Nurses' Time Allocation and Multitasking of Nursing Activities: A Time Motion Study

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Abstract

Nurses have been required to provide more patient-centered, efficient, and cost effective care. In order to do so, they need to work at the top of their license. We conducted a time motion study to document nursing activities on communication, hands-on tasks, and locations (where activities occurred), and compared differences between different time blocks (7am-11am, 11am-3pm, and 3pm-7pm). We found that nurses spent most of their time communicating with patients and in patient rooms. Nurses also spent most of their time charting and reviewing information in EHR, mostly at the nursing station. Nurses' work was not distributed equally across a 12-hour shift. We found that greater frequency and duration in hands-on tasks occurred between 7am-11am. In addition, nurses spent approximately 10% of their time on delegable and non-nursing activities, which could be used more effectively for patient care. The study results provide evidence to assist nursing leaders to develop strategies for transforming nursing practice through re-examination of nursing work and activities, and to promote nurses working at top of license for high quality care and best outcomes. Our research also presents a novel and quantifiable method to capture data on multidimensional levels of nursing activities.

Introduction

Besides producing high quality patient outcomes, nursing care has been required to be more patient-centered, efficient, and cost effective. However, research suggests that nurses spend a considerable amount of non-value added time on activities that could potentially be delegated to other team members with greater cost effectiveness.[1] Inefficiencies also contribute to non-value added time.[1-3] Within the past 10 years, Health Information Technology (IT) has had a major impact on health systems. Electronic health records (EHR) system adoption rose from 10% (2008) to 80% (2015) in the United States because of national regulation and incentives.[4-6] In addition, mobile devices, smart infusion pumps, barcode medication administration systems (BCMA), electronic whiteboards, and numerous technologies have been implemented or are pending implementation in hospitals. Health IT influences patient care, nursing activities, and turnover time and volume.[7] However, study results are mixed when evaluating the effect of EHR implementation on care and documentation times. Several studies reported an increase in patient care time due to decreased administrative task time and documentation time after implementing the electronic documentation system.[8,9] Others reported increased documentation time.[7,10] How these findings could support nurses' work remains unclear.

Working within the complex healthcare environment of today, nurses must provide care that is efficient and effective. There is a growing body of literature describing nurses' work using observational studies.[11-19] Some of this research have been conducted using electronic devices, such as a Personal Digital Assistant (PDA),[20,21] while others have utilized a stopwatch and paper/pencil. Observation accuracy could be limited because of the time necessary for paper/pencil documentation. While these studies reported a wide range of observation timeframe (e.g. 5am-5pm), none reported the distribution of the time period observed.[20-24] As a result, it is unclear whether the data were skewed to certain hours that observations were easier to schedule, if the observation was taken during the full shift length (8-12 hours), or whether observation fatigue was taken into account for quality control. Also, although task definitions were provided in most studies, it is unclear whether the start time and the end time of each activity was controlled, thus limiting the replication of the study. Other methodological limitations include randomly selected observation periods of 1-3 hours,[20,25,26] self-monitoring time motion study,[27] manual paper-based & stopwatch data collection,[22] confounding variables (e.g. nurse-patient ratio and patient acuity level[28-30]) not observed or controlled, and focusing on single nursing activity (e.g. documentation,[7,9] medication administration,[31-33] communication,[34] glycemic control[26]). These limitations prevent study replication and generalizability of study findings.

Multitasking is the nature of nurses' work. To understand multitasking, examining the context of patient care is essiential.[35] Measuring multitasking enables healthcare organizations to improve efficiency, quality and safety, workflow, and clinician job satisfaction.[36] The concept of multitasking is often confused with task switching, which involves frequent and rapid changes between two tasks.[37] Various methods have been used to understand multitasking. However, reliability, accuracy, or generalizability of these studies[20,36,38-40] were compromised due to limited approaches or technology (e.g. manual recording process,[38,39] poorly designed electronic data collection device.[20,21,41])

The work of nursing also involves interruptions. While some interruptions may be necessary for positive patient outcomes,[42] most are not.[43,44] A study reported that nurses were most likely to be interrupted and to multitask during medication administration.[21] Such overrepresentation of multitasking behavior during medication administration raises patient safety issues. Medication interruptions have been widely reported to be associated with medication errors[45,46] and can pose life-threatening consequences for patients.[43,44,47] Research is needed to accurately capture interruptions as they relate to multitasking behaviors and how these behaviors contribute to nuring errors.

We conducted a time motion study to observe and record nursing activities during their working day shifts between 7am to 7pm. In a prior publication, we reported our time motion study design and approaches to collect and visualize nursing workflow in three activity dimensions: communication, task and location.[48] Communication represents whom nurses are interacting with; hands-on tasks represent tasks nurses are physically performing (i.e. preparing medication); and location represents where nursing activities take place. We operationalized our definition of multitasking as the observable performance of two or more tasks simultaneously,[49] for example, talking to a patient and preparing medication. We explored these three activity dimensions, across the continuum of time to understand multitasking and task switching in nursing practice.[48] We also controlled the distribution of observation time by splitting the 12-hour nursing day shift into three time blocks: 7am-11am, 11am-3pm, and 3pm-7pm.

The purposes of the study were to 1) quantify nurses' time allocation on communication, hands-on tasks, and locations, 2) compare nurses' allocation between different time blocks (7am-11am, 11am-3pm, and 3pm-7pm), 3) discover nurses' multitasking and location traits, and 4) examine nurses' phone call interruptions. To our knowledge, this was the first time motion study controlling the distribution of observation time as well as comparing nurses' time allocation in different time blocks.

Methods:

Setting and Sample

The study was conducted on a medical-surgical (med-surg) unit at a Mid-west academic medical center. We selected the 12-hour 7am to 7pm day shift, since a high volume of nursing activities is perceived to be typical during that time. We recruited registered nurses who met the following inclusion criteria: (1) full-time staff Registered Nurses (RNs) working at the academic medical center with more than two years of acute care nursing work experience, and (2) greater than or equal to six months of work experience on the study unit. We observed nurses in the general patient care and adjacent areas such as the nursing station, hallway, medication room, patient rooms, and supply areas. In these units, nurse patient ratios ranged from 1:4 to 1:5 depending on patient acuity.

Observed nursing activities

We observed nursing activities, such as hand-off (shift reporting), direct patient care (patient assessment, medication administration, procedures), indirect patient care (medication preparation, getting medication), interprofessional communication, and EHR review and charting. We also observed delegable nursing activities, such as vital sign and patient positioning (e.g., to patient care assistant), and delegable non-nursing activities such as records transfer and copying, which could be delegated to non-nursing team members (e.g., unit clerk). We did not document nurses' hands-on tasks and communication in the isolation room (patient rooms in isolation), as observers were not allowed to follow nurses to the isolation room for safety reasons. The observable nursing activities list was refined iteratively and finalized during the training and trial observations. In total, we defined 11 types of communication, 32 hands-on tasks, and 14 locations. A list of example activities with definitions and start-end times has been published.[48]

Instrument

We loaded the defined nursing activities into TimeCaT (Figure 1),[50] a validated electronic time capture tool developed to support data collection for time motion studies, optimized for touch enabled tablet computers and iPads. Observers used TimeCaT to document nursing activities with electronic timestamps, and capture multitasking and interruptions.[50] In TimeCaT, we were also able to visualize workflow and explore the location where nursing activities occurred. The workflow visualization illustrated nursing activities in three activity dimensions: communication, hands-on task and location, across the continuum of time. The data collected in TimeCaT allows us to portray nurses' work: with whom the nurse was speaking (communication), while doing what (hands-on task), and at what location.[48]

Observers & Inter-observer reliability assessment (IORA)

Our observers were three nursing students, including one PhD nursing student and two undergraduate senior nursing students. Because of their nursing background and clinical experience, they were able to recognize and distinguish various nursing activities. Observers were required to attend training sessions and trial observations for at least 12 hours. They were also required to have three rounds of inter-observer reliability assessment to ensure data consistency before beginning data collection.

We established the inter-observer reliability via the IORA feature provided in TimeCaT.[50] TimeCaT IORA assesses four types of agreements: 1) proportion-kappa (P-K): evaluates the overall agreement on the proportion of time devoted to specific activities. P-K provides a global assessment of the agreement over time; 2) naming-kappa (N-K): evaluates the naming agreement on observed activities; N-K assesses observers' understanding of activity definition in order to name an activity correctly;

Figure 1. TimeCaT screenshot

3) duration-concordance correlation coefficient (D-CCC): evaluates the duration agreement of activities. D-CCC assesses observers' agreement on the timing of the start and end of an event (activity), and results in duration agreement; 4) sequence-Needleman-Wunsch (S-NW): evaluates the sequence agreement of activities. S-NW focuses on the sequence/order of activities, which could help describe similarities among distinct workflows. The IORA provides quantitative reports as well as visualized side-by-side workflow comparison to assist in observers training.[48] Our IORA results indicated substantial agreement between our observers.[48]

Data Collection

After approval from the local Institutional Review Board, observers obtained informed consent from the observed nurse as well as permission from patients to observe their care. No identifiable information or health records were collected. A typical 12-hour nursing day shift was split into three time blocks: 7am-11am, 11am-3pm, and 3pm-7pm. The 4-hour observation time block minimized the chance of un-balanced data if a 12-hour day shift happened to have a heavy or light workload, and also prevented observer fatigue. Each 4-hour observation was a one-on-one observation: one observer shadowed one nurse. Observers kept a certain distance from the observed nurse during the observation, but were not allowed to interact with the observed nurse in order to collect data reflecting true time duration and context. Observers arranged observations based on their availability about one to three times a week. Observers were suggested not to schedule observations at the same time to minimize distraction in the unit.

Data Analysis

We performed descriptive analysis to summarize nurses' time allocation on communication, hands-on tasks, and locations. To examine whether there were differences in how nurses distributed their time in activities (ranking on frequency and duration) between time blocks (7am-11am, 11am-3pm, and 3pm-7pm), we used R to perform the Wilcoxon test to determine whether two time blocks have the same distribution of activities. To detect group differences on specific activities between time blocks (7am-11am, 11am-3pm, and 3pm-7pm), we performed the non-parametric independent-samples Kruskal-Wallis test with the criteria alpha set at 0.05. Post hoc pairwise comparison used Bonferroni correction. We used SPSS Statistics 25 and MS Excel for analysis and to generate graphs and tables.

Results

We completed a total of 79 observations (316 hours) with 15 registered nurses. Among the 79 observations, nine were on Monday, 14 on Tuesday, 12 on Wednesday, 23 on Thursday, 16 on Friday, 2 on Saturday, and 3 on Sunday; 23 were 7am-11am, 30 were 11am-3pm, and 26 were 3pm-7pm.

