

Impact of a Clinical Information System on Multitasking in Two Intensive Care Units

Mark A. Ballermann¹, Nicola T. Shaw², Damon C. Mayes¹, and R.T. Noel Gibney³

¹Alberta Health Services, Edmonton, AB, Canada

²Health Informatics Institute, Algoma University, Sault Ