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Time-motion analysis of research nurse activities in a lung transplant home monitoring study

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Abstract

Background—The emergence and subsequent integration of new technologies precipitate changes in roles and work lives of nurses. The nurses' work with home monitoring technologies within a spirometry-based program that transmits pulmonary function data after lung transplantation has characteristics that are distinct from other types of direct patient care. Nurses' changing roles in such programs after transplantation have not been well described.

Objective—To describe a time-motion study of 2 research nurses in the context of a home-spirometry study to monitor patients' pulmonary status after lung transplantation.

Method—A detailed list of research nurses' 67 routine work-related activities was developed and validated to monitor and record activities of research home monitoring nurses. Two weeks of observations were completed; recordings of a second observer established reliability of observations.

Results—In 48.8 hours of observation, 610 tasks related to monitoring of 45 patients were recorded. Task time ranged from brief seconds (eg, data review) to 39 minutes (eg, clinic visits). Between-observer intraclass correlation ($r=0.96$) reflected high agreement in observations of the duration of activities. Agreement for category of activity was strong ($\kappa=0.82$), with high levels of agreement (96%). Computer tasks were the most frequent (118 tasks/week) and most time-intensive activities. Nurses' face-to-face interactions with health professionals were equally time intensive (both 267 minutes/week), but not as frequent. Data review tasks were the second most frequent (49/week), although less time-intensive (47 minutes/week).

Conclusion—Findings reveal patterns of effort and time expenditure in nurses' evolving roles in home monitoring of the health status of patients after lung transplantation. These findings highlight the centrality and importance of well-developed data management, computer skills, and interprofessional communication skills of nurses who perform responsibilities in this emerging role in transplantation. Efforts to streamline computerized information access, as through integrated information systems, and methods to enhance efficiency in connecting with patients in the clinic may free up time for nurses to engage in other activities of direct benefit to patients.

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Strategies to supplement face-to-face meetings among professionals with electronic modalities may reduce the time spent meeting, while maintaining or enhancing communication.

Lung transplantation for patients with end-stage lung disease has become available to many, with 1699 lung transplants performed at centers in the United States from July 1, 2009, through June 30, 2010.¹ After transplant, home monitoring of pulmonary function and respiratory symptoms provides the opportunity for early detection of health decline and for early intervention. Early intervention may prevent relatively more serious injuries of patients' organ systems and may minimize debilitation.² Home spirometry programs can enable early detection of worsening pulmonary function (eg, that due to rejection and infection). This detection enables early medical intervention, before declines further jeopardize the health of the transplant recipient or cause irreversible damage of the transplanted lung. However, as more patients undergo transplantation, and as outcomes improve (ie, 83.3% 1-year patient survival, 54.4% 5-year patient survival),³ the volume of data generated in home monitoring programs becomes increasingly daunting. In such programs, nurses are typically responsible for triage based on the transmitted home monitoring data and therefore must be able to efficiently identify significant clinical changes from the reams of patient data that are generated.

Home monitoring after lung transplantation has been developed and studied by a number of institutions for more than a decade.⁴⁻⁷ Home monitoring protocols generally differ at different institutions. This article refers to lung transplant home monitoring as conducted at the University of Minnesota. Research nurses are hired to work on a funded research grant focused on methods of collecting home monitoring data and the identification of patterns in patients' data that warrant clinical follow-up by transplant coordinators. At this site, we have found that home monitoring involves routine processes that are predictable and repetitive. Generally, patients perform pulmonary function tests and rate their pulmonary-related symptoms by using a home spirometry device. Data are stored and transmitted automatically via modem to the data center over standard telephone landlines, and a report is generated weekly for review by research nurses. The data report is then analyzed by research nurses, and alerts are generated by the research nurses and delivered to the clinic for the attention of clinical nurse transplant coordinators in the transplant center whenever patterns of potential deviations from any patient's recent norms are detected.