Nurses' time allocation on communication, hands-on tasks, and locations

We summarized nurses' time allocation on communication, hands-on tasks, and locations (Table 1). On average, in a 4-hour observation, nurses spent the most time communicating with patients (29.99 mins) and other nurses (26.68 mins). As for hands-on tasks, they spent the most time charting in EHR (31.63 mins) and reviewing information in EHR (21.51 mins), following by medication administration (15.70 mins) and getting medications (8.15 mins). They also spent about 13.52 mins on delegable tasks. When looking at locations, nurses spent most time in their patients'
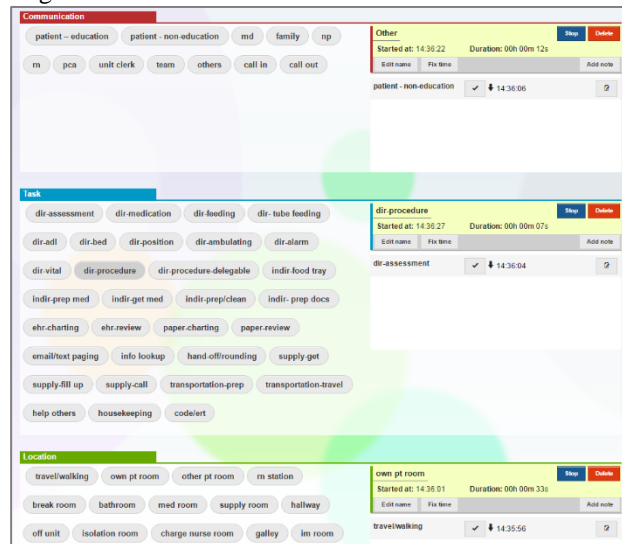
room (60.17 mins) and at the nursing station (53.55 mins), following by in the hallway (37.74 min). We listed the top 10 tasks nurses performed in the hallway; nurses were charting and reviewing on EHR most of the time (Table 1a).

Table 1. Nurses' time allocation on communication, hands-on tasks, and location (mins per 4-hour obs.)

Communication	mins
Patient	29.99
RN	26.68
PCA	6.20
Call in	5.44
Call out	3.99
Others	3.23
Family	2.43
MD	2.11
Unit clerk	1.76
Team	1.70
NP	0.06

Hands on task	mins		mins
Non-delegable	58.71	Delegable	7.43
dir-medication	15.70	dir-procedure-delegable	1.82
indir-get med	8.15	dir-adl	2.00
hand-off/rounding	8.05	dir-position	1.51
indir-prep/clean	7.30	dir-feeding	0.57
dir-procedure	4.71	dir-bed	0.47
dir-assessment	3.91	dir-ambulating	0.40
email/text paging	2.89	dir-vital	0.38
info lookup	2.66	dir- tube feeding	0.29
indir- prep docs	1.65	Supply	4.43
help others	1.60	supply-get	3.93
indir-prep med	0.94	supply-fill	0.47
dir-alarm	0.44	supply-call for	0.04
code/ert	0.72	Transportation	0.48
Documentation	59.78	transportation-prep	0.46
EHR-charting	31.63	transportation-travel	0.02
EHR-review	21.51	Non-nursing	1.17
paper-charting	4.16	indir-food tray	0.84
paper-review	2.47	housekeeping	0.34

Location	mins
RN's pt room	60.17
Nursing station	53.55
Hallway	37.74
Travel/walking	22.68
Isolation room	21.09
Med room	14.61
Break room	10.31
Off unit	7.37
Charge nurse room	4.06
Galley	3.10
Other RN's pt room	2.63
Bathroom	2.04
Supply room	0.53
BMI exam room	0.20

Hallway Hands-on task	mins
EHR-charting	8.11
EHR-review	5.61
hand-off/rounding	4.87
indir-prep/clean	2.11
paper-charting	1.12
email/text paging	0.87
paper-review	0.69
info lookup	0.58
indir-prep med	0.42
indir- prep docs	0.27
total	24.7

Communication — Patient and family; Healthcare professions; Phone call; Others

Hands-on Task — Non-delegable activities; Documentation; Delegable activities; Supply-related; Transportation; Non-nursing

Location — Patient + Isolation room; Nursing station; Hallway; Travel/walking; Med room; Others

Comparison of time spent during 7am-11am, 11am-3pm, and 3pm-7pm

We also examined whether nurses spent time differently during 7am-11am, 11am-3pm, and 3pm-7pm time blocks. Figure 2 shows nurses' time spent on communication, hands-on tasks, and locations. The Wilcoxon test only found a difference between 11am-3pm and 3pm-7pm on mean frequency of activities. In other words, nurses distributed their time in activities similarly across 7am-11am, 11am-3pm, and 3pm-7pm. The Kruskal-Wallis test show statistical significance in some group comparisons. The blue curves in Figure 1 represent group difference with statistical significance ($p < 0.05$). For example, in the Communication bar chart, nurses spent less time communicating with family during 7am-11am than during 11am-3pm and 3pm-7pm. This could result from family visits taking place largely in the afternoon. Also, we found that nurses spent more time getting medications and supplies during 7am-11am, and spent more time in the med room during 7am-11am as well. Additionally, nurses spent more time in the hallway during 7am-11am, which can possibly be attributed to hand-offs and rounding that occurs in the hallway at this time.

Multitasking

We looked into nurses' multitasking traits as they engaged in communication and hands-on tasks simultaneously. We found that on average, nurses multitasked 59.95 minutes (37.17%) during 7-11am; 42.29 mins (26.25%) during 11am-3pm; and 51.62 mins (32.01%) during 3-7pm. The frequency and multitasking duration of hands-on tasks were higher during 7am-11am (Table 2). Also, among the top 10 multitasks, seven are consistently in the top 10 (Table 2). Nurses communicating with patients during medication administration, patient assessment, and charting were common multitasks; nurses also often communicated with other nurses while charting and reviewing in the EHR.

