Observations of Residents' Work Activities for 24 Consecutive Hours: Implications for Workflow Redesign

Patricia A. Gabow, MD, Amit Karkhanis, MS, Andrew Knight, RN, Paula Dixon, PhD, Sheri Eisert, PhD, and Richard K. Albert, MD

Abstract

Purpose
To examine resident workflow as part of an institutional approach to redesigning the processes of health care delivery.

Method
In 2003 the authors observed the workflows for 24 hours of seven residents who were at various levels of training (two each from the internal medicine, pediatrics, and obstetrics and gynecology programs, and one from general surgery) at Denver Health Medical Center, an urban, public teaching hospital.

Results
Although the residents spent varying proportions of their time in various activities, all had extremely fragmented workflows as they engaged in from 5.0 to 11.3 different activities per hour of nonsleeping time, many of which required only minutes to complete. All residents experienced frequent interruptions and changes in focus. The internal medicine and surgery residents spent large amounts of time traveling, covering three and six miles, respectively, during their 24-hour shifts. Three of the residents slept between one-quarter and one-third of their time on duty (one without any interruption).

Conclusions
The authors suggest that fragmented workflow exists in all residency programs and that applying the same work limitations to all residents in all training programs (to reduce fatigue-related errors) may be overly restrictive. Improving these processes of care will be difficult and will likely require analytic skills and knowledge of systems engineering that most physicians do not have.

Acad Med. 2006; 81:766–775.

The Residency Review Committee of the Accreditation Council for Graduate Medical Education established new limitations on resident work hours in July 2003 in response to concerns that restricted sleep was adversely affecting trainees' performance and causing in errors in care.[1] Most institutions and training programs responded to these limitations by adding additional residents, nurse practitioners, physician assistants or hospitalists, using night or day floats, and/or by creating or expanding nonteaching services. While all of these changes focused on reducing the volume of work required of residents, none addressed the possibility that dysfunctional work processes and/or workflow could be contributing to errors, nor considered that work processes and/or workflow might need substantial redesign.

Accordingly, we studied resident workflow as part of an overall initiative aimed at redesigning the processes of health care in our teaching hospital. The workflows of selected first-, second-, and/or third-year residents (R1, R2, R3, respectively) in pediatrics, internal medicine (IM), obstetrics and gynecology (ob–gyn), and general surgery are the subject of this report.

Dr. Gabow is chief executive officer and medical director of Denver Health and professor of medicine, University of Colorado Denver Health Sciences Center, Denver, Colorado.

Mr. Karkhanis is a project manager in health services research at Denver Health, Denver Colorado.

Mr. Knight is the manager of Aspen Healthcare Metrics, Englewood, Colorado.

Dr. Dixon is a research coordinator at the University of Colorado Denver Health Sciences Center, Denver, Colorado.

Dr. Eisert is director of health services research at Denver Health, Denver, Colorado.

Dr. Albert is chief of the Department of Medicine at Denver Health and professor of medicine at the University of Colorado Denver Health Sciences Center, Denver, Colorado.

Correspondence should be addressed to Dr. Albert, Denver Health Medical Center, 777 Bannock, MC 4000, Denver, CO 80204-4507.

Method

We performed our study in 2003 at Denver Health Medical Center (DHMC), a 300-bed urban, public teaching hospital that is part of Denver Health and is the principal safety net institution for Colorado. The DHMC utilizes 66 residents from DHMC-specific training programs (emergency medicine, oral surgery, general practice dentistry) and 536 residents from University of Colorado School of Medicine training programs who rotate through the DHMC each year. On any given month over 176 residents are working at the DHMC.

In 2003, Denver Health received a Phase 1 grant from the Agency for Healthcare Research and Quality to examine and improve the process of health care. As part of this grant a team of two nurses (AN), one health services researcher (PD) and one industrial engineer (AK) working eight-hour shifts observed all activities of seven selected residents for 24 consecutive hours. Two of the residents were from pediatrics (R1, R2), two from internal medicine (R1, R3), two from ob–gyn (both R2), and one from general surgery (R3). Because the pediatrics and ob–gyn residents worked 12-hour shifts, one of the shifts of these groups was followed from 7:00 AM to 7:00 PM, and the other, from 7:00 PM to 7:00 AM; the two sets of data were combined.