The clinical nurse transplant coordinators interpret the alert in the context of their knowledge of the patient's condition and care plan and make a judgment regarding the need for action related to the alert; they make all the patient contacts related to the symptoms and pulmonary data and do all the patient education related to their physical clinical care, whereas the research nurses contact the patients only with regard to education and performance of the monitoring functions. Patients call the nurse transplant coordinators for urgent matters related to their pulmonary health; they call the nurse researcher for matters related to home monitoring and the functioning of their equipment. The work of the research nurses to manage the growing volumes of data from patients in this spirometry-based home monitoring program is labor intensive. Further, the necessary communications between the research nurses and transplant nurse coordinators, physicians, and other members of the health care team are critical, time-sensitive, and time-consuming.

Over time, general decision guidelines or “rules” have been developed by the home monitoring team that guide and govern their manual review of home monitoring data.⁸ Concerns about suspicious trends are communicated by the home monitoring team to clinical transplant coordinators who are directly involved in the delivery of patient care. Nurse coordinators review the data and determine the need and urgency for follow-up with patients.

The conceptual model shown in Figure 1 highlights the home monitoring patient care process and operationalizes the study’s home monitoring activities. The primary outcome of the study is the percentage decline in forced expiratory volume in 1 second in year one. The lung transplant recipient (the patient) is the center of the home monitoring process. All home monitoring information flows from patients to the transplant center, and when necessary, information or treatment recommendations flow back to patients. Patients follow the usual home care procedures and contact their health care providers during scheduled or as needed clinic/physician visits or by telephone. Patients also record spirometry, vital signs, symptoms, and bronchopulmonary event information by using the home monitor device, which automatically transmits the information to the data center. Our time-motion study was developed to elucidate the activities involved in the work of research nurses in our lung transplant home monitoring research program.

Management of technology and communication of information are essential parts of the evolving role of research nurses involved in clinical telehealth research programs, such as the Lung Transplant Home Monitoring Program. Key facets of research nurses’ role include patient education, monitoring of patient pulmonary status and promotion of adherence as well as collaboration with professionals from diverse disciplines. The desire to better understand the many complex aspects of this evolving role and interest in identifying ways to optimize research nurses’ efficiency and effectiveness were the impetuses for undertaking a time-motion study.

Time-motion studies are a means to identify how workers’ time and effort are spent in work-related tasks and processes. This information may be used to understand better the nature of the work done by individuals and groups, and it may be used to refine work processes and their efficiency and effectiveness. Time-motion studies are often used to determine the efficiency of human work related to movement and processes so as to optimize performance and attendant productivity.⁹ Such studies can yield insight into work- and role-related efficiencies and can be used to study efficiencies gained by revising processes of interest. More recently, they have been used in studies of nurses and other health professionals in a variety of health care settings.^{10–13}

The nursing labor shortage across the United States¹⁴ presents a compelling need for this type of study to better understand the scope, nature, and changes in nurses’ work activities, especially when new technologies are introduced that could increase productivity and effectiveness, and to reduce costs. Indeed, demands are increasing for integration of technology within health care to improve care; to increase precision; and to improve costs, efficacy, and efficiency.¹⁵ However, to achieve the potential benefits of technology, understanding and refinement of nurses’ role-related activities and design are needed so that

systems and processes may be refined to make applications such as home monitoring maximally efficient and cost-effective. Better understanding of the nature of nurses' work in a technologically advancing world may inform educators and help them to prepare nurses better and to provide administrators needed information to design and improve the systems in which nurses work. Our home-monitoring program presents an ideal opportunity to study this interface of technology and nursing.

Purpose

Although many articles heralding the era of technological advances designed to create new efficiencies and improve care have been published, few data are available on the effects of these technologies on the work-related tasks, activities, and roles of nurses using the technology. In this article, we describe our work to address that gap in knowledge. This paper describes a time-motion study of 2 research nurses in the context of a home-spirometry study monitoring patients' pulmonary status after lung transplantation. It also describes the methods used to quantify the research nurses' routine role activities (ie, monitoring, triage, and research activities).

