps. Acad Med. 2004;79:186–194.
8 Keyes C. Coordination of care provision: The role of the 'handoff.' Int J Qual Health Care. 2000;12:519.
9 Volpp KGM, Grande D. Residents' suggestions for reducing errors in teaching hospitals. N Engl J Med. 2003;348:851–855.
10 The Joint Commission. FAQs for the Joint Commission's 2009 National Patient Safety Goals: Hand-off communications. Available at: http://www.jointcommission.org/AccreditationPrograms/Hospitals/Standards/09_FAQs/NPSG/Communication/NPSG.02.05.01/hand_off_communications.htm. Accessed August 18, 2009.
11 Gandhi TK, Kachalia A, Thomas EJ, et al. Missed and delayed diagnoses in the ambulatory setting: A study of closed malpractice claims. Ann Intern Med. 2006;145:488–496.

12 Kachalia A, Gandhi TK, Puopolo AL, et al. Missed and delayed diagnoses in the emergency department: A study of closed malpractice claims from 4 liability insurers. Ann Emerg Med. 2007;49:196–205.
13 Greenberg CC, Regenbogen SE, Studdert DM, et al. Patterns of communication breakdowns resulting in injury to surgical patients. J Am Coll Surg. 2007;204:533–540.
14 Gawande AA, Zinner MJ, Studdert DM, Brennan TA. Analysis of errors reported by surgeons at three teaching hospitals. Surgery. 2003;133:614–621.
15 Jagsi R, Kitch BT, Weinstein DF, Campbell EG, Hutter M, Weissman JS. Residents report on adverse events and their causes. Arch Intern Med. 2005;165:2607–2613.
16 Agency for Healthcare Quality and Research. Hospital Survey on Patient Safety Culture: 2008 Comparative Database Report. Available at: http://www.ahrq.gov/qual/hospsurvey08. Accessed August 24, 2009.
17 Sorokin R, Riggio JM, Hwang C. Attitudes about patient safety: A survey of physicians-in-training. Am J Med Qual. 2005;20:70–77.
18 Fletcher KE, Parekh V, Halasyamani L, et al. Work hour rules and contributors to patient care mistakes: A focus group study with internal medicine residents. J Hosp Med. 2008;3:228–237.
19 Fins JJ. Professional responsibility: A perspective on the Bell Commission reforms. Bull NY Acad Med. 1991;67:359–364.
20 Barden CB, Specht MC, McCarter MD, Daly JM, Fahey TJ. Effects of limited work hours on surgical training. J Am Coll Surg. 2002; 195:531–538.
21 Laine C, Goldman L, Soukup JR, Hayes JG. The impact of a regulation restricting medical house staff working hours on the quality of patient care. JAMA. 1993;269:374–378.
22 Petersen LA, Brennan TA, O'Neil AC, Cook EF, Lee TH. Does housestaff discontinuity of care increase the risk for preventable adverse events? Ann Intern Med. 1994;121:866–872.
23 Charap M. Reducing resident work hours: Unproven assumptions and unforeseen outcomes. Ann Intern Med. 2004;140:814–815.
24 Buff DD, Shabti R. The night float system of resident on call: What do the nurses think? J Gen Intern Med. 1995;10:400–402.
25 Gandhi TK. Fumbled handoffs: One dropped ball after another. Ann Intern Med. 2005;142: 352–358.
26 Coiera E. When conversation is better than computation. J Am Med Inform Assoc. 2000; 7:277–286.
27 Coiera EW, Jayasuriya RA, Hardy J, Bannan A, Thorpe MEC. Communication loads on clinical staff in the emergency department. Med J Aust. 2002;176:415–418.
28 Coiera E, Tombs V. Communication behaviors in a hospital setting: An observational study. BMJ. 1998;316:673–676.
29 Parker J, Coiera E. Improving clinical communication: A view from psychology. J Am Med Inform Assoc. 2000;7:453–461.
30 DeFrances CJ, Lucas CA, Buie VC, Golosinskiy A. 2006 National Hospital Discharge Survey. National Health Statistics Report. July 30, 2008. Available at: http://www.cdc.gov/nchs/data/nhsr/nhsr005.pdf. Accessed August 24, 2009.
31 Institute for Healthcare Communication Web site. Available at: http://www.healthcarecomm.org/index.php?sec=who. Accessed August 24, 2009.
32 The Joint Commission. National Patient Safety Goals: 2006 Critical Access Hospital and Hospital National Patient Safety Goals. Available at: http://www.jointcommission.org/PatientSafety/NationalPatientSafetyGoals/06_npsg_cah.htm. Accessed August 24, 2009.
33 The Joint Commission. Accreditation Program: Hospital National Patient Safety Goals. Available at: http://www.jointcommission.org/NR/rdonlyres/31666E86-E7F4-423E-9BE8-F05BD1CB0AA8/0/HAP_NPSG.pdf. Accessed August 24, 2009.
34 Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. J Epidemiol Community Health. 1998;52:377–384.
35 West S, King V, Carey TS, et al. Systems to Rate the Strength of Scientific Evidence. Evidence Report/Technology Assessment No. 47 (Prepared by the Research Triangle Institute-University of North Carolina Evidence-based Practice Center under Contract No. 290-97-0011). AHRQ Publication No. 02-E016. Rockville, MD: Agency for Healthcare Research and Quality. April 2002. Available at: http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=hstat1.chapter.70996. Accessed August 24, 2009.
36 Deeks JJ, Dinnes J, D'Amico R, et al. Evaluating non-randomised intervention studies. Health Technology Assessment. 2003; 7(27). Available at: http://www.ncchta.org/fullmono/mon727.pdf. Accessed August 24, 2009.
37 Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res. 2005;15:1277–1288.
38 Communication strategies for patient handoffs. Obstet Gynecol. 2007;109:1503–1505.
39 Handoff information should cover past, future. Healthc Risk Manag. 2005;27:94.
40 Measure understanding during handoffs: A naval hospital uses an evaluation tool to determine whether information is understood. Brief Patient Saf. 2006:8–9.
41 Patient handoff must be more than a formality. Healthc Risk Manag. 2005;27:93.
42 Strategies for improving OR handoffs. OR Manager. 2005;21(8):9–10.
43 What's wrong with this hand-off? Brief Patient Saf. 2006;7(1):9,12.
44 Arora V, Johnson J. National patient safety goals. A model for building a standardized hand-off protocol. Jt Comm J Qual Patient Saf. 2006;32:646–655.
45 Beach C, Croskerry P, Shapiro M. Profiles in patient safety: Emergency care transitions. Acad Emerg Med. 2003;10:364–347.
46 Chacko V, Varvarelis N, Kemp DG. eHand-offs: An IBM Lotus Domino application for ensuring patient safety and enhancing resident supervision in hand-off communications. AMIA Annu Symp Proc. 2006:874.
47 Dracup K, Morris PE. Passing the torch: The challenge of handoffs. Am J Crit Care. 2008; 17:95–97.
48 Frazer TS. "Doctor's notes": A computerized method for managing inpatient care. Fam Med. 1988;20:223–224.
49 Goldman L, Pantilat SZ, Winthrop F, Whitcomb WF. Passing the clinical baton: 6 principles to guide the hospitalists. Am J Med. 2001;111(9B):36S–39S.
50 Kushniruk A, Karson T, Moore C, Kannry J. From prototype to production system: Lessons learned from the evolution of the SignOut System at Mount Sinai Medical Center. AMIA Annu Symp Proc. 2003:381–385.
51 Landucci D, Gipe BT. The art and science of the handoff: How hospitalists share data. Hospitalist. 1999;3:4.
52 Luo J, Hales RE, Hilty D, Brennan C. Clinical computing: Electronic sign-out using a personal digital assistant. Psychiatr Serv. 2001;52:173–174.
53 Mukherjee S. A precarious exchange. N Engl J Med. 2004;351:1822–1824.
54 Nemeth C, Nunnally M, O'Connor M, Cook R. Creating resilient IT: How the sign-out sheet shows clinicians make healthcare work. AMIA Annu Symp Proc. 2006:584–588.
55 Sarkar U, Carter JT, Omachi TA, et al. SynopSIS: Integrating physician sign-out with the electronic medical record. J Hosp Med. 2007;2:336–342.
56 Sutker WL. The physician's role in patient safety: What's in it for me? Baylor Univ Med Cent Proc. 2008;21:9–14.
57 Vidyarthi AR, Arora V, Schnipper JL, Wall SD, Wachter RM. Managing discontinuity in academic medical centers: Strategies for a safe and effective resident sign-out. J Hosp Med. 2006;1:257–266.
58 Weinstock M. Transitioning care: H&HN′s 'Saves Lives Now' series profiles a better way to handle patient handoffs. Hosp Health Netw. 2005;79(6):27–28.
59 Haig KM, Sutton S, Whittington J. SBAR: A shared mental model for improving communication between clinicians. Jt Comm J Qual Patient Saf. 2006;32:167–175.
60 Arora VM, Johnson JK, Meltzer DO, Humphrey HJ. A theoretical framework and competency-based approach to improving handoffs. Qual Saf Health Care. 2008;17:11–14.
61 Singer JI, Dean J. Emergency physician intershift handovers: An analysis of our transitional care. Pediatr Emerg Care. 2006; 22:751–754.
62 Solet DJ, Norvell JM, Rutan GH, Frankel RM. Lost in translation: Challenges and opportunities in physician-to-physician communication during patient handoffs. Acad Med. 2005;80:1094–1099.
63 Guise JM, Lowe NK. Do you speak SBAR? J Obstet Gynecol Neonatal Nurs. 2006;35:313–314.
64 Jauhar S. Patient handoffs, or walking along a narrow mountain ledge. Medscape J Med. 2008;10(3):57.
65 Philibert I, Leach DC. Re-framing continuity of care for this century. Qual Saf Health Care. 2005;14:394–396.
66 Lee LH, Levine JA, Schultz HJ. Utility of a standardized sign-out card for new medical interns. J Gen Intern Med. 1996;11:753–755.
67 Van Eaton EG, Horvath KD, Lober WB, Rossini AH, Pellegrini CA. A randomized, controlled trial evaluating the impact of a computerized rounding and sign-out system