Table 1

Names and Definitions of Activities Carried Out by Seven Residents and Observed During a 24-Hour Period, Denver Health Medical Center, 2003*

Activity name	Definition
Adjust equipment	Adjusting any type of patient-specific equipment (e.g., IV pump)
Administrative	Performing administrative or office-type duties
Answer telephone	Answering the telephone
Answer page	Responding to a page
Answer alarm	Answering an alarm on patient-specific equipment (e.g., IV pump, cardiac monitor)
Assessment	Assessing a patient's condition
Attend to patient	Any nonspecific contact with the patient
Attending class	Attending an educational class
Break time	Time spent going to the restroom, not otherwise working
Call for assistance	Calling for assistance to help with a task
Charting (orders)	Writing orders in the patient's medical record
Charting (progress note)	Documenting the patient's progress in the medical record
Cor-0 or Code blue	Working in a code or cor situation
Consent	Obtaining consent for a procedure
Consult with nurse	Discussing a patient's medical care with a nurse
Consult with provider	Discussing a patient's medical care with an attending, resident, intern, therapists, nurse, etc.
Copy	Copying records or papers
Delivery	Delivery of a baby
Discharge	Discharge of a patient
Down time	Time not used to benefit the patient (e.g., eating lunch)
Education	Conferences, literature review, reading medical literature
Entering orders	Entering orders into a CPOE system. (Computerized Physician Order Entry)
Family interaction	Speaking with a patient's family member
Lab draw	Obtaining a specimen from a patient
Looking up labs	Looking up laboratory results on a computer
Making copies	Making photocopies
Monitors EKG's	Watching the unit's central cardiac monitor station
Obtain vital signs	Obtaining a patient's vital signs
Paperwork	Working on non-medical paper work
Paging	Paging another member of the staff
Pharmacy	Interacting with pharmacy about medications
Procedure (simple)	Performing non-surgical procedure, usually in the patient's room (e.g., inserting a peripheral catheter)
Procedure (invasive)	Performing an invasive procedure outside the OR (usually at the bedside) (e.g., inserting central line)
Review chart	Reviewing the medical record
Review films/lab	Reviewing X-rays or laboratory results
Rounds	Patient care rounds
Searching	Searching for some item not readily available
Sleep	Time spent sleeping (quantified by direct questioning)
Supplies	Obtaining needed supplies, changing clothes
Surgery	Performing surgery in the OR
Technical problem	Working on or fixing some type of technical problem, usually related to computer systems
Telephone call	Making a telephone call
Transport	Moving a patient from one area of the hospital to another
Travel	Moving from one area of the hospital to another
Travel supply	Traveling to a supply station or a supply room to obtain supplies
Waiting	A period of inactivity while waiting

* Activity names and definitions were developed by the authors on the basis of direct observations of residents from pediatrics (two; one in year 1, one in year 3), internal medicine (two; year 2, year 3), obstetrics and gynecology (two; year 1, year 2), and general surgery (one; year 3).

The study was approved by the combined institutional review board of the University of Colorado School of Medicine, and by the research committee of Denver Health. Written consent was obtained from all residents and patients observed.

We began this study with no formal categorization of resident activities. The ultimate list of 46 activities was developed empirically on the basis of our direct observations using the principle that an activity was considered to be distinct if it had a specific time it began and a specific time it ended and it was not interrupted by travel. Data-recording forms were developed to reduce interobserver variability in activity classification. These were modified as experience was gained. The final activities recorded are described in Table 1. For purposes of analysis many of these were grouped (e.g., all charting activities and order writing grouped as "Charting," making and answering telephone calls as "Telephone," all consulting activities as "Consulting"). Time spent alone in call rooms was classified as "sleeping" time only if the residents stated they were going to sleep, otherwise time in call rooms was classified as "down time." Interruptions were defined as external, unplanned events that delayed or interfered with task completion, or with the continuity of the resident's cognitive focus.[2] Walking distance was monitored using a pedometer.

Results

As would be expected, residents from the different disciplines spent different amounts of time in the various activities (see Table 2). The ob–gyn residents spent twice as much time directly attending to, or assessing their patients (28%) than did the pediatrics R2s or the internal medicine R3s (14% each). The pediatrics R3 had 2.9 hours of down time and six hours of sleep. The pediatric R1 had seven hours of sleep (without interruption) while the surgery R3 only slept 1.7 hours (with one interruption). The ob–gyn residents spent the most time charting and the IM residents spent the most time rounding.