Figure 2. Time spent (mins) on communication, hands-on tasks, and location
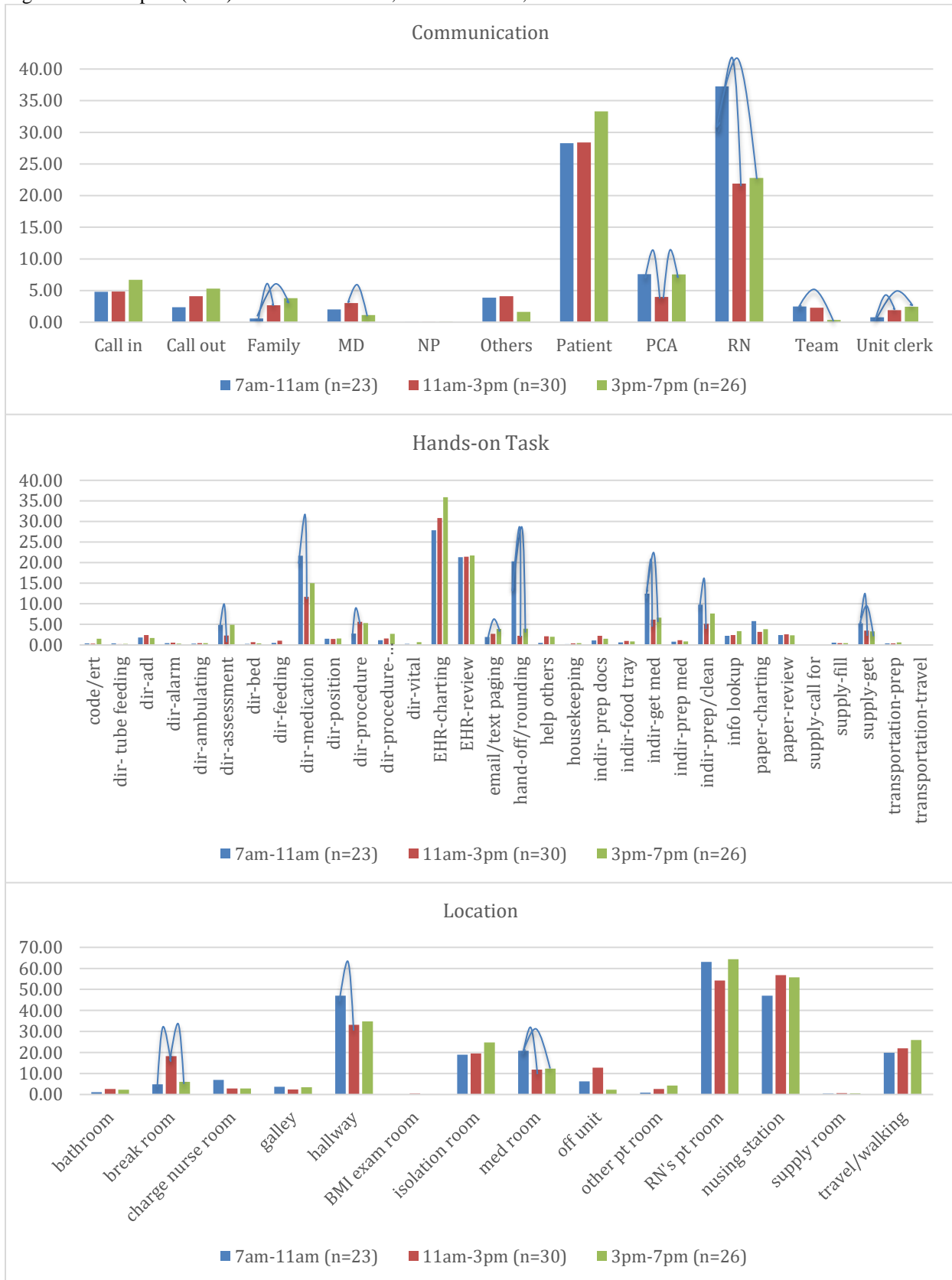
Use of EHR

Real time documentation has been a foreseen advantage as EHRs launched in hospitals. Nurses are encouraged or even required to document assessment findings and performed nursing activities in the EHR in the patient room. The electronic timestamps would reflect the time nursing activities performed. In our study, we found that among all EHR time, nurses spent the most time charting and reviewing in the EHR at the nurse station, followed by in the hallway, and then their patient rooms (Table 4). This reflects an opportunity to define real time documentation, and identify obstacles hindering real time documentation.

Communicating with Patients

As indicated in Figure 1, nurses spent the most time communicating with patients. We examined what nurses were doing (hands-on tasks) while communicating with patients to understand how they spent time with patients. Table 5 list the top 10 hands-on tasks during the communication. Medication administration is the time when nurses interacted with patients the most (9.85 mins during 7am-11am). Note that each nurse was assigned 4 to 5 patients; more had 5 patients. Thus, the time available to devote to each patient would be less.

Phone call Interruptions

Interruption is common during patient care. Nurses are frequently interruptted by conversation, alarms or phone calls. Interruptions in patient rooms and the medication room are distractive, and can potentially lead to error. We analyzed the proportion of times (frequency) that nurses received phone calls while in patient rooms and the medication room. We found that nurses were interrupted by phone calls 16% of the times in patient rooms, and 10% of the times in the medication room (Table 6).

Discussion

To our knowledge, this was the first study using a time motion study to quantify and compare nurses' time allocation in different time blocks (7-11am, 11-3pm, and 3-7pm). In addition, with our study design and approaches, we were able to detect multitasking and traits of nursing activities in different time blocks and locations. Our data also reflected the "busyness" of nurses' work in the day shift.