Methods

Design

A descriptive correlational design was used to evaluate research nurse activities in the home monitoring of lung transplant patients.

Subjects and Setting

The setting for this time-motion study was the Lung Transplant Clinic at the University of Minnesota Medical Center, Fairview, where 30 to 40 patients typically receive transplanted lungs annually.

Program Description

The time required for research nurses' home monitoring triage processes is an important outcome in this study. Another task that the research nurses are responsible for is following up with patients in the study at their regularly scheduled clinic appointments. This offers a "double-check" to determine how patients are functioning physically, mentally, and emotionally. It also provides an opportunity to "troubleshoot" potential technical problems with home spirometry devices and an opportunity to encourage patients to adhere to the home monitoring study protocol. The research nurses were both master's prepared nurses with more than a decade of experience in nursing; they had worked with the transplant study and patients for more than 2 years.

Each patient who submits data has a weekly home monitoring report. Patients were "excused" from their spirometry in the analyses if they were on vacation or in the hospital; patients who did not adhere to the use of the spirometer had missed weeks if data were not transmitted. The portfolio of tasks performed by the research nurse each week included (1) review of patients' weekly home monitoring reports consisting of pulmonary function

measures, respiratory symptoms, weight, and vital signs; (2) interpretation of home monitoring reports to identify those subjects requiring an alert; (3) generation of an “alert” list for delivery to the nurse coordinators at the transplant center; (4) contacting subjects regarding missing data, poor measurement technique, adherence problems, clarification of reported clinical events (bronchopulmonary or other events); (5) follow-up with the transplant center nurse coordinators regarding a need for any additional home monitoring information (eg, adherence history, pulmonary and symptom trends, and home monitoring reported event history); and (6) documenting the transplant center’s response (eg, telephone follow-up calls, medication changes, tests ordered, scheduled clinic visits for subjects on the weekly alert list).

Data Collection

A doctorally prepared nurse coinvestigator with previous time-motion study experience served as the single primary observer. She observed the 2 home monitoring project nurses for 10 days in the equivalent of a 2-week period by using a digital stopwatch to measure the time each nurse spent on specific tasks related to the home monitoring program.

Comprehensive List of Work Activities and Categories

A comprehensive list of activities and categories was developed by the investigators. First, each of the 2 research nurses generated a list of their activities. These lists were combined and differences in task categories and definitions were reconciled. This process was repeated several times such that the task list became increasingly inclusive. The comprehensiveness of the list of activities was verified by a nurse observer during several 2-hour observation periods. After each period, the list of categories was further refined by the observer with additional input of the research nurses. This iterative process continued for 4 weeks with input from the research team. The final comprehensive list was adopted when the observer and research nurses confirmed and validated the activities and categories; ultimately this list comprised 67 items (“activities”) in 10 categories.

Reliability

A 1-hour period of observation was conducted during the time-motion study to establish the reliability of the primary observer to use the recording instrument with observations of a second observer. The goal was to establish that the primary time-motion observer could reliably record the category of the activities and the amount of time spent on these tasks. A second observer simultaneously observed the work of the home monitoring nurses for 1 hour using the recording rubric. Both observers watched a study nurse perform 50 activities and recorded the duration in minutes or seconds and the type of activity from a list of 10 categories and 67 activities during the observation period. The agreement between observers (both time and activities) was determined and served as a measure of the reliability of observations.

Procedures

The list of activities was used to guide the recording of the research tasks performed by the research nurses. The activities and their categories are specified in the Table. The recording

sheet included columns for clock time, activity (from the comprehensive list mentioned earlier), the patients' research identification number, and the time that the activity took in minutes and seconds. There was also a comment sheet to record anything relevant to the research nurses' activities. The amounts of time spent in activities for home monitoring were determined to document the time and relative frequency of activity and categories of activity. The primary nurse observer conducted observations for 2 weeks (10 working days) with a digital timer. The observations conducted during this period identified the category of activity and time taken for all of the activities of the research nurse on a recording sheet. The observations were recorded and then summarized by the total time of the task by overall categories and further broken down by specific activities.