Common to all disciplines was the fact that during the 24-hour period all the residents performed numerous, different activities, many of which required only

Table 2

Type and Duration of Activities Carried Out by Seven Residents and Observed During a 24-Hour Period, Denver Health Medical Center, 2003*

	Pediatrics residents		Internal medicine residents		Ob-Gyn residents‡	General surgery residents
Activity	1st-year % total time (number of events)	2nd-year % total time (number of events)	1st-year % total time (number of events)	3rd-year % total time (number of events)	Two 2nd-year % total time (number of events)	3rd-year % total time (number of events)
Attend to, assess patient	11 (10)	13 (15)	20 (12)	14 (23)	28 (66)	15 (33)
Attend to delivery of baby	3 (1)	7 (5)			11 (6)	
Charting	10 (16)	6 (9)	13 (8)	6 (14)	25 (64)	13 (30)
Consult with MD or nurse	20 (23)	8 (19)	6 (16)	13 (35)	11 (26)	17 (32)
Down time	6 (5)	12 (5)	7 (12)	6 (11)	6 (12)	5 (13)
Educational activity	4 (1)	8 (7)	4 (2)	1 (1)	1 (4)	1 (3)
Family Interaction	3 (2)			1 (2)		
Paging/phone		1 (3)	4 (10)	3 (15)	3 (15)	3 (29)
Procedure		3 (4)	1 (1)	2 (2)	4 (5)	2 (3)
Review films/lab	3 (2)	3 (8)	7 (19)	11 (26)		14 (17)
Rounds	11 (7)	13 (13)	20 (9)	11 (10)	4 (4)	6 (2)
Sleep	29 (1)	25 (6)	15 (1)	28 (2)	†	7 (2)
Surgery					6 (2)	10 (3)
Travel		1 (7)	3 (12)	4 (20)	1 (2)	7 (86)
Total	100 (68)	100 (101)	100 (102)	100 (161)	100 (206)	100 (253)

* The authors directly observed residents from pediatrics (two; one in year 1, one in year 2), internal medicine (two; year 2, year 3), obstetrics and gynecology (two; year 1, year 2), and general surgery (one; year 3). The activities listed are combined versions of the activities listed in Table 1 (e.g., "Charting" refers to all charting activities and order writing). The table illustrates the fragmented nature of the residents' activities across years and specialties.

† Shift work with no expected sleep time.

‡ Data combined, since each worked a 12-hr. shift.

minutes to complete, and all experienced frequent interruptions and changes in focus (Table 2). Outside of the operating room, the work done by the general surgery resident was extremely fragmented, with many of the tasks being performed in several-minute increments (see the Appendix). The number of activities performed during nonsleeping time was 5.0/hour for the internal medicine R1, 5.6/hour for the pediatrics R3, 9.3/hour for the internal medicine R3 and 11.3/hour for the surgery R3. The internal medicine R1 and the surgery R3 both spent large amounts of time traveling, covering over three and six miles, respectively, during their 24-hour shifts.

Discussion

The most important finding of this study was that the workflow for residents in all disciplines studied, and at all levels of training, is extremely fragmented. This could have substantial implications for patient safety.

Although our conclusions are limited by the fact that we only observed seven residents, marked workflow fragmentation was a consistent finding for all. Accordingly, it seems unlikely that additional observations would alter this conclusion. While the process of observing the residents might have altered their behavior (i.e., the Hawthorne effect), particularly with respect to down time, we see no way that this potential problem could affect our conclusion. Observing more residents over a longer period of time could, however, cause us to revise the percentages of time spent on the various activities (as shown in Table 2).

Most studies designed to evaluate the effect of interruptions on errors indicate that that the reprocessing of information that occurs following an interruption predisposes the individual involved to make inaccurate decisions, and that errors increase as the frequency of the interruptions and the reprocessing periods increase.[2,3] Airline accidents and nuclear power plant shutdowns have been related to interruptions, distractions, or preoccupation with one task to the exclusion of another,[4–6] as have medication-dispensing errors in pharmacies and by nurses.[7–9] One paradigm categorizes memory as being divided into *long-term* versus *working* categories, with familiar tasks being accomplished with long-term memory and working memory being available for responding to distractions.[10] Because residents have not yet developed long-term memory for many of their job-related tasks, they may be more likely to utilize a greater amount of working memory when carrying out their duties, thereby being more susceptible to distractions than are their more experienced supervisors.

Although numerous studies have described the number of hours residents from various disciplines spend in various activities,[11] only a few have examined the actual flow of work. Chisholm and colleagues[3,4] observed emergency

medicine physicians for three- to four-hour periods and found that they changed tasks from five to seven times an hour, a finding that is consistent with, but somewhat lower than, the five to 11.3 different tasks performed per nonsleeping hour by the residents that we observed. Having documented this fragmented work pattern and its potential for error, the question arises as to how to address it.

Grouping of pages or using digital pagers to designate the urgency of pages, using e-mail for nonurgent messages, using computer order entry systems to reduce questions arising from illegible handwriting and provide standard order sets and rules engines have all been suggested as ways of reducing interruptions in resident's work processes and improving job satisfaction,[12] but the small fraction of time our residents spent dealing with these interruptions suggests these types of solutions would not reduce the work fragmentation we observed to any substantive extent. Accordingly, it appears that a more sophisticated strategy addressing workflow redesign will be needed.