on continuity of care and resident work hours. J Am Coll Surg. 2005;200:538–545.
68 Lofgren RP, Gottlieb D, Williams RA, Rich EC. Post-call transfer of resident responsibility: Its effect on patient care. J Gen Intern Med. 1990;5:501–505.
69 Arora V, Kao J, Lovinger D, Seiden SC, Meltzer D. Medication discrepancies in resident sign-outs and their potential to harm. J Gen Intern Med. 2007;22:1751–1755.
70 Borowitz SM, Waggoner-Fountain LA, Bass EJ, Sledd RM. Adequacy of information transferred at resident sign-out (inhospital handover of care): A prospective survey. Qual Saf Health Care. 2008;17:6–10.
71 Frank G, Lawler LA, Jackson AA, Steinberg TH, Lawless ST. Resident miscommunication: Accuracy of the resident sign-out sheet. J Healthc Qual. 2005;27(2): (Web Exclusive):W2-10–W2-14. Available at: http://www.nahq.org/journal/online/pdf/webex0305.pdf. Accessed August 24, 2009.
72 Horwitz LI, Krumholz HM, Green ML, Huot SJ. Transfers of patient care between house staff on internal medicine wards: A national survey. Arch Intern Med. 2006;166:1173–1177.
73 Sinha M, Shriki J, Salness R, Blackburn PA. Need for standardized sign-out in the emergency department: A survey of emergency medicine residency and pediatric emergency medicine fellowship program directors. Acad Emerg Med. 2007;14:192–196.
74 Frank G, Lawless ST, Steinberg TH. Improving physician communication through an automated, integrated sign-out system. J Healthc Inf Manag. 2005;19(4):68–74.
75 Horwitz LI, Moin T, Green ML. Development and implementation of an oral sign-out skills curriculum. J Gen Intern Med. 2007;22:1470–1474.
76 Kannry J, Moore C. MediSign: Using a Web-based SignOut System to improve provider identification. Proc AMIA Symp. 1999:550–554.
77 Petersen LA, Orav EJ, Teich JM, O'Neil AC, Brennan TA. Using a computerized sign-out program to improve continuity of inpatient care and prevent adverse events. Jt Comm J Qual Improv. 1998;24:77–87.
78 Ram R, Block B. Signing out patients for off-hours coverage: Comparison of manual and computer-aided methods. Proc Annu Symp Comput Appl Med Care. 1992:114–118.
79 Van Eaton EG, Horvath KD, Lober WB, Pellegrini CA. Organizing the transfer of patient care information: The development of a computerized resident sign-out system. Surgery. 2004;136:5–13.
80 Apker J, Mallak LA, Gibson SC. Communicating in the "gray zone": Perceptions about emergency physician–hospitalist handoffs and patient safety. Acad Emerg Med. 2007;14:884–894.
81 Arora V, Johnson J, Lovinger D, Humphrey HJ, Meltzer DO. Communication failures in patient sign-out and suggestions for improvement: A critical incident analysis. Qual Saf Health Care. 2005;14:401–407.
82 Kellogg KC, Breen E, Ferzoco SJ, Zinner MJ, Ashley SW. Resistance to change in surgical residency: An ethnographic study of work hours reform. J Am Coll Surg. 2006;202:630–636.
83 Laxmisan A, Hakimzada F, Sayan OR, Green RA, Zhang J, Patel VL. The multitasking clinician: Decision-making and cognitive demand during and after team handoffs in emergency care. Int J Med Inform. 2007;76:801–811.
84 Davidoff F, Batalden P. Toward stronger evidence on quality improvement. Draft publication guidelines: The beginning of a consensus project. Qua Saf Health Care. 2005;14:319–325.
85 Hamilton P, Gemeinhardt G, Mancuso P, Sahlin CL, Ivy L. SBAR and nurse–physician communication: Pilot testing an educational intervention. Nurs Adm Q. 2006;30:295–299.
86 Pope BB, Rodzen L, Spross G. Raising the SBAR: How better communication improves patient outcomes. Nursing. 2008;38(3):41–43.
87 Winters BD, Pham J, Pronovost PJ. Rapid response teams—Walk, don't run. JAMA. 2006;296:1645–1647.
88 Stevens DP. Why new guidelines for reporting improvement research? And why now? Qual Saf Health Care. 2005;14:314.
89 SQUIRE Guidelines. Available at: www.sgim.org/userfiles/file/AMHandouts/AM08/WD08%20Shojania.pdf. Accessed August 24, 2009.
90 Fitch K, Bernstein SJ, Aguilar MD, et al. The RAND/UCLA Appropriateness Method User's Manual. Santa Monica, Calif: RAND; 2001.
91 Patterson ES, Roth EM, Woods DD, Chow R, Gomes JO. Handoff strategies in settings with high consequences for failure: Lessons for health care operations. Int J Qual Health Care. 2004;16:125–132.

