ARTICLE

Unit-Based Care Teams and the Frequency and Quality of Physician-Nurse Communications

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Objective: To determine whether reorganizing physicians into unit-based teams in general pediatric wards is associated with greater ability to identify other care team members, increased face-to-face communication between physicians and nurses, greater perception that their patient care concerns were met, and decreased number of pages to residents.

Design: Prospective intervention study with data collected before and at 2 time points after implementation of unit-based teams.

Setting: General pediatric wards at an urban, tertiary care, freestanding children's hospital from April 1, 2008, through June 30, 2009.

Participants: Pediatric residents rotating in the medical wards (n=60) and ward-based pediatric nurses (n=154).

Intervention: We reorganized resident-physician care teams to be based on specific inpatient units, with residents admitting and caring only for patients on their assigned unit.

Main Outcome Measures: Anonymous physician and nurse self-reports of communication practices and number of pages residents received.

Results: In the unit-based team system, physicians were more likely to be able to identify the nurse for their patients with the most complex conditions (62.3% vs 82.8% vs 82.5%, $P=.05$), to report contacting (27.3% vs 64.9% vs 56.9%, $P=.01$) and being contacted by (7.7% vs 48.2% vs 55.2%, $P=.002$) that nurse in person, and to believe their patient care concerns were met (44.2% vs 82.1% vs 81.8%, $P=.009$). Nurses reported parallel improvements in communication patterns. The mean number of pages per day to residents decreased by 42.1% (19 vs 10 vs 11, $P<.001$).

Conclusion: Unit-based teams improve the frequency and quality of multidisciplinary communication, which may create an improved climate for patient safety.

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IMPAIRED COMMUNICATION IS A MAJOR contributor to medical error.[1-12] In particular, physician-nurse communication failures have adverse consequences for patients.[13,14]

Previous work[14-16] demonstrates several discrete elements of multidisciplinary team communication that may each have an effect on patient safety, including openness, understanding, and collaboration. A first step toward fostering such attitudes may be to enhance face-to-face communication among caregivers.[3]

In this study, we sought to determine whether creating unit-based care teams affected the quantity or quality of patient care communications between pediatric residents and nurses. We hypothesized that our unit-based reorganization would facilitate face-to-face communication between nurses and physicians and would lead to stronger beliefs among team members that their patient care concerns were being met. To our knowledge, ours is the first study investigating the effect of caregiver geography on multidisciplinary communication.

METHODS

SETTING

We conducted a prospective intervention study in the pediatric medical wards at Children's Hospital Boston, an academic, tertiary care children's hospital. The medical wards contain a mix of general pediatrics and subspecialty patients. All wards are considered to be of regular acuity and are not distinguished by age.

Before June 30, 2008, daily rounds for medical inpatients occurred in a conference room, after which residents dispersed to as many as 5 different floors and 8 different units to care for their patients. Nurses assigned to individual patients were unit based. Physicians and nurses were thus not associated geographically as a team. Efforts were made to have nurse representatives from each floor present at morning rounds, but attendance was variable, depending on the floor and competing needs at the patient bedside. The resident teams con-

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sisted of 4 interns with primary patient care responsibilities, supervised by a senior resident who oversaw the care of all patients assigned to the team.

INTERVENTION

In June 2008, two resident care teams were reorganized to be based on specific inpatient units. We developed the intervention in response to positive feedback regarding communication and overall satisfaction from floor nurses and residents who worked together in a new small intermediate care unit.

In the baseline system, patients were assigned to a team based on their disease. For example, hematologic and endocrine patients (among others) went exclusively to 1 team, pulmonary and renal patients (among others) went to the other team, and some general pediatrics patients were assigned to 1 team and some to the other in equal numbers.

In the intervention system, residents admitted and cared only for patients in their assigned unit, and no other teams admitted patients to these units. To accomplish this, most patients were no longer admitted to a team primarily based on disease but based on bed availability. Other off-service subspecialty patients (ie, cared for by their own resident team) were treated in separate units. The on-service patient populations who required separate treatment because of infection control or nursing expertise were not large enough to threaten the system (ie, we were always able to find room in the appropriate unit for such patients). Among the 2 geographic units, admissions alternated between teams as much as possible to make the patient census even. The intervention was not designed to reduce the census of either team; nevertheless, the new geography necessarily enforced a cap on the census. Because the wards differed in maximum capacity (21 vs 29 beds), an even census was not always maintained. On the occasions in which both teams were caring for a maximum number of individuals, patients were admitted off unit but cared for by a different (nonstudy) team.