A second potentially important observation relates to the marked differences in the percentages of time the various residents spent sleeping during the 24-hour period of observation. If such differences were confirmed after expanding the number of observations, it would suggest that applying the same work limitations to all residency programs for the purpose of reducing fatigue-related errors might be overly restrictive.

While attention to sleep deprivation was an important step in reducing errors, our data also strongly suggest that the processes and flow of resident work must also be redesigned with the idea of emphasizing value-added work and eliminating dysfunctional, fragmented processes. Accomplishing such an in-depth redesign will be a daunting task, in part because we believe that it will require analytic skills and knowledge of systems engineering that are not familiar to most physicians. Accordingly, we suggest that individuals from other disciplines, who have addressed optimal work design in other industries, will be needed to apply their specialized knowledge to the health care workplace. Resulting improvements in work processes would likely reduce both work hours and errors in care.

Acknowledgment

This work was supported in part by the Agency for Healthcare Quality Contract No. 290-00-0014, Task Order No. 7, "Improving Efficiency through Hospital Redesign," 9/22/03–10/22/04.

References

1 Accreditation Council for Graduate Medical Education. Resident duty hours (http:/www.acgme.org/acWebsite/home/home.asp). Accessed 24 April 2006.

2 Speier C, Valacich JS, Vessey I. The Effects of Task Interruption and Information Presentation on Individual Decision Making. Proceedings of the XVIII International Conference on Information Systems, Atlanta, GA: Association for Information Systems, 1997; pp. 21–36.

3 Hirst W, Kalmar D. Characterizing attentional resources. J Exp Psychol Gen. 1987;116:68–81.

4 Dismukes K, Young G, Wumwalt R. Cockpit interruptions and distractions: effective management requires a careful balancing act. ASRS (Aviation Safety Reporting System) Directline. 1988Dec.:4–9.

5 Chisholm CD, Collison EK, Nelson DR, Cordell WH. Emergency department workplace interruptions: are emergency physicians "interrupt-driven" and "multitasking"? Acad Emerg Med. 2000;7:1239–43.

6 Chisholm CD, Dornfeld AM, Nelson DR, Cordell WH. Work interrupted: a comparison of workplace interruptions in emergency departments and primary care offices. Ann Emerg Med. 2001;32:146–51.

7 Flynn EA, Barker EN, Gibson TJ, Pearson RE, Berger BA, Smith LA. Impact of interruptions and distractions on dispensing errors in an ambulatory care pharmacy. Am J Health Syst Pharm. 1999;56:1399–25.

8 Peterson GM, Wu MSH, Bergin JK. Pharmacists' attitudes towards dispensing errors: their causes and prevention. J Clin Pharm Ther. 1999;24:57–71.

9 Gladstone J. Drug administration errors: a study into the factors underlying the occurrence and reporting of drug errors in a district general hospital. J Adv Nurs. 1995;22:628–37.

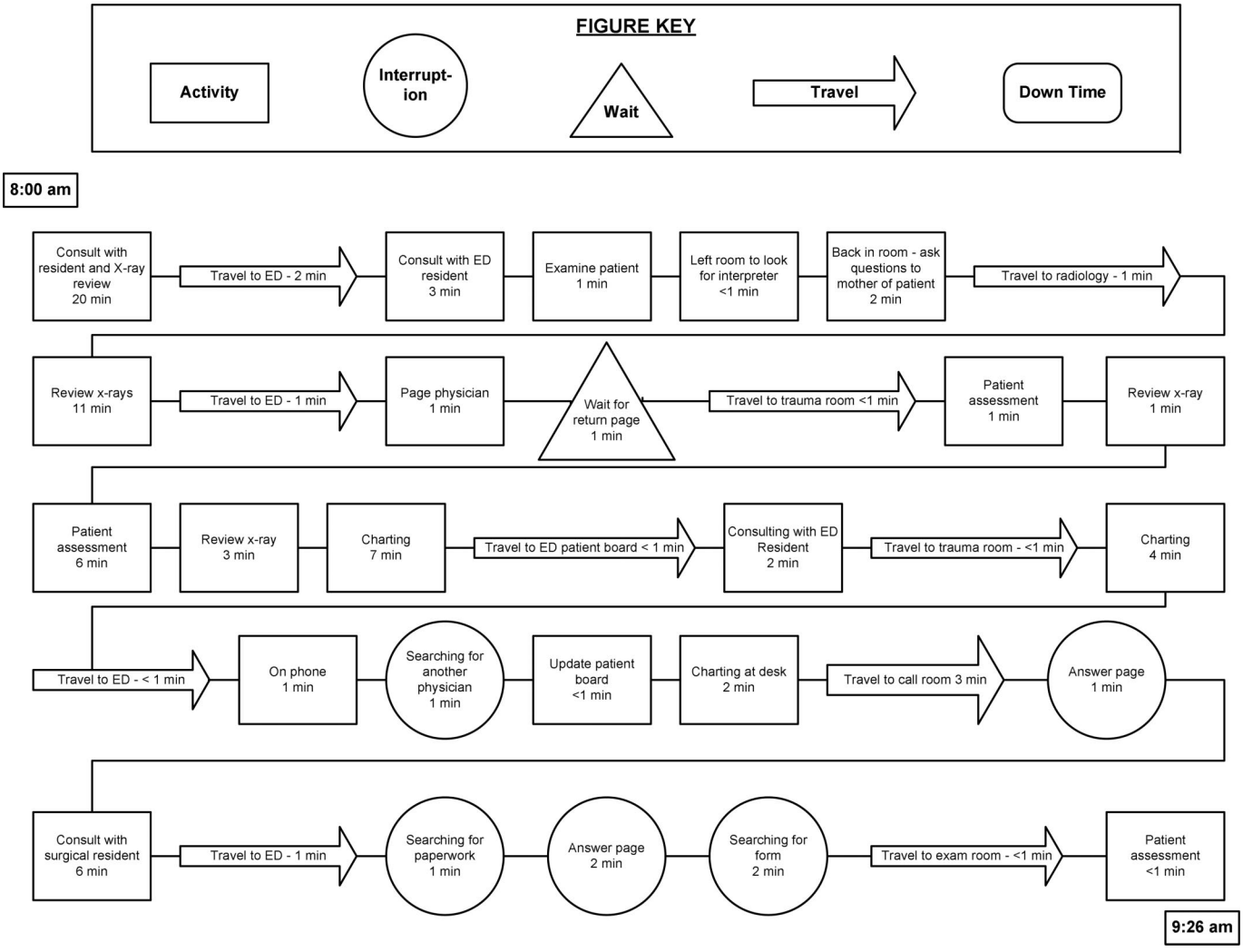
10 Jett QR, George JM. Work Interrupted: a closer look at the role of interruptions in organizational life. Acad Manage Rev. 2003;28:494–507.

11 Lurie N, Rank B, Parenti C, Woolley T, Snoke W. How do house officers spend their nights? A time study of internal medicine house staff on call. N Engl J Med. 1989;320:1673–77.

12 Volpp KGM, Grande D. Residents' suggestions for reducing errors in teaching hospitals. N Engl J Med. 2003;348:851–55.

Appendix

Workflow of a Third-Year Surgery Resident, Including Interruptions, Over a 23-Hour Period*