Appendix

Research Studies of U.S. Residents' and Attending Physicians' Handoffs Identified in the English-Language Literature, 1987 to June 2008

Source	Design	Study participants	Results	Quality score
Randomized controlled trial				
Lee et al, 1996[66]	Prospective randomized controlled trial in which 1 group used a standardized sign-out card and the control group could use any other handoff method. After night call, each intern was asked to complete a brief questionnaire.	19 interns on an inpatient cardiovascular medicine service at St. Marys Hospital in Rochester, Minnesota, were studied for 92 days in 1994. They were randomly assigned to teams: 10 to the study group and 9 to the control group. 252 of 384 (66%) possible questionnaires were collected, 138 of 192 (72%) for the intervention group, and 114 of 192 (59%) for the control group.	Poor sign-out was reported on 8 (5.8%) questionnaires in the intervention group and 17 (14.9%) in the control group ($P = .016$). In the intervention group, 8 discrete incidents of poor sign-out were described, whereas 25 discrete incidents were reported in the control group. 50 randomly selected standardized sign-out cards and 50 nonstandardized sign-out sheets were analyzed. Comparison yielded patient code status 74% versus 22%; age 80% versus 50%; allergies 72% versus 20%; and medications 88% versus 36%; standardized versus nonstandardized, respectively. Nonstandardized sign-outs had no consistent format and were written on varying sizes of paper. The intervention group reported spending a median of 5 minutes (range 5–15) to complete the standardized sign-out card. 8 of 10 intervention interns reported that the standardized sign-out cards helped them stay organized and improved patient care. All agreed that using a standardized sign-out should be an expected part of an intern's duties.	12
Van Eaton et al, 2005[67]	Prospective, randomized, crossover study, with a 6-week prerandomization run-in period and a 14-week randomized crossover study period. Conducted a telephone survey and administered a 16-item anonymous Web-based survey 3 times. Junior residents were interviewed twice.	A total of 161 residents (21% of the resident population) participated over the course of the study: 14 inpatient resident teams (6 general surgery, 8 internal medicine) at 2 teaching hospitals, University of Washington Medical Center and Harborview Medical Center, Seattle, Washington, in 2003. 1,365 telephone surveys of residents were completed.	Use of the University of Washington Computerized Rounding and Sign-out system (UWCores) reduced the overall number of patients missed on resident round from 5 to 2.5 patients/team/month ($P = .0001$). Residents reported better sign-out quality (69.6% agree or strongly agree) and improved continuity of care (66.1% agree or strongly agree). Residents spent 40% more of their prerounding time seeing and talking with patients ($P = .36$). Use of UWCores reduced the mean portion of prerounding time spent hand-copying vital signs and lab values from 24% to 12% ($P < .0001$). It shortened overall team rounds by 1.5 minutes per patient ($P = .0006$). The majority of residents reported finishing their work sooner with UWCores compared with those without UWCores (82.1% agreed or strongly agreed).	12
Nonrandomized trial with comparison group				
Lofgren et al, 1990[68]	Retrospective analysis of medical records data in a natural experiment, where 2 units had different handoff arrangements.	146 patients admitted after 5 PM to a medicine service at the Minneapolis Veterans Affairs Medical Center, Minneapolis, Minnesota: half admitted by a cross-covering senior resident and then transferred to a different senior resident the following day and half evaluated by the primary senior resident; conducted in 1986 and 1987. 146 eligible patients: 72 were admitted by the primary evaluation (PE) senior resident and 74 were admitted by a cross-coverage (CC) senior resident.	DNR orders were written for 28% of the PE group versus 20% of the CC group (not statistically significant). The CC group of patients had significantly more laboratory tests performed during their hospital stay than did the PE group of patients (44 versus 32, $P = .01$). Median lengths of stay were 7 and 9 days for the PE and CC groups, respectively ($P = .06$).	9

(*Appendix continues*)

Appendix, continued

Source	Design	Study participants	Results	Quality score
Cohort				