Table 2. Frequency and duration of multitasking (communication + hands-on tasks)

time	Ave obs. duration (mins)	Communication freq (no./4h)	Communication duration (mins/4h)	Hands-on tasks freq (no./4h)	Hands-on tasks duration (mins/4h)	Multitasking (Comm. + Hands-on) duration (mins/4h)	Multitasking (Comm. + Hands-on) proportion
7am-11am	161.28	108	90.04	233	149.95	59.95	37.17%
11am-3pm	161.09	112	77.30	170	116.31	42.29	26.25%
3pm-7pm	161.21	115	85.15	201	134.26	51.61	32.01%

Table 3. Top 7 multitasks across all time blocks

Comm. with	Hands-on task	Total	7-11am (mins)	11-3pm (mins)	3-7pm (mins)
patient	dir-medication	25.05	9.85	6.52	8.68
RN	ehr-charting	9.15	1.84	3.28	4.03
patient	dir-procedure	7.25	1.26	3.26	2.73
patient	dir-assessment	7.09	2.94	1.28	2.87
RN	ehr-review	5.92	1.95	2.30	1.67
patient	ehr-charting	4.68	1.36	1.33	1.99
patient	indir-prep/clean	3.57	1.43	0.81	1.33

Table 4. Locations of EHR use

	EHR-charting 7am-11am		EHR-charting 11am-3pm		EHR-charting 3pm-7pm		EHR-review 7am-11am		EHR-review 11am-3pm		EHR-review 3pm-7pm	
Total	27.86	100%	30.83	100%	35.91	100%	21.3	100%	21.5	100%	21.7	100%
Nursing station	15.24	55%	17.14	56%	18.88	53%	9.59	45%	12.5	58%	11	50%
hallway	6.88	25%	8.25	27%	9.03	25%	6.56	31%	4.85	23%	5.66	26%
RN's pt room	4.92	18%	3.65	12%	6.49	18%	2.26	11%	1.7	8%	3.15	15%
other	0.82	3%	1.79	6%	1.51	4%	2.93	14%	2.42	11%	1.95	9%

Table 5. Top 10 hands-on tasks during comm. w/patients

	7am-11am (mins)	11am-3pm (mins)	3pm-7pm (mins)
Total comm. w/patients	28.28	28.40	33.32
dir-medication	9.85	6.52	8.68
dir-assessment	2.94	1.28	2.87
indir-prep/clean	1.43	0.81	1.33
EHR-charting	1.36	1.33	1.99
dir-procedure	1.26	3.26	2.73
dir-adl	0.75	1.18	0.82
dir-position	0.70	0.95	0.86
ehr-review	0.67	0.70	1.09
dir-procedure-delegable	0.38	0.70	1.43
dir-feeding	0.40	0.65	0.09

Table 6. Phone call interruption

	7am-11am	11am-3pm	3pm-7pm	total
no. of times in the patient room	425	661	622	1708
Received calls in the patient room	67	103	109	279
proportion	16%	16%	18%	16%
no. of time in the med room	202	289	245	736
Received calls in the med room	27	23	24	74
proportion	13%	8%	10%	10%

Studies have been conducted to investigate nurses' time allocation on nursing activities in order to describe and support nursing practice. Nurses spent approximately 34% of time in the patient room.[51] Lengthy documentation time has been

a major challenge in the current EHR environment. Studies reported nurses spent 26.2 - 41% of their time on documentation[51,52]. However, these studies did not specify the distribution of the observation hours. It is unclear if the findings were representative for a longer timeframe (e.g. 7am-7pm, 5am-5pm). In our study, we found nurses spent 35% of their time in the patient room (including the isolation room) and spent about 25% of their time on documentation, including EHR and paper charting and review. Direct comparisons between our current study and previous work is challenging due to differences in methodologies, nursing specialty areas observed and variations in timing of observations relative to shift activities. As nurses' work was not distributed equally across a 12-hour shift, we also found that greater frequency and duration in hands-on tasks were exhibited during 7am-11am. Future studies should consider the distribution of observation time to demonstrate representable and comparable findings.

Top-of-license practice

In 2010, The Institute of Medicine (IOM) published a report, *The Future of Nursing: Leading Change, Advancing Health*[53] recommending that "*nurses should practice to the full extent of their education,*" in other words, to work at the "top-of-license".[54,55] Top-of-license nursing practice addresses how nurses should spend their time across the care continuum and suggest that "non-valued-added" activities should be delegated and executed by other healthcare personnel.[2,3] We conducted focus groups to explore nurses' perception of their daily nursing activities.[56] Nurses expressed they were distracted and burdened by performing delegable and non-nursing activities due to insufficient staffing or inattention by other departments (dietary, housekeeping, transportation) or other nursing staff (patient care assistant and unit clerk), and wished to have more time being with their pateints.[56] Our time motion study confirmed these findings that nurses spent approximately 10% of time on delegable and non-nursing activities. Other studies reported similar findings of time spent on delegable activities (8-16%).[57-60] Although it does not seem to be a large amount, given that nurses' spent 26% of time in patient rooms and 12.5% of time interacting with their four to five assigned patients. The 10% of time contributed to delegable or non-nursing activities could have been used more effectively for patient care. As the healthcare environment becomes complex,[49] future research should re-examine the current nursing practice to develop new strategies to improve nurses' time allocation for high quality patient care.[30,61]