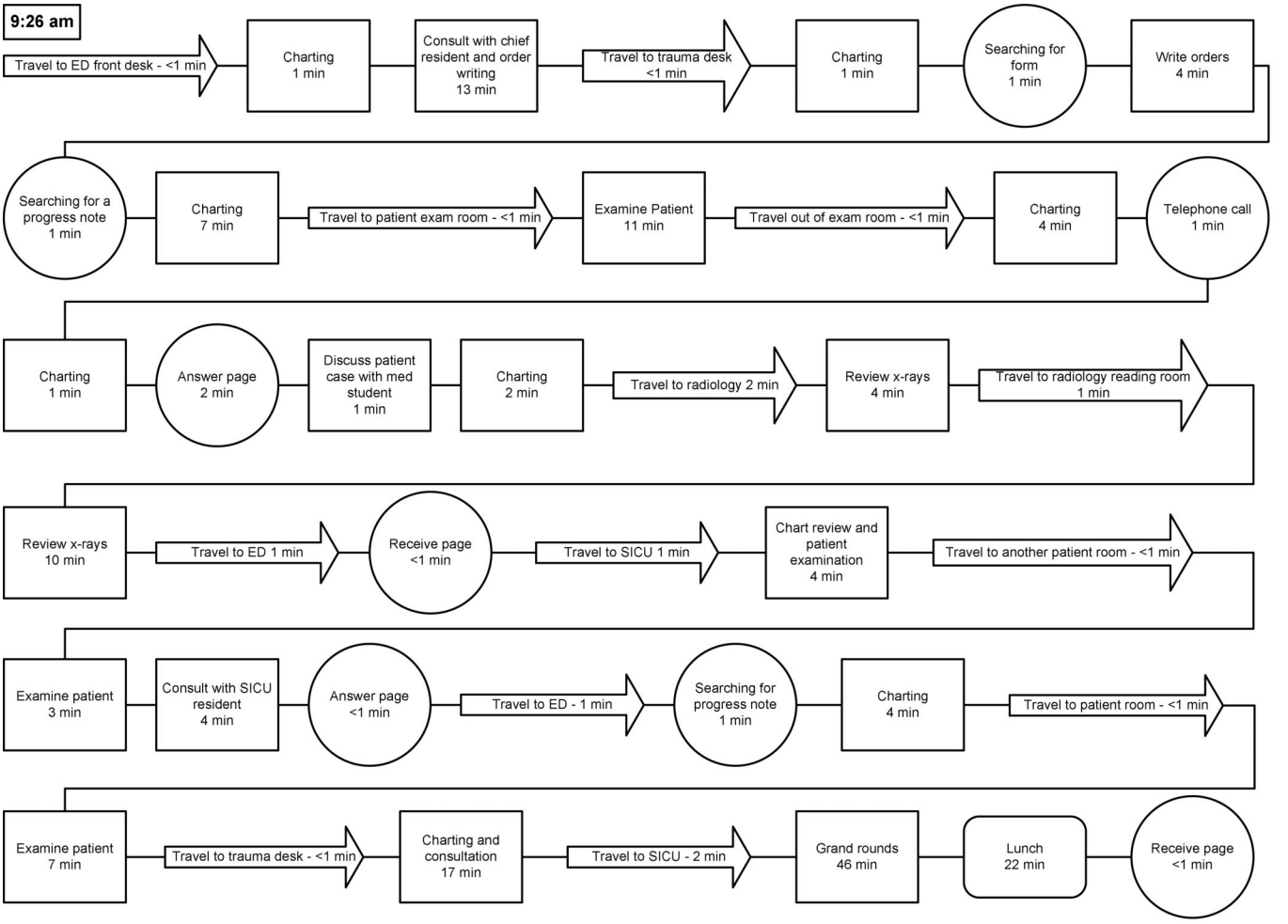


(*Appendix continues*)

*This resident was one of seven residents in various specialties and levels of training whose activities the authors observed over a 24-hour period. (Because of an unexpected circumstance, this resident was observed for only 23 hours.) The chart on this and the following pages illustrates that the workflow of this resident was extremely fragmented. This was also the case with the workflows of the other six residents.

Appendix

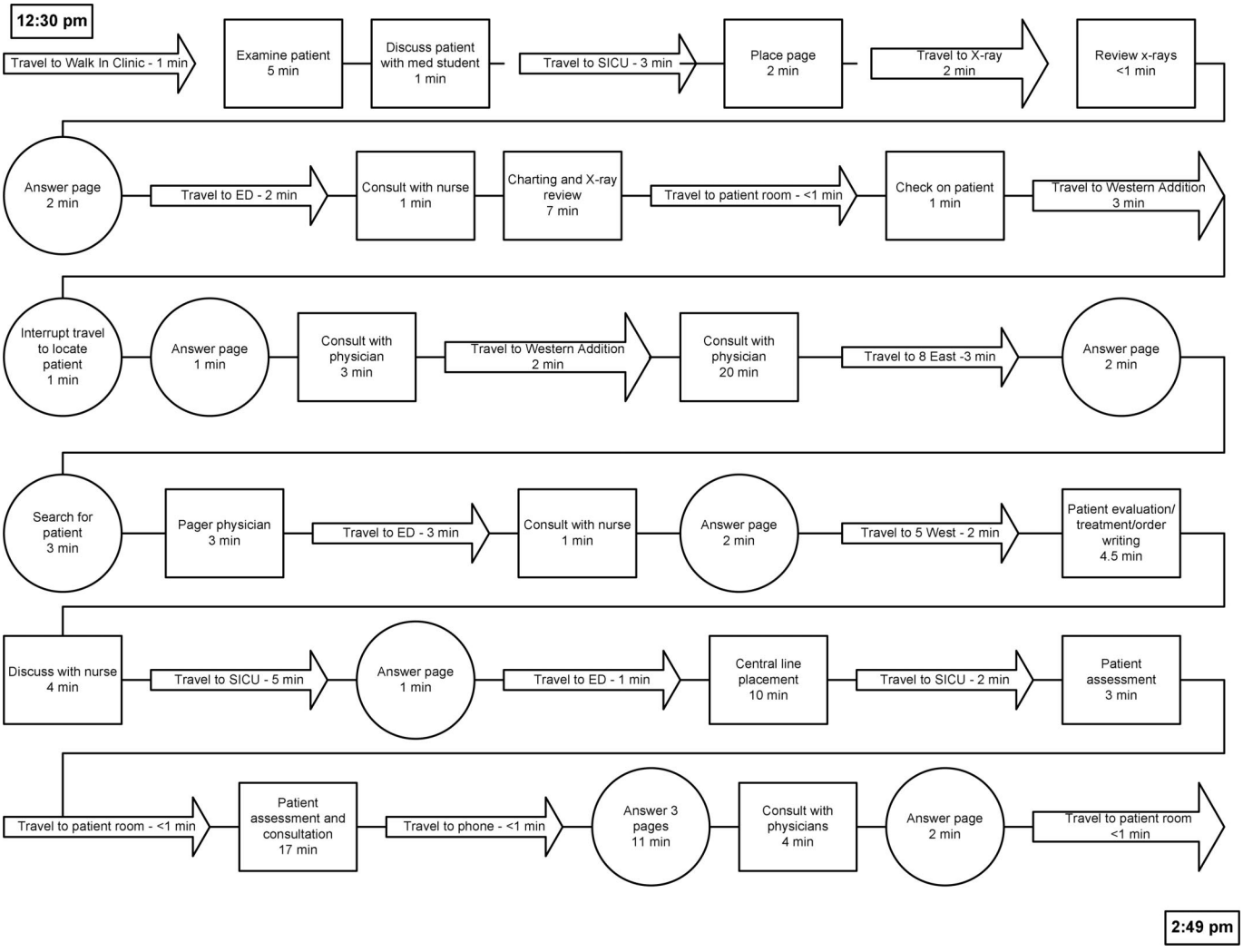
(*Continued*)