Arora et al, 2007[69]	Retrospective cohort study of resident daily sign-out sheets compared with medication lists in patient charts (gold standard).	186 of 247 (75%) patients on general medicine inpatient service and 10 (100%) internal medicine interns caring for those patients consented to participate in Chicago, Illinois in 2006. 165 patient charts abstracted and compared with resident sign-out sheets.	There were 1,876 of 6,942 (27%) medication chart entries that were discrepant with the sign-out, with 80% (1,490/1,876) labeled omissions. These discrepancies originated from 758 index errors, of which 63% (481) persisted past the first day. Omissions were more likely to persist than commissions (68% versus 53%, $P < .001$). Greater than half of all index discrepancies were moderate or severely harmful. Although omissions were more frequent, commissions were more likely to be severely harmful (38% versus 11%, $P < .0001$).	13
Cross-sectional				
Borowitz et al, 2008[70]	Survey completed immediately after an on-call night.	Residents on 2 pediatric wards at the University of Virginia Children's Hospital, Charlottesville, Virginia, for 98 days spanning 2005 and 2006. 158 of 196 (81%) potential surveys were completed.	On 49 (31%) surveys, residents indicated something happened while on call for which they were not adequately prepared. In 40/49 instances residents did not receive information during sign-out that would have been helpful, and in 33/40 the situation could have been anticipated and discussed during sign-out. The quality of sign-out (using a 5-point Likert scale, where 1 = inadequate to answer call questions and 5 = adequate to answer call questions) on the nights when something happened the resident was not adequately prepared for were significantly different than the nights nothing happened [mean (SD) 3.58 (0.92) and 4.48 (0.70); $P = .001$].	9.5
Frank et al, 2005[71]	Resident sign-out sheet compared with Computerized Provider Order Entry for accuracy of patient weight, allergies, and medications.	74 general pediatric and subspecialty patients consecutively admitted to A I duPont Children's Hospital, Wilmington, Delaware, during a 5-day period.	67.6% of patients had at least 1 error of content on the resident sign-out sheet (RSS), 22% of ordered medications were not listed on the RSS, and 8% of medications on the RSS were not ordered.	8.5
Horwitz et al, 2006[72]	Self-administered surveys mailed to chief resident.	Surveys completed by 202 (62%) of the 324 eligible chief residents at accredited internal medicine residency programs outside of New York state in 2005.	Most respondents reported always providing either an oral (66%) or written sign-out (63%) during sign-out of care. 45% required both methods at all times. 59% had no means of informing nurses when a transfer occurred. 60% of programs did not provide lectures or workshops on sign-out skills. Residents in 27% of the programs received neither training nor supervision of sign-out.	12
Sinha et al, 2007[73]	Web-based survey.	Survey sent to all emergency medicine (EM) residency program directors (including associate and assistant program directors) and pediatric EM fellowship program directors at accredited programs in the United States in 2006. 153 (59.3%) EM program directors and 32 (71.1%) pediatric EM fellowship program directors responded, total of 185 respondents.	136 (73.5%) reported that sign-outs at change of shift occurred in a common area within the emergency department (ED), and 79 (42.7%) indicated combined sign-outs in the presence of both attending and resident physicians. 71.6% agreed that specific practice parameters regarding transfer of care in the ED would improve patient care. 72.3% agreed that a standardized sign-out system in the ED would improve communication and reduce medical errors. 50.3% reported that physicians sign out patient details verbally only, and 42.9% noted that transfer of attending responsibility was rarely documented. 119 of 133 programs (89.5%) had no uniform written policy regarding patient sign-out. 34 of 133 (25.6%) programs had formal didactic sessions focused on sign-outs.	11.5
Intervention with no control group				
Frank et al, 2005[74]	Automated and integrated sign-out system (AISS) was implemented on a pilot basis, and use of AISS was audited.	Residents and attending physicians at A. I. duPont Hospital for Children, Wilmington, Delaware, in 2004 and 2005 used AISS. The AISS records for 5,208 inpatients were audited.	On average, each form was modified 6.3 times.	4

(*Appendix continues*)

Appendix, continued

Source	Design	Study participants	Results	Quality score
Horwitz et al, 2007[75]	Developed and implemented a 1-hour curriculum on sign-out followed by an evaluation that used a retrospective pre–post evaluation.	Internal medicine interns and medical students in New Haven, Connecticut. Did not take attendance at the educational session; collected 34 completed evaluations.	Perceived comfort at providing sign-out increased from 3.27 ± 1.0 to 3.94 ± 0.90, $P < .001$. Sign-out was ranked as important or very important to patient care, 4.88 ± 0.33 (on a 5-point scale). The mnemonic SIGNOUT was rated as useful or very useful (4.46 ± 0.78) and received a slightly higher rating than the mnemonic SBAR (4.18 ± 0.83).	8.5
Kannry et al, 1999[76]	Implemented a new Web-based sign-out system and assessed accuracy of provider identification, in 1997 against attending patient logs, and in 1998 against chart review.	Residents and attending physicians at Mount Sinai Medical Center, New York, New York, in 1997 and 1998. 34 patients in 1997 and 40 in 1998.	Analyzed accuracy of provider identification, which was 100% in 1997 and 93% in 1998. The hospital bed census correctly identified the attending provider 50% in 1997 and 73% in 1998.	8
Petersen et al, 1998[77]	Implemented a computerized sign-out system and collected self-report of adverse events at baseline, preintervention, intervention, and postintervention. Also collected usage numbers in 1997.	Residents at the Brigham and Women's Hospital in Boston, Massachusetts. 84 of 99 (85%) residents during the 6-month study period (1992–1993). Postintervention follow-up occurred in 1997, when 35 of 46 (76%) interns completed a survey assessing use of the electronic sign-out system.	No significant difference between the rate of adverse events during the preintervention period compared with the baseline period (3.1% versus 3.9%). There were significantly fewer adverse events after the intervention was instituted compared with the baseline period (2.4% versus 3.9%; $P < .001$). The rates of preventable adverse events in the baseline and preintervention periods were the same (1.7%), but after the intervention there were fewer (1.7% versus 1.2%; $P < .01$). In 1997, use of sign-out after intervention was measured; 35/46 (76%) interns responded. 33 (94%) reported signing out 100% electronically, and 2 (6%) reported using the sign-out for 85%–90% of cases.	10
Ram and Block, 1992[78]	Implementation of computer sign-out system, with pre- and postintervention questionnaire.	2 family practice medicine residencies, 1 in Buffalo, New York and 1 in Pittsburgh, Pennsylvania. Study 1: 16 family practice residents at each site (32 total) completed a baseline satisfaction survey. Study 2: Used presurvey data from 7 of the family practice residents in Buffalo, New York. Then, implemented the new computer sign-out system and readministered the satisfaction survey to these residents.	Study 1: Overall, 69% of residents completing the baseline satisfaction survey reported that important components were not provided at sign-out. Study 2: On a 5-point scale, where 1 = very good and 5 = bad, the average satisfaction score improved after implementation (3.7 versus 1.1). 14% pre- and 100% postimplementation responded that they currently got the components of sign-out information considered important.	6.5
Van Eaton et al, 2004[79]	Used a 4-step process to design University of Washington Computerized Resident Sign-Out system (UWCores) and then assessed use.	38 residents from 31 inpatient services participated in the initial evaluation and analysis stage. 28 residents from 8 services participated in the planning and modification stage. Collected data on number of patients in the UWCores system.	During the first month after the system was introduced, residents had used it to manage information on 3,613 patients and had printed 6,705 reports. At 6 months the number of patients added per month had risen to 4,606 and residents were generating 10,398 printed lists or notes per month. At the end of 6 months of use, the number of patients active in the system at a given time was 66% of the combined total inpatient capacity.	7
Qualitative study				
Apker et al, 2007[80]	Semistructured interviews to identify perceptions regarding handoffs. Qualitative analysis of interview scripts.	12 physicians (6 emergency medicine and 6 hospitalists) at a midwestern hospital.	Researchers identified 2 major themes in the transcripts: 1. Barriers in the gray zone of handoff communication —Poor communication behaviors —Conflicting information expectations 2. Handoffs contribute to boarding-related safety risks —Risks to boarded patients —Risks to emergency department patients	9

(*Appendix continues*)

Appendix, continued

Source	Design	Study participants	Results	Quality score
Arora et al, 2005[81]	Interviews employing the critical incident technique designed to elicit communication failures during verbal or written sign-out. Interns were interviewed after receiving sign-out from another intern.	26 of 30 (87%) first-year internal medicine residents (interns) on the inpatient general medicine service at the University of Chicago Hospitals in 2004 were interviewed. These residents were caring for 82 patients.	25 critical incidents were reported caused by communication failures. 21/25 of these communication failures led to uncertainty by the intern during patient care decisions. In the 21 intern-described worst events caused by poor sign-out, 17 were caused by content omissions. Omitted content or failure-prone communication processes emerged as major categories of failed communication.	11
Kellogg et al, 2006[82]	Ethnographic field study, with observations, interviews, and documentation review and subsequent restructuring of handoff system.	57 sign-outs made by surgical residents at Brigham and Women's Hospital in 2002 and 2003.	Handoffs of unfinished work during sign-out were coded as attempted or not attempted and as accomplished or not accomplished. Initially, only 14% of handoffs of unfinished work during sign-out were accomplished. They implemented iterative process changes, and eventually 79% of handoffs of unfinished work were accomplished.	6.5
Laxmisan et al, 2007[83]	Ethnographic observations and semistructured interviews focused on the nature of interruptions and multitasking during shift change.	6 subjects were interviewed; they represented the core clinical team of emergency department attending physicians, residents, and nurses located within a large tertiary care teaching hospital affiliated with 2 university medical schools in New York City. No data on the number of observations	Handoffs were carried out differently depending on preference of physicians, with 3 formats identified: 1. Sit-down rounds—Outgoing physician printed list of patients from electronic patient tracking system and explained each case, with incoming physician making notes 2. Walk rounds—Bedside handovers, incoming physician making notes on printout 3. Combined sit-down and walking rounds Transfer of information began at the point of handoff/shift changes and continued through various other activities such as documentation, consultation, teaching activities, and use of computer resources. On average, there was an interruption every 9 and 14 minutes for attending physicians and residents respectively. The workflow analysis showed gaps in information flow due to multitasking at shift change.	7.5