Object of Measurement

All activities that were essential to the weekly routines of the home monitoring program were conducted during the observation periods (ie, no essential work could transpire when the observer was not present). Activities were observed with time used as the unit of measurement. The activities within each category and the corresponding time were recorded to the nearest second. During the observations, 45 patients were enrolled in the home monitoring research study. The time of observations of activities was restricted to the time that could be observed over the equivalent of 2 five-day weeks. Observation times were scheduled when the observer and one of the research nurses were available.

Analysis

The kappa statistic and intraclass correlation were used to quantify interobserver agreement. Descriptive statistics were calculated to summarize the number of tasks within categories and the time involved in tasks. The home monitoring study was reviewed and approved by the University of Minnesota institutional review board's human subjects committee, and the time-motion study was conducted in keeping with the approved protocol.

Results

The methods and procedures yielded reliable data regarding the time duration and frequency of categories of activities and specific activities.

Observer Reliability

The 2 observers recorded identical time for 41 activities and had 82% agreement overall in estimating the times spent among the activities (Figure 2). In Figure 2, the time recorded by observer 1 for each of the 50 unique observations are recorded on the y-axis and the corresponding time for that activity that was recorded by observer 2 on the x-axis. They differed by 1 second for 7 activities, 1 minute for 1 activity and 3 minutes for 1 activity. The intraclass correlation was 0.96. The kappa statistic was 0.82 (95% confidence interval, 0.61 to 1.00), indicating strong agreement in classifying activities. Disagreement occurred for only 2 of the 50 activities. For example, the primary observer classified 1 activity as "planning or processing," whereas the secondary observer classified the same activity as a "nonspecific activity." The instrument was judged to provide a reproducible quantification of

nurses' behaviors, and the primary observer was deemed sufficiently consistent in recording study observations.

Tasks and Times

A total of 610 tasks for 45 patients were recorded in 48.8 hours of observation during the observation period (see Table). This translates into 24.4 hours per week, with 305 activities observed per week. The time spent on individual tasks ranged from mere seconds (eg, data review) to 81 minutes (research team meetings). Nurses were engaged in a wide range of activities reflecting both their work related to patients and their duties in conducting an organized study. The activities observed were judged as representative of the work done routinely within the role of the research nurse.

Computer tasks were the most frequent (118.5 tasks/week) type of tasks executed by the research nurses. They were also the most time-intensive, along with face-to-face interaction of nurses with health professionals (both 267 minutes per week). The health care professionals with whom the nurses had face-to-face interactions included study investigators, clinical coordinators, and the other research nurse. Computer-related tasks occupied significant amounts of the nurses' time. These tasks included documenting, checking records, and writing progress notes. Data review tasks were the next most frequent (49/week), but not time-intensive (47 minutes per week). Substantial time was spent in organizing, planning, and processing information, and working with supplies and materials (195 minutes/week). "Other" activities, filing and communicating through the study newsletter that was developed and sent quarterly to patients or hard-copy correspondence to patients meant less time spent in direct patient care. The transplant clinic time comprised time spent waiting for patients to be available, seeking clinic sources of information, and participating in direct interactions with patients.

Only 82.5 minutes per week were spent directly with the patients during this observation period. Not all of the 45 enrolled patients were seen during the 2-week period of observation. A number of patients who were not seen directly received e-mails or phone calls. Encounters with patients were determined by the clinic schedule and depending on the patient's readiness for recruitment or the desire or need for follow-up meetings. Figure 3 presents the rate (incidence and relative frequency) of nurse activity within each category of task. Figure 4 presents the relative percentage of time spent on the tasks in each category of task. Computer-related tasks and data review were the most frequent activities. However, data review was relatively short in duration, and proportionately, it was not especially time-consuming compared with other activities (Figure 4). Communication and clinic work were activities of relatively low frequency, but as can be seen in Figure 4, verbal face-to-face communications were among the most relatively time-consuming categories.

Figure 4 also reveals that much of the workweek was spent on tasks that are more or less invisible to patients and others, including office activities such as organizing, data review (monitoring), documenting, and other computer-related activities. More than half of the time was spent in the research office (ie, away from patients). Approximately one-third of nurses' time involved face-to-face encounters with other health professionals or in the clinic with patients or clinic staff.

Discussion

Our time-motion study was undertaken to elucidate the relative distribution of research nurses' work activities in the home monitoring program of lung transplant recipients. Nurses were engaged in a broad range of activities, only some of which might be construed as traditional "nursing" or be currently taught in nursing curricula. Many activities consumed more of nurses' time than had been expected (eg, computer documentation). A number of activities took less time than anticipated, for example, the data review. Upon reflection, this result should not have been so surprising because this activity to identify potential rejection and infection in patients is foundational to this home-monitoring program, and the process has matured and been streamlined over time. For example, the weekly report that is generated has a well-organized display of current and recent historic data, and a graphic visualization tool has been developed to assist the research nurse by providing a clear graphic display of current and recent past data to facilitate the visualization of important trends in the data to assist in their analysis and decision making. As evident in the time-motion study, these displays have resulted in rapid review of patients' data. All patients' reports are part of the weekly data review. The median time taken for the research nurse to review a patient's report was 30 seconds. This short time can be explained by the fact that a number of patients had no data for the week (eg, if a patient were hospitalized or on vacation) or that it is quickly apparent if a patient's condition is stable.

As new technologies that are introduced in health care drive the development of broader roles for nurses, time-motion studies may help elucidate the human capital requirements involved in implementing these technological innovations. More comprehensive understanding of the activities and time taken by nurses is necessary for recognizing research staffing needs. Greater understanding of the array of nursing activities also could be helpful in delineating the inherent complexity and challenges of these nursing roles and optimizing nurses' efficiency and effectiveness. The true benefit (ie, time savings, improvements in health, cost-benefit ratio) associated with new technologies can be determined only if the nursing input and processes are fully identified and explored.

The greatest amount of nurses' time was spent on computer-related activities and face-to-face interaction with health care providers (267 minutes per week each). The nurses spent a substantial amount of time reviewing patient-related information, searching for the data from a number of different electronic sources in order to draw conclusions regarding the patient's pulmonary status, to confirm follow-up and to document that follow-up in the study database. This observation supports the notion of the nurse as an information worker and highlights the importance of informatics in education and practice. Computer skills and the ability to communicate in writing are vital to the nurse's role in this research-focused home monitoring program.

The research nurse was observed moving from database to database in search of information related to patients' status. Additional information regarding patients' status was sought in the clinic from care providers as well as over the phone during calls to offices of primary care provider. The nurse spent significant amounts of time seeking patient-related information in order to process, interpret, and draw conclusions about the patient's status.

This fact highlights the state of our health care “system,” in which information about a single patient is fragmented and not contained in a single, convenient source for provider monitoring and early detection and intervention of adverse changes that could benefit patients with chronic conditions. Nurses have a clear role to play in the development of electronic health records to aid in their work of monitoring and providing continuity of care for patients as the patient’s transition across settings. Ideally, report forms could be developed that could be populated by data from a variety of sources to provide nurses with an integrated set of information upon which to base decisions. The time saved by sparing nurses from the search for information can be used to provide care or benefit the patient in other ways.

In addition, verbal communication in interdisciplinary face-to-face interactions required a significant proportion of nursing time. The ability to clearly report and receive patient-related information in an interdisciplinary team context is also a vital part of the nurse’s role in work setting, and is an important competency to be developed through education or in practice.

Study limitations include the fact that only a limited period of time was studied in a single lung transplant home monitoring program; it is the study of the observations (time-motion) of the research nurses at the University of Minnesota. It is acknowledged that the outcomes could be quite different at other transplant institutions. Nonessential work (eg, new database development, database training) was put on hold and work was restricted to the times when the research nurses and observer could be present simultaneously. It is recognized that days throughout the ongoing project vary and that it was not possible to observe at all times. The times and activities selected were those that were routine and contained the essential nurse activities of day-to-day management of the home monitoring program. It is not known how fully these findings generalize to studies involving other technologies and populations or to clinical programs of home monitoring that are not research focused. Although the preliminary nature of these findings make it inappropriate to make projections of nurse staffing needs for research programs at this time, it seems likely that data gleaned from similar studies over time may provide a more empirical basis for modeling staffing needs for both research and clinical programs.

Despite the fact that computerization and informatics have become commonplace in our health care system, there are few programs and even fewer data on this topic.¹⁶ Even with their methodological limitations, studies of this type provide a window on the work of informatics, the research enterprise, and the role-related activities inherent in incorporating new technologies in health care. Such information can be used to gain insight into the nature of the work and can be used to anticipate roles and competencies needed by future or practicing nurses. More complex understanding of nurses’ activities can be instructive in the planning of nursing curricula. Indeed, informatics has become an increasingly common topic covered in undergraduate and graduate nursing programs.¹⁷

Conclusions and Recommendations

This study presents data on the home monitoring and research activities of research nurses working in the context of a randomized controlled trial that is focused on the review of pulmonary health-related data of patients after lung transplant. The observational process revealed detailed patterns of research nurses' effort and time expenditure peculiar to their evolving roles in the home monitoring of patients with a chronic health condition.

Several recommendations can be made on the basis of the type of data generated. As more studies are conducted, they will provide a foundation for data-based scheduling, and workload assignments, and for modifying work-related processes. Some tasks may be identified that could be carried out by individuals with less professional training than nurses to free nurses to spend their time on problems that require their particular professional expertise (eg, trouble-shooting equipment failure). Targeted attention can be given to streamline activities that consume excessive or disproportionate amounts of time (eg, planning and processing time).

Sequential time-motion studies may be done to evaluate the consequences of changes in procedures and in the allocation and relative distribution of work, so that their impact on efficiency and effectiveness may be determined. Another time-motion study was done to determine whether the research nurses' increased experience improves efficiency or changes the pattern of work activities over time. Further, it was designed to determine whether time is saved by the use of a computer algorithm to accomplish weekly data review and identify patterns reflective of potential rejection and infection. The times required for manual versus automated review were compared.¹⁸

Although time spent with patients was relatively small, overall the time spent in seeking, monitoring, and processing patient-related information was significant. Patients' satisfaction and feelings of assurance may be increased by the information that their condition is being watchfully monitored. Innovative methods to provide patients with such information are recommended. In our home-monitoring program, targeted feedback messages delivered through their spirometer are one method to provide that sort of "personal" information to the patient. Perhaps the design of a future home-monitoring device could also report to the patient a log of the times in which their data are being reviewed or processed.

As evident in the time taken in work activities of the research nurses related to information seeking, nurses must be involved in the creation of facets of a fully integrated electronic medical record to provide useful displays and comprehensive reports of information that reflect an up-to-date, integrated capture of patient-related data from multiple providers and settings. Such a system serving as the backbone of an integrated medical record would improve nurses' efficiency, and since decisions would be made with a broader, more comprehensive and timely set of patient-related information, better decisions and outcomes for patients could result.

Relevance to Practice

The applications of new technologies in health care that require substantial data management, review, interpretation, and follow-up to derive patient care benefits have resulted in the evolution of new roles and opportunities for nurses. These roles could increase the ability to diagnose and resolve problems at a distance and foster greater access and timeliness of early intervention to maintain optimal health of more patients with transplants and who are living with other chronic conditions.

Findings highlight the centrality and importance of well-developed data management, computer skills, and interprofessional communication skills of nurses who perform responsibilities in this emerging role in transplantation. Efforts to streamline computerized information access, as through integrated information systems, and methods to enhance efficiency in connecting with patients in the clinic may free up time for nurses to engage in other activities of direct benefit to patients. Strategies to supplement face-to-face meetings among professionals with electronic modalities may reduce the time spent meeting, while maintaining or enhancing communication.

The roles of health professionals providing direct patient care are anticipated to continue to evolve as they have access to greater volumes and frequency of patient data and chronic care becomes less episodic and more continuous. It is hoped that such developments will provide more “real time” care that can smooth the tumultuous trajectories of chronic illness. In order to contend effectively with the increasing quantity of patient-related data, it will be critical to manage the work flow of the professionals involved in these activities. Effective management requires more accurate appraisal of the time inherent in a range of specific activities. Indeed, as technology creates opportunities for greater automation and time savings in some areas, it also places more burdens on individuals in new ways. The outcome of time-motion studies may yield benchmarks for overall productivity that may reasonably be expected of research nurses as they balance their complex interactions, patient-related activities, and research responsibilities within the constraints of their available time.

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Figure 1.

Conceptual framework of the transplant program's home monitoring activities. The percentage decline in forced expiratory volume in 1 second from baseline in year 1 is the primary outcome. The decline in forced expiratory volume in 1 second in years 2 and 3 and outcomes tied to health-related quality of life at years 1, 2, and 3 after transplant are secondary outcomes.

Figure 2. Reliability agreement of activity duration recorded by 2 observers. Fifty activities were observed, timed, and recorded independently by each observer.

Figure 3.
The relative frequency of research nurse tasks during the 2-week time-motion study.

Figure 4.
The relative time spent by research nurses on tasks by category during the 2-week time-motion study.

Table

Rate and time of all research nurses' tasks observed in the time-motion study by category and activity

Category/activity	Rate of task per week ^a	Total time per week, ^b min	Minutes of each task per week, ^c median (range)
All tasks	305.0	1464.97	2.00 (0.03–81.00)
Data review	49.0	46.77	0.53 (0.03–6.92)
Spirometry report	44.0	28.47	0.49 (0.03–2.55)
Alert preparation	5.0	18.30	3.00 (2.00–6.92)
Computer:	118.5	267.20	1.00 (0.03–22.00)
Weekly summary	15.5	35.33	0.75 (0.17–22.0)
List of events	0.5	1.00	—
Review spreadsheet	0.5	1.50	—
Update spreadsheet	51.5	26.91	0.33 (0.03–6.00)
Enter subject data	2.5	17.00	6.00 (3.00–14.00)
Chart progress note	16.0	58.00	3.00 (1.00–9.00)
Print schedule/graphs	5.0	25.00	5.00 (1.00–10.00)
Alert follow-up	2.0	5.50	2.00 (1.00–6.00)
Log event into database	0.0	—	—
Enter form data	6.5	20.00	3.00 (2.00–8.00)
Check clinic schedule	1.0	4.50	4.50 (3.00–6.00)
Check patient in the electronic medical record	4.0	20.50	4.50 (1.00–16.00)
Alert/task coordinator	6.0	39.77	6.00 (4.00–10.97)
Review progress notes	7.5	12.19	1.00 (0.17–6.00)
E-mail	23.5	70.00	2.00 (1.00–17.00)
Request graphs	2.0	4.00	2.00 (1.00–3.00)
Read/respond to e-mail	0.5	3.50	—
Investigator e-mail	19.5	46.50	1.00 (1.00–8.00)
Clinical staff e-mail	1.0	7.50	7.50 (7.00–8.00)
Transviva/consultant	0.0	—	—
Initiate patient e-mail	0.5	8.50	—
Clinic	31.0	177.50	4.00 (1.00–39.00)
Review patient records	5.0	28.50	3.00 (1.00–25.00)
Interact directly with patient	8.0	82.50	7.50 (1.00–39.00)
Deliver graphs	1.0	7.00	7.00 (1.00–13.00)
Follow-up alerts with coordinator	0.0	—	—
Recruitment and consents	0.0	—	—
Review pulmonary function test with therai	Dist 1.0	2.00	2.00 (1.00–3.00)
Waiting	5.5	17.50	2.00 (1.00–12.00)
Walk to or from clinic	10.5	40.00	4.00 (2.00–5.00)
Mail/letters:	5.0	50.00	10.00 (2.00–24.00)