(*Appendix continues*)

Appendix

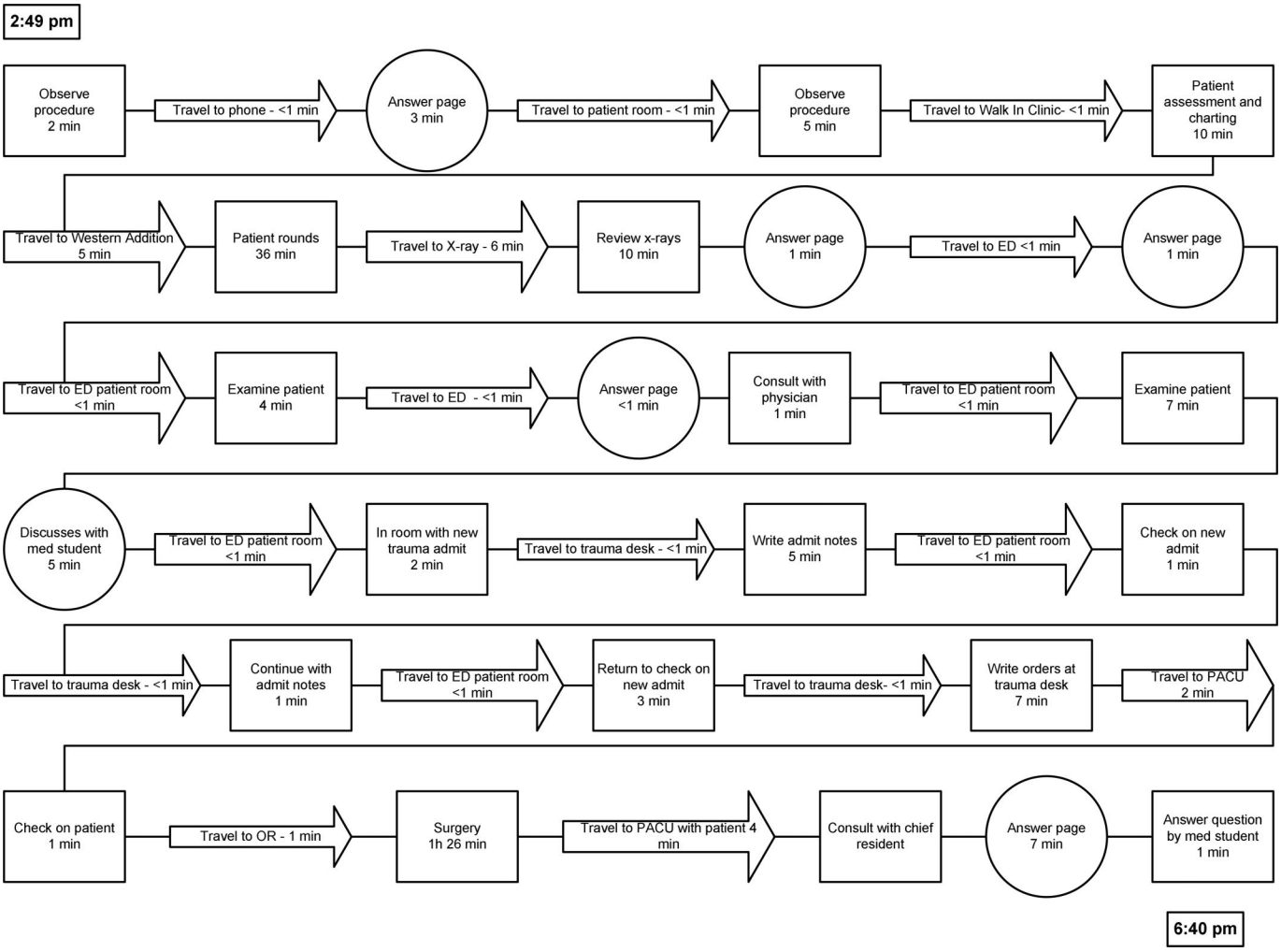
(*Continued*)