Real time documentation

Timely documentation is essential for decision support and triggering alerts needed to draw attention on patient condition. Using EHR at the bedside was expected to increase the amount of time that nurses can spend in the patient room. However, nurses expressed the challenge of sharing their attention between patients and the EHR, resulting in more time on the computer screen.[62] Although real time documentation provided more thorough medical records, nurses' still miss information because their communication broke down and nurses lost part of the conversation while typing in the EHR.[62] Nurses are also required to complete the mandatory documentation within a certain time frame, which competes with the time needed to fulfill patients' needs.[63] Our study supports these nursing concerns in that nurses spent more time charting at the nursing station and the hallway than in patient rooms. Our study also shows a trend of increased documentation during 3pm-7pm. Although not statistically significant, these findings are consistent with a previous study reporting that afternoon was the peak time for nursing documentation.[64]

Phone call interruption

Interruptions occur commonly in patient rooms and the medication room[43,44] and are threats to patient safety.[65,66] A recent study reported that medication administration was more likely to be rechecked because of interruptions, resulting in an decrease of wrong-dose errors,[67] this also implied work inefficiency. We also found that nurses communicated with patients primarily during medication administration. The conversation could be self-directed interruption (initiated by nurses), or unexpected interruptions (initiated by patients). We found that nurses spent 8-13% of the time in the medication room dealing with phone interruptions and 16-18% of the time in patient rooms dealing with phone interruptions. Interruptions by phone calls during patient care increases nurses' stress.[68] Innovative solutions are necessary to minimize interruptions. For example, a wireless call system could provide more information (e.g. who and what the call is about) for nurses to manage interruptions.[68]

Study Limitations

The study was limited to one unit in one hospital within one academic health system, thus limiting generalizability. Data collection occurred only over a four-month period subject to seasonal variations in hospital admissions. We also did not document nurses' communication and hands-on tasks in the isolation room, as observers were not allowed access to the isolation room for safety reason. Participation bias was a limitation, as the study required nurses' participation and consent. Also, observational research is limited by the human capacity to accurately record every action that occurs, especially in a high stress environment.[69] We may have missed some activities in rapidly changing hands-on tasks, communications or locations/movements. We could not guarantee 100% accuracy, but we minimized the inconsistency between observers through rigorous training, IORA, and clearly defining definitions of each activity.

Conclusion

The time motion study portrays nurses' work in a 12-hours day shift. Our research also demonstrates a novel and quantifiable method of measuring multidimensional levels of nursing activities. The study results provide additional evidence to the growing body of literature on nurses' time allocation, multitasking, patient care traits, and interruptions. This work can assist nursing leaders to develop strategies for transforming nursing practice through re-examination of nursing work and activities, and to maximize the potential of the nursing workforce by supporting nurses to truly practice at the top of their license.

References

1. Kudo Y, Yoshimura E, Shahzad MT, Shibuya A, Aizawa Y. Japanese professional nurses spend unnecessarily long time doing nursing assistants' tasks. *Tohoku J Exp Med.* 2012;228(1):59-67.
2. Storfjell JL, Ohlson S, Omoike O, Fitzpatrick T, Wetasin K. Non-value-added time: the million dollar nursing opportunity. *J Nurs Adm.* 2009;39(1):38-45.
3. Storfjell JL, Omoike O, Ohlson S. The balancing act: patient care time versus cost. *J Nurs Adm.* 2008;38(5):244-249.
4. Adler-Milstein J, DesRoches CM, Furukawa MF, et al. More Than Half of US Hospitals Have At Least A Basic EHR, But Stage 2 Criteria Remain Challenging For Most. *Health Aff (Millwood).* 2014.
5. DesRoches CM, Charles D, Furukawa MF, et al. Adoption of electronic health records grows rapidly, but fewer than half of US hospitals had at least a basic system in 2012. *Health Aff (Millwood).* 2013;32(8):1478-1485.
6. Adler-Milstein J, Holmgren AJ, Kralovec P, Worzala C, Searcy T, Patel V. Electronic health record adoption in US hospitals: the emergence of a digital "advanced use" divide. *J Am Med Inform Assoc.* 2017;24(6):1142-1148.
7. Read-Brown S, Sanders DS, Brown AS, et al. Time-motion analysis of clinical nursing documentation during implementation of an electronic operating room management system for ophthalmic surgery. *AMIA Annu Symp Proc.* 2013;2013:1195-1204.
8. Banner L, Olney CM. Automated clinical documentation: does it allow nurses more time for patient care? *Comput Inform Nurs.* 2009;27(2):75-81.
9. Wong D, Bonnici T, Knight J, Gerry S, Turton J, Watkinson P. A ward-based time study of paper and electronic documentation for recording vital sign observations. *J Am Med Inform Assoc.* 2017;24(4):717-721.
10. Sanders DS, Read-Brown S, Tu DC, et al. Impact of an electronic health record operating room management system in ophthalmology on documentation time, surgical volume, and staffing. *JAMA Ophthalmol.* 2014;132(5):586-592.
11. Benner P, Sheets V, Uris P, Malloch K, Schwed K, Jamison D. Individual, practice, and system causes of errors in nursing: a taxonomy. *J Nurs Adm.* 2002;32(10):509-523.
12. Clarke SP, Aiken LH. Failure to rescue. *Am J Nurs.* 2003;103(1):42-47.
13. Ebright PR, Patterson ES, Chalko BA, Render ML. Understanding the complexity of registered nurse work in acute care settings. *J Nurs Adm.* 2003;33(12):630-638.
14. Higuchi KA, Donald JG. Thinking processes used by nurses in clinical decision making. *J Nurs Educ.* 2002;41(4):145-153.
15. Potter P, Wolf L, Boxerman S, et al. *An Analysis of Nurses' Cognitive Work: A New Perspective for Understanding Medical Errors Advances in Patient Safety: From Research to Implementation (Volume 1: Research Findings).* Rockville MD2005.
16. Wolf LD, Potter P, Sledge JA, Boxerman SB, Grayson D, Evanoff B. Describing nurses' work: combining quantitative and qualitative analysis. *Hum Factors.* 2006;48(1):5-14.
17. Tang Z, Mazabob J, Weavind L, Thomas E, Johnson TR. A time-motion study of registered nurses' workflow in intensive care unit remote monitoring. *AMIA Annu Symp Proc.* 2006:759-763.
18. Capuano T, Bokovoy J, Halkins D, Hitchings K. Work flow analysis: eliminating non-value-added work. *J Nurs Adm.* 2004;34(5):246-256.
19. Blay N, Duffield CM, Gallagher R, Roche M. A systematic review of time studies to assess the impact of patient transfers on nurse workload. *Int J Nurs Pract.* 2014;20(6):662-673.
20. Westbrook JI, Ampt A, Williamson M, Nguyen K, Kearney L. Methods for measuring the impact of health information technologies on clinicians' patterns of work and communication. *Stud Health Technol Inform.* 2007;129(Pt 2):1083-1087.

21.   Westbrook JI, Duffield C, Li L, Creswick NJ. How much time do nurses have for patients? A longitudinal study quantifying hospital nurses' patterns of task time distribution and interactions with health professionals. *BMC Health Serv Res.* 2011;11:319.
22.   Abbey M, Chaboyer W, Mitchell M. Understanding the work of intensive care nurses: a time and motion study. *Aust Crit Care.* 2012;25(1):13-22.
23.   Sakai Y, Yokono T, Mizokami Y, et al. Differences in the working pattern among wound, ostomy, and continence nurses with and without conducting the specified medical act: a multicenter time and motion study. *BMC Nurs.* 2016;15:69.
24.   Wright G, O'Mahony D, Kabuya C, Betts H, Odama A. Nurses behaviour pre and post the implementation of data capture using tablet computers in a rural clinic in South Africa. *Stud Health Technol Inform.* 2015;210:803-807.
25.   Tuinman A, de Greef MH, Krijnen WP, Nieweg RM, Roodbol PF. Examining Time Use of Dutch Nursing Staff in Long-Term Institutional Care: A Time-Motion Study. *J Am Med Dir Assoc.* 2016;17(2):148-154.
26.   Gartemann J, Caffrey E, Hadker N, Crean S, Creed GM, Rausch C. Nurse workload in implementing a tight glycaemic control protocol in a UK hospital: a pilot time-in-motion study. *Nurs Crit Care.* 2012;17(6):279-284.
27.   Hendrich A, Chow MP, Skierczynski BA, Lu Z. A 36-hospital time and motion study: how do medical-surgical nurses spend their time? *Perm J.* 2008;12(3):25-34.
28.   Chan TC, Killeen JP, Vilke GM, Marshall JB, Castillo EM. Effect of mandated nurse-patient ratios on patient wait time and care time in the emergency department. *Acad Emerg Med.* 2010;17(5):545-552.
29.   van Oostveen CJ, Gouma DJ, Bakker PJ, Ubbink DT. Quantifying the demand for hospital care services: a time and motion study. *BMC Health Serv Res.* 2015;15:15.
30.   Sochalski J. Is more better?: the relationship between nurse staffing and the quality of nursing care in hospitals. *Med Care.* 2004;42(2 Suppl):II67-73.
31.   Elganzouri ES, Standish CA, Androwich I. Medication Administration Time Study (MATS): nursing staff performance of medication administration. *J Nurs Adm.* 2009;39(5):204-210.
32.   Qian S, Yu P, Hailey DM. The impact of electronic medication administration records in a residential aged care home. *Int J Med Inform.* 2015;84(11):966-973.
33.   Qian S, Yu P, Hailey DM, Wang N. Factors influencing nursing time spent on administration of medication in an Australian residential aged care home. *J Nurs Manag.* 2016;24(3):427-434.
34.   Popovici I, Morita PP, Doran D, et al. Technological aspects of hospital communication challenges: an observational study. *Int J Qual Health Care.* 2015;27(3):183-188.
35.   de Ruiter HP, Demma JM. Nursing: the skill and art of being in a society of multitasking. *Creat Nurs.* 2011;17(1):25-29.
36.   Bastian ND, Munoz D, Ventura M. A Mixed-Methods Research Framework for Healthcare Process Improvement. *J Pediatr Nurs.* 2016;31(1):e39-51.
37.   Draheim C, Hicks KL, Engle RW. Combining Reaction Time and Accuracy: The Relationship Between Working Memory Capacity and Task Switching as a Case Example. *Perspect Psychol Sci.* 2016;11(1):133-155.
38.   Edwards A, Fitzpatrick LA, Augustine S, et al. Synchronous communication facilitates interruptive workflow for attending physicians and nurses in clinical settings. *Int J Med Inform.* 2009;78(9):629-637.
39.   Spencer R, Coiera E, Logan P. Variation in communication loads on clinical staff in the emergency department. *Ann Emerg Med.* 2004;44(3):268-273.
40.   Berg LM, Kallberg AS, Goransson KE, Ostergren J, Florin J, Ehrenberg A. Interruptions in emergency department work: an observational and interview study. *BMJ Qual Saf.* 2013;22(8):656-663.
41.   Walter SR, Li L, Dunsmuir WT, Westbrook JI. Managing competing demands through task-switching and multitasking: a multi-setting observational study of 200 clinicians over 1000 hours. *BMJ Qual Saf.* 2014;23(3):231-241.
42.   McGillis Hall L, Pedersen C, Hubley P, et al. Interruptions and Pediatric Patient Safety. *Journal of Pediatric Nursing.* 2010;25(3):167-175.
43.   Johnson M, Sanchez P, Langdon R, et al. The impact of interruptions on medication errors in hospitals: an observational study of nurses. *J Nurs Manag.* 2017;25(7):498-507.
44.   Thomas L, Donohue-Porter P, Stein Fishbein J. Impact of Interruptions, Distractions, and Cognitive Load on Procedure Failures and Medication Administration Errors. *J Nurs Care Qual.* 2017;32(4):309-317.
45.   McGillis Hall L, Pedersen C, Fairley L. Losing the moment: understanding interruptions to nurses' work. *J Nurs Adm.* 2010;40(4):169-176.