Category/activity	Rate of task per week ^a	Total time per week, ^b min	Minutes of each task per week, ^c median (range)
Mail event audit letter	0.0	—	—
Mail or write/edit letters	1.5	12.50	9.00 (5.00–11.00)
Mail patient care provider letters	1.5	22.00	14.00 (13.00–17.00)
Birthday/special event cards	0.0	—	—
Adherence letter	1.5	14.00	2.00 (2.00–24.00)
Opening mail	0.5	1.50	—
Phone calls	21.0	100.50	3.00 (1.00–27.00)
Call physician's office for events	0.0	—	—
Call member of research team	1.0	9.00	9.00 (1.00–17.00)
Call transplant coordinators	0.0	—	—
Call to informatics assistant	0.0	—	—
Patient adherence call	5.5	26.50	3.00 (1.00–27.00)
Patient return call	0.0	—	—
Patient technology troubleshooting	2.0	14.50	5.00 (3.00–16.00)
Call Transviva/consultants	2.5	11.00	4.00 (2.00–8.00)
Clinic nurse updates	0.0	—	—
Review voicemail	3.0	5.50	1.50 (1.00–3.00)
Call to the office	3.0	9.00	2.00 (2.00–7.00)
Patient check-in	2.5	20.00	10.00 (1.00–16.00)
Patient learning center calls	1.5	5.00	3.00 (3.00–4.00)
Verbal face-to-face	14.0	267.50	16.50 (1.00–56.00)
Investigators	4.5	107.50	23.00 (2.00–56.00)
Research nurses	3.5	82.50	24.00 (3.00–45.00)
Discussion with coordinators	3.5	19.00	3.00 (1.00–16.00)
Premeeting study coordinators	2.0	56.00	30.00 (9.00–43.00)
Interact with physician	0.5	2.50	—
Other	9.5	165.75	6.00 (0.50–81.00)
Files/forms on new subjects	2.0	7.50	3.50 (2.00–6.00)
Transplant coordinator meeting	0.0	—	—
Research team meetings	1.0	76.50	76.50 (72.00–81.00)
Walk to or from team meetings	1.5	6.00	6.00 (6.00–6.00)
Newsletter	2.5	64.50	17.00 (3.00–46.00)
Make copies	1.0	6.00	6.00 (2.00–10.00)
Review paper information	1.5	2.25	1.00 (0.50–3.00)
Support group meetings	0.0	—	—
Organizational	29.0	194.75	5.00 (0.50–33.00)
Gather equipment and supplies	2.5	14.00	3.00 (1.00–17.00)
Test equipment/spirometry	1.5	10.00	8.00 (4.00–8.00)
Planning and processing	23.0	165.25	5.00 (0.50–33.00)

Category/activity	Rate of task per week ^a	Total time per week, ^b min	Minutes of each task per week, ^c median (range)
Filing (electronic/paper)	0.5	0.50	—
Gathering paperwork	1.5	5.00	3.00 (2.00–5.00)
Nonspecific activity	4.5	125.00	16.00 (2.00–71.00)

^aThe 2-week total number of tasks within each category and activity was divided by 2 to get the mean number of tasks per week.

^bThe 2-week total time in minutes within each category and activity was divided by 2 to get the mean time per week.

^cThe median and range of the time for individual tasks within each category and activity during the 2-week period. For example, there were 31 “Weekly Summary” entries under computer. Half of them were shorter than 0.75 minutes and half of them were longer. The shortest time was 0.17 minutes and the longest was 22 minutes.