In the new system, rounds occurred in a conference room in the unit, and teams maintained the model of 4 interns and 1 senior resident, as previously described. The attending structure changed only in that subspecialty attending physicians in the new system might need to perform rounds with more than 1 team.

Nursing participation in rounds did not change as a prescribed element of the intervention but naturally evolved as a result. Before and after the intervention, the charge nurse and primary nurse for each patient planned to attend physician rounds. At baseline, this was rarely accomplished because of the intricacies of timing discussions with multiple caregivers who were based on different floors. After the intervention, the charge nurse for the unit could easily routinely attend all rounds, and each primary nurse (inevitably only a room or 2 away) more often was available when requested. Nurse staffing ratios did not change during the intervention period.

During our study, a night-float system was introduced. In the baseline system, the 4 interns rotated call nights throughout the month, thus taking call every fourth night. In the new system, the 4 interns each spent 1 week of their 4-week rotation working a 12-hour night shift and worked 12-hour day shifts during the remaining 3 weeks. To accommodate work hour restrictions, traditional 24-hour shifts were used to allow for days off on the weekends.

STUDY DESIGN

We assessed resident physician and nurse communication patterns at 9 time points, each representing a separate week of data collection in each of the months noted. These time points were then grouped into 3 distinct study periods: preintervention (April 1 through June 30, 2008), early postintervention (postintervention period 1: December 1, 2008, through March 31, 2009), and late postintervention (postintervention period 2: April 1 through June 30, 2009). Of note, data collection in postintervention period 1 did not include the holiday period and occurred before implementation of the night-float system. This design allowed us to include separate groups of residents as they rotated through the medical services.

During each of the 9 data collection weeks, all residents assigned to the medical care teams described were e-mailed a brief log in which to report their communication patterns at that time point. The questionnaire asked the resident to consider who he or she perceived to be his or her patient with the most complex condition (to minimize recall bias) and to answer the following questions:

1. I know who this patient's primary nurse is (yes/no).
2. The primary means this nurse contacted me today (did not contact/page/phone/left message with teammate/in person/other).
3. The primary means by which I contacted this nurse (did not contact/phone/left message with teammate/in person/other).
4. Total time (minutes) spent discussing this patient with all of his/her nurses (0-5 minutes, 6-10 minutes, etc).
5. The primary nurse responded to my concerns in a timely fashion (5-point Likert scale, strongly disagree to strongly agree).

Similarly, for time points during each of the preintervention and 2 postintervention periods (total of 9 time points), questionnaires were e-mailed to all nurses assigned to the medical care units described. The questions posed to nurses mirrored those posed to residents; however, no relationship was found between the data from the nurses and that from the residents (eg, each could choose the patient that he or she believed to have the most complex condition).

For each study period, residents' paging records were obtained from the hospital operator. Those records identified the number of pages received per 24-hour period. The nurses at Children's Hospital Boston do not carry pagers.

Finally, we collected hospital administrative data to examine basic patient characteristics (census data, age, race/ethnicity, illness severity weight, and health insurance status) in medical wards during the preintervention and postintervention periods to ensure that any changes in communication were not confounded by changes in patient mix. This study was approved by the Children's Hospital Boston institutional review board.

STATISTICAL ANALYSIS

For resident and nurse questionnaires, we calculated proportions of respondents who indicated they could identify the primary resident or nurse of a patient and that they contacted or were contacted by their counterpart in person. We dichotomized the time spent discussing the condition of the patient to 15 minutes or more (as reported on the questionnaires) and treated it as a proportion. We grouped the 5-point Likert scale for responding to concerns into "strongly agree" (the highest score of 5) and "other" (all other scale points) and analyzed the data proportionally. We calculated means and standard deviations for the number of pages per day. Because of the small number of senior residents, we analyzed interns and senior residents together. We compared responses to the communication questionnaire across all 3 time points using generalized estimating equations with repeated measures to account for heterogeneity of response rate between individuals and for multiple responses within individuals. In post hoc analysis, we com-

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Table 1. Patient Characteristics Before and After Intervention

Characteristic	April 1 Through June 30, 2008	April 1 Through June 30, 2009	*P* Value
No. of patients	1669	1710	
Age, mean (SD), y	7.0 (7.0)	7.6 (7.0)	.01
Severity weight, mean (SD)[a]	0.88 (1.5)	0.91 (1.1)	.55
Race/ethnicity other than white, No. (%)	721 (43.2)	716 (41.7)	.84
Public pay, No. (%)	480 (28.8)	450 (26.2)	.49

[a]Severity weight is the National Association of Children's Hospitals and Related Institutions cost weight. The cost weight is intended to be a marker of hospital resource use and is derived from the diagnosis code and severity score. The severity score is assigned based on secondary diagnoses and procedures. The average patient would be assigned a severity weight of 1. Severity weight data are based on samples sizes of 1538 (in the year 2008) and 1577 (in the year 2009) because the available cost database included only direct admissions to the designated wards but not transfers.

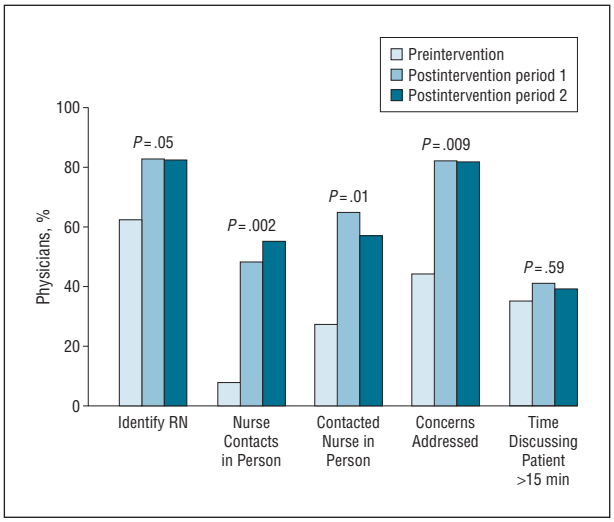

Figure 1. Physician-reported communication with nurses. The preintervention period was April 1 through June 30, 2008. Postintervention period 1 was December 1, 2008, through March 31, 2009. Postintervention period 2 was April 1 through June 30, 2009. *P* values are for the overall measures of effect across time points. RN indicates registered nurse.

Table 2. Responses of Residents Compared by Team Assignment[a]

Response	Team 1, No. (%)	Team 2, No. (%)	*P* Value
Identify nurse (yes)	41 (82.0)	54 (83.1)	.88
Nurse contacts in person (yes)	26 (52.0)	33 (51.6)	.97
Contacts nurse in person (yes)	34 (68.0)	36 (55.3)	.32
Concerns addressed (yes)	41 (85.4)	50 (79.4)	.51

[a]Maximum census on team 1 was 21 patients vs 29 patients on team 2.

bined data from the postintervention period 1 and 2 time points and then compared responses between the 2 unit-based resident teams to determine whether any unmeasured or systematic differences (eg, in maximum census—21 vs 29 beds) influenced communication data. We analyzed physician and nurse responses similarly.

We summarized continuous patient characteristics as mean (SD) and compared them across periods (preintervention vs postintervention period 2 to match seasonality) using 2-sample *t* tests. Categorical characteristics were compared using χ^2 tests. All analyses were performed using SAS statistical software, version 9.2, of the SAS System for Windows (SAS Institute Inc, Cary, North Carolina). Statistical significance was achieved with a 2-sided $P < .05$.

RESULTS

STUDY PARTICIPANTS

Overall, 60 of 81 eligible residents (74.1%) enrolled in this study, completing at least 1 usable time point–specific questionnaire. Twenty-four individuals were eligible to participate during more than 1 rotation. In total, 107 possible resident rotations existed, of which data were collected from 77 (9 individuals participated during more than 1 time point). A total of 201 time point–specific questionnaires regarding communication patterns were completed by the residents.

Of 179 eligible nurses, 154 participated at least once (86.0%), completing 652 time point–specific questionnaires regarding their communication patterns. Demographic characteristics were not assessed for physicians or nurses to maintain anonymity.

PATIENT CHARACTERISTICS

The general medical ward census from April 1 through June 30, 2008, was similar to the corresponding period in 2009 (1669 vs 1710). Mean (SD) patient age was marginally higher in the latter period (7.0 [7.0] vs 7.6 [7.0] years, $P=.01$). Patient characteristics were otherwise similar between 2008 and 2009 (**Table 1**).

RESIDENT COMMUNICATION DATA

After the institution of the unit-based system, residents were more likely to be able to identify a patient's primary nurse (62.3% vs 82.8% vs 82.5%, $P=.05$), to report contacting the nurse in person (27.3% vs 64.9% vs 56.9%, $P=.01$), and to report being contacted by the nurse in person (7.7% vs 48.2% vs 55.2%, $P=.002$) compared with being contacted via telephone, page, or an intermediary (**Figure 1**). Residents were also more likely to agree that the primary nurse responded to their concerns in a timely manner (44.2% vs 82.1% vs 81.8%, $P=.009$). The amount of time residents reported discussing the condition of the patient with the nurse did not change. Post hoc analysis revealed no large differences in responses between residents assigned to the team with 21 beds vs the team with 29 beds (**Table 2**).

Paging records were obtainable for 76 of the 77 eligible residents (1 senior resident's records had been erased by the operator after the resident had graduated but before data were gathered). These included records for each data collection period for individuals who participated across time points. The mean number of pages that residents received decreased by 42.1% after implementation of the unit-based system, from 19 to 10 to 11 per day ($P<.001$).

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NURSE COMMUNICATION DATA

Analysis of nursing questionnaire data largely confirmed the change in communication patterns identified among the residents (**Figure 2**). After implementation of the unit-based system, nurses were more likely to know which intern was assigned to a patient (71.3% vs 83.4% vs 87.8%, $P=.01$) and to know which supervising resident was responsible for a patient (58.7% vs 79.6% vs 82.1%, $P<.001$). Nurses were more likely to report that interns contacted them in person (31.8% vs 54.5% vs 65.9%, $P<.001$) and to report that they contacted interns in person regarding their patient with the most complex condition (12.5% vs 52.5% vs 61.5%, $P<.001$). Nurses reported no change in whether they contacted the intern at all regarding this patient (8.6% did not contact vs 9.5% vs 8.1%, $P=.89$). Nurses were also significantly more likely to agree strongly that residents responded to their concerns in a timely fashion during the postintervention period (38.3% vs 37.8% vs 49.5%, $P=.04$).

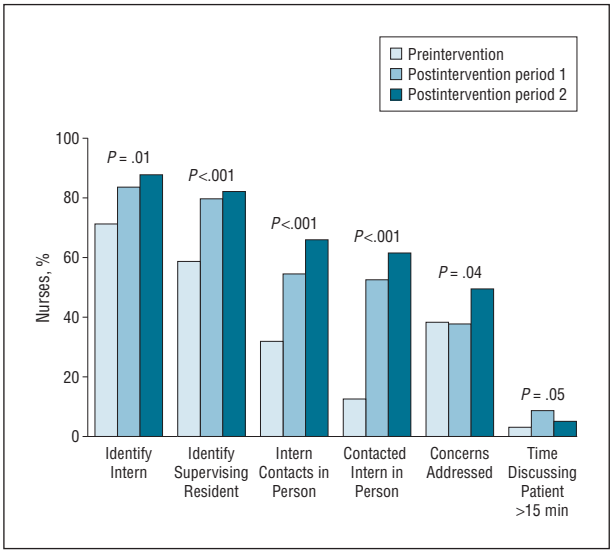

Figure 2. Nurse-reported communication with physicians. The preintervention period was April 1 through June 30, 2008. Postintervention period 1 was December 1, 2008, through March 31, 2009. Postintervention period 2 was April 1 through June 30, 2009. *P* values are for the overall measures of effect across time points.

COMMENT

In this study, unit-based reorganization of patient care teams increased physicians' and nurses' ability to identify key team members and to interact face to face. The intervention also improved both groups' perceptions that their patient care concerns were addressed. This change in communication pattern was associated with fewer pages to residents.

Increasingly, communication failures are identified as the root cause of unfavorable patient outcomes. A previous study[4] that examined strategies for prevention of medication errors in pediatric inpatients estimated that improvements in physician-nurse communication, such as increasing nursing involvement in rounds, could have prevented 17.4% of all medication errors and 29.2% of errors that posed the greatest risk of harm. Similarly, a study[5] of medical error reports in neonatal intensive care settings showed that one of the most common factors contributing to errors and adverse events was communication problems, occurring in 22% of reports. Communication failures appear particularly common in the most serious errors, known as sentinel events. The Joint Commission has found communication failure to be a root cause in 66% of all sentinel events, making it the leading cause of those errors.[17]

Several discrete elements of communication each may have an effect on patient safety: increasing face-to-face communication between nurses and physicians could potentially improve timeliness of action, accuracy of performance, and understanding, openness, and collaboration among caregivers.[14-16] Physicians in our study reported increased timeliness of response and the perception that patient care concerns were better met in a unit-based system that provided more opportunity for face-to-face contacts. These in-person interactions may have enhanced understanding by allowing for exchange of nonverbal cues regarding patient status or level of concern.[18] Furthermore, the improved ability of physicians and nurses to identify each other after the intervention may have contributed to an atmosphere supporting openness and collaboration.[19] The concomitant reduction in paging of residents may further strengthen the potential of this intervention to improve care.[20-23]

Although nurse and physician reports of identification and mode of communication were similar (eg, both groups believed they could identify each other approximately 60% of the time before and 80% of the time after intervention), they differed in their overall assessments of how often their concerns were met and how much time they spent discussing the conditions of their patients. Nurses, on average, reported less response from residents than residents from nurses and were much less likely to report spending more than 15 minutes discussing the most complex conditions of their patients. Partly, this may be an artifact of patient assignments. For example, a more experienced nurse may care for several patients with complex conditions, accounting for several residents' comments but only one of his or hers, but the colleagues of the nurses are then identifying patients with relatively less complex conditions. One could also speculate that these responses reflect underlying attitudes and biases regarding nurses and physicians.[24] For example, a nurse who believes that, in general, residents make him or her feel unimportant is perhaps more likely to underreport time spent in discussion; conversely, residents may overreport time spent if they undervalue the discussion. Direct observation of time in contact and further qualitative work may help elucidate these discrepancies.

This study has several limitations. We evaluated a nonrandomized intervention in a single institution in which other changes were underway concurrently. Specifically, the night-float system may have had an effect on resident and nurse communications. However, our time-ordered data demonstrate that changes in communication patterns had already occurred by the start of the postintervention period 1 data collection period (ie, before introduction of the night-float system), which suggests

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that the night-float cointervention was not the driver of the changes in communications we observed. The sole exception is the change in nurse perception of resident response to their concerns, which did not change until postintervention period 2. It is possible that the night-float system improved the ability of residents to respond to nurses or that this metric was most sensitive to the resident learning curve and patient census differences in the spring compared with the winter. We are not aware of any other major cointerventions in the units we observed during the time of the study, but we cannot rule out the possibility that secular trends or other unknown cointerventions had an effect. Some unmeasured changes, noted anecdotally after the implementation of this system, could have mediated the improved communication noted by study participants, namely, increased participation of nurses during rounds and increased ability of physicians to spend time at the bedside. It is possible that these changes would have improved communication regardless of caregiver geography; however, we believe it is more likely that the system reorganization facilitated these changes.[25] This study does not address considerations such as the role of off-shift communications, patient outcomes, or effect on resident education; these issues represent important avenues for future investigation.

To our knowledge, ours is the first study of the effects of geographic care team reorganization on communication patterns in general pediatrics units. The shift to in-person physician-nurse interactions apparently led to a reduction in paging and improved communication quality, which may have great potential to improve patient outcomes in this setting. At the same time, the fact that even after intervention only 49.5% of nurses believed that residents responded to their concerns in a timely fashion suggests that much work needs to be done. Further research should continue to elucidate the ways that specific changes in physician-nurse communication can improve inpatient pediatric care and directly measure the effects of such reorganizations on patient safety outcomes.

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REFERENCES

1. Kohn LT, Corrigan JM, Donaldson MS, eds. To err is human: building a safer healthcare system. In: *Committee on Quality and Healthcare in America*. Washington, DC: National Academy Press; 2000.
2. Wilson RM, Runciman WB, Gibberd RW, Harrison BT, Newby L, Hamilton JD. The Quality in Australian Health Care Study. *Med J Aust*. 1995;163(9):458-471.
3. Manser T. Teamwork and patient safety in dynamic domains of healthcare: a review of the literature. *Acta Anaesthesiol Scand*. 2009;53(2):143-151.
4. Fortescue EB, Kaushal R, Landrigan CP, et al. Prioritizing strategies for preventing medication errors and adverse drug events in pediatric inpatients. *Pediatrics*. 2003;111(4, pt 1):722-729.
5. Suresh G, Horbar JD, Plsek P, et al. Voluntary anonymous reporting of medical errors for neonatal intensive care. *Pediatrics*. 2004;113(6):1609-1618.
6. Pronovost PJ, Thompson DA, Holzmueller CG, et al. Toward learning from patient safety reporting systems. *J Crit Care*. 2006;21(4):305-315.
7. Donchin Y, Gopher D, Olin M, et al. A look into the nature and causes of human errors in the intensive care unit. *Crit Care Med*. 1995;23(2):294-300.
8. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. An evaluation of outcome from intensive care in major medical centers. *Ann Intern Med*. 1986;104(3):410-418.
9. Reader TW, Flin R, Cuthbertson BH. Communication skills and error in the intensive care unit. *Curr Opin Crit Care*. 2007;13(6):732-736.
10. Tully MP, Ashcroft DM, Dornan T, Lewis PJ, Taylor D, Wass V. The causes of and factors associated with prescribing errors in hospital inpatients: a systematic review. *Drug Saf*. 2009;32(10):819-836.
11. O'Mahony S, Mazur E, Charney P, Wang Y, Fine J. Use of multidisciplinary rounds to simultaneously improve quality outcomes, enhance resident education, and shorten length of stay. *J Gen Intern Med*. 2007;22(8):1073-1079.
12. Landry MA, Lafrenaye S, Roy MC, Cyr C. A randomized, controlled trial of bedside versus conference-room case presentation in a pediatric intensive care unit. *Pediatrics*. 2007;120(2):275-280.
13. Manojlovich M, DeCicco B. Healthy work environments, nurse-physician communication, and patients' outcomes. *Am J Crit Care*. 2007;16(6):536-543.
14. Baggs JG, Ryan SA, Phelps CE, Richeson JF, Johnson JE. The association between interdisciplinary collaboration and patient outcomes in a medical intensive care unit. *Heart Lung*. 1992;21(1):18-24.
15. Manojlovich M, Antonakos CL, Ronis DL. Intensive care units, communication between nurses and physicians, and patients' outcomes. *Am J Crit Care*. 2009;18(1):21-30.
16. Reader TW, Flin R, Mearns K, Cuthbertson BH. Interdisciplinary communication in the intensive care unit. *Br J Anaesth*. 2007;98(3):347-352.
17. The Joint Commission. Improving America's Hospitals: The Joint Commission's Annual Report on Quality and Safety 2007. Joint Commission Web site. http://www.jointcommission.org/assets/1/18/2007_Annual_Report.pdf. Accessed February 22, 2011.
18. 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(12):1094-1099.
19. Reader TW, Flin R, Mearns K, Cuthbertson BH. Developing a team performance framework for the intensive care unit. *Crit Care Med*. 2009;37(5):1787-1793.
20. Reason JT. *Human Error*. New York, NY: Cambridge University Press; 1990.
21. Katz MH, Schroeder SA. The sounds of the hospital: paging patterns in three teaching hospitals. *N Engl J Med*. 1988;319(24):1585-1589.
22. Blum NJ, Lieu TA. Interrupted care: the effects of paging on pediatric resident activities. *Am J Dis Child*. 1992;146(7):806-808.
23. Volpp KGM, Grande D. Residents' suggestions for reducing errors in teaching hospitals. *N Engl J Med*. 2003;348(9):851-855.
24. Tjia J, Mazor KM, Field T, Meterko V, Spenard A, Gurwitz JH. Nurse-physician communication in the long-term care setting: perceived barriers and impact on patient safety. *J Patient Saf*. 2009;5(3):145-152.
25. Vazirani S, Hays RD, Shapiro MF, Cowan M. Effect of a multidisciplinary intervention on communication and collaboration among physicians and nurses. *Am J Crit Care*. 2005;14(1):71-77.

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