(*Appendix continues*)

Appendix

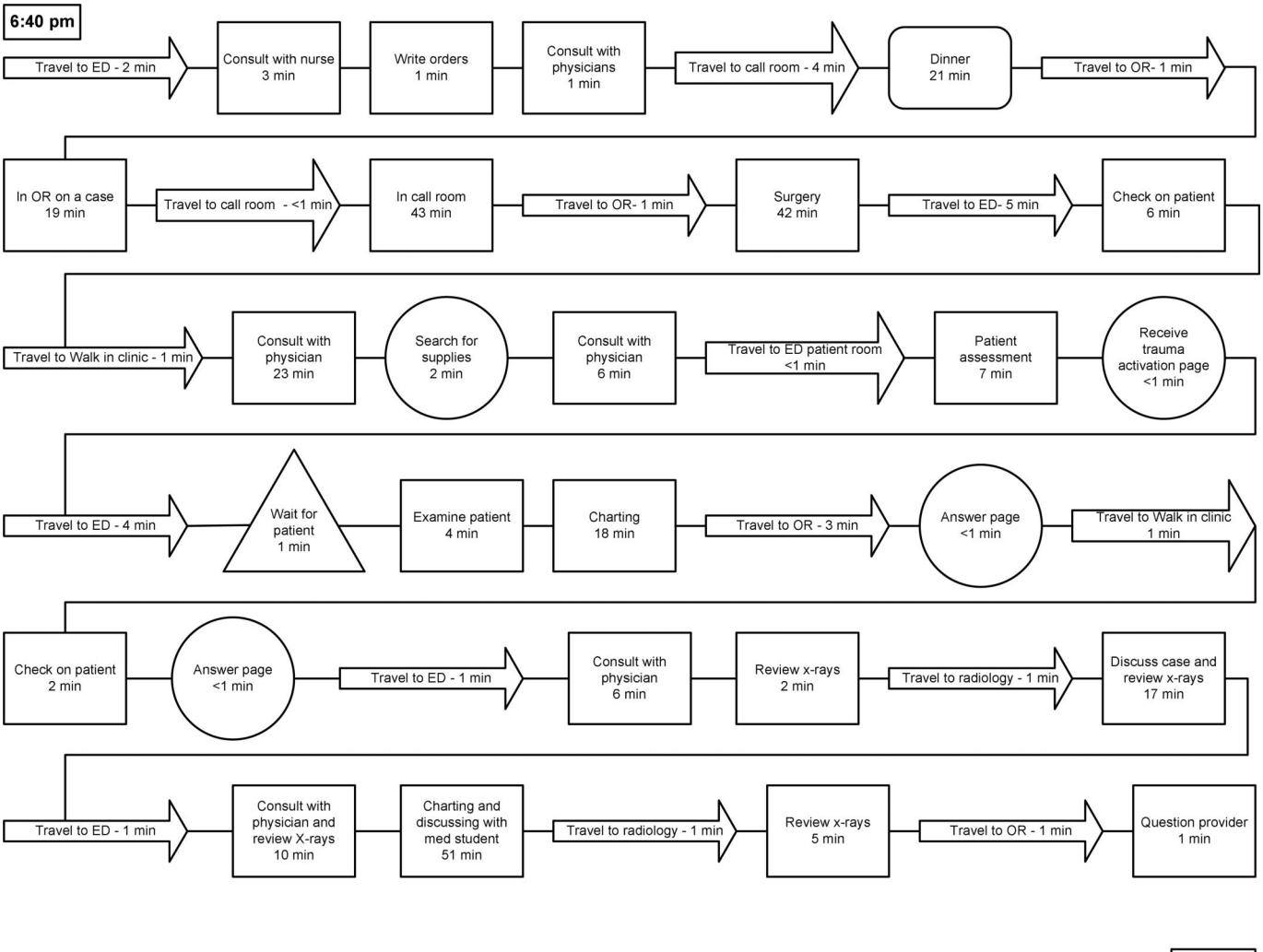
(*Continued*)



(*Appendix continues*)

Appendix

(*Continued*)



(*Appendix continues*)

Appendix

(*Continued*)