46.   Westbrook JI, Woods A, Rob MI, Dunsmuir WM, Day RO. Association of interruptions with an increased risk and severity of medication administration errors. *Archives of Internal Medicine.* 2010;170(8):683-690.

47.   Flynn F, Evanish JQ, Fernald JM, Hutchinson DE, Lefaiver C. Progressive Care Nurses Improving Patient Safety by Limiting Interruptions During Medication Administration. *Crit Care Nurse.* 2016;36(4):19-35.

48.   Yen PY, Kelley M, Lopetegui M, et al. Understanding and Visualizing Multitasking and Task Switching Activities: A Time Motion Study to Capture Nursing Workflow. *AMIA Annu Symp Proc.* 2016;2016:1264-1273.

49.   Kalisch BJ, Aebersold M. Interruptions and multitasking in nursing care. *Jt Comm J Qual Patient Saf.* 2010;36(3):126-132.

50.   Lopetegui M, Yen PY, Lai AM, Embi PJ, Payne PR. Time Capture Tool (TimeCaT): development of a comprehensive application to support data capture for Time Motion Studies. *AMIA Annu Symp Proc.* 2012;2012:596-605.

51.   Schenk E, Schleyer R, Jones CR, Fincham S, Daratha KB, Monsen KA. Time motion analysis of nursing work in ICU, telemetry and medical-surgical units. *J Nurs Manag.* 2017.

52.   Roumeliotis N, Parisien G, Charette S, Arpin E, Brunet F, Jouvet P. Reorganizing Care With the Implementation of Electronic Medical Records: A Time-Motion Study in the PICU. *Pediatr Crit Care Med.* 2018.

53.   Institute of Medicine. *The Future of Nursing: Leading Change, Advancing Health.* Washington DC: National Academy of Sciences; 2011.

54.   Company TAB. Achieving Top-of-License Nursing Practice. 2013; http://www.advisory.com/research/nursing-executive-center/studies/2013/achieving-top-of-license-nursing-practice. Accessed April 30th, 2015.

55.   Company TAB. What is top-of-license nursing practice? 2014; http://www.advisory.com/research/nursing-executive-center/multimedia/video/2014/defining-top-of-license-practice. Accessed April 30th, 2015.

56.   Buck J, Loversidge J, Chipps E, Gallagher-Ford L, Genter L, Yen P-Y. Top-Of-License Nursing Practice Part 1: Describing Common Nursing Activities and Nurses' Experiences that Hinder Top-of-License Practice. *Journal of Nursing Administration.* 2018;(in press).

57.   Schachner MB, Recondo FJ, Sommer JA, et al. Pre-Implementation Study of a Nursing e-Chart: How Nurses Use Their Time. *Stud Health Technol Inform.* 2015;216:255-258.

58.   Antinaho T, Kivinen T, Turunen H, Partanen P. Nurses' working time use - how value adding it is? *J Nurs Manag.* 2015;23(8):1094-1105.

59.   Song X, Kim J-H, Despins L. A Time-Motion Study in an Intensive Care Unit using the Near Field Electromagnetic Ranging System. Paper presented at: Proceedings of the 2017 Industrial and Systems Engineering Conference2017.

60.   Krugman M, Sanders C, Kinney LJ. Part 2: Evaluation and outcomes of an evidence-based facility design project. *J Nurs Adm.* 2015;45(2):84-92. doi: 10.1097/NNA.0000000000000162.

61.   Lavander P, Merilainen M, Turkki L. Working time use and division of labour among nurses and health-care workers in hospitals - a systematic review. *J Nurs Manag.* 2016;24(8):1027-1040.

62.   Duffy WJ, Kharasch MS, Du H. Point of care documentation impact on the nurse-patient interaction. *Nurs Adm Q.* 2010;34(1):E1-E10.

63.   Gaudet CA. Electronic Documentation and Nurse-Patient Interaction. *ANS Adv Nurs Sci.* 2016;39(1):3-14.

64.   Laitinen H, Kaunonen M, Astedt-Kurki P. The impact of using electronic patient records on practices of reading and writing. *Health Informatics J.* 2014;20(4):235-249.

65.   Hopkinson SG, Jennings BM. Interruptions during nurses' work: A state-of-the-science review. *Res Nurs Health.* 2013;36(1):38-53.

66.   Raban MZ, Westbrook JI. Are interventions to reduce interruptions and errors during medication administration effective?: a systematic review. *BMJ Qual Saf.* 2014;23(5):414-421.

67.   Blignaut AJ, Coetzee SK, Klopper HC, Ellis SM. Medication administration errors and related deviations from safe practice: an observational study. *J Clin Nurs.* 2017;26(21-22):3610-3623.

68.   Klemets J, Evjemo TE. Technology-mediated awareness: facilitating the handling of (un)wanted interruptions in a hospital setting. *Int J Med Inform.* 2014;83(9):670-682.

69.   Vankipuram M, Kahol K, Cohen T, Patel VL. Toward automated workflow analysis and visualization in clinical environments. *J Biomed Inform.* 2011;44(3):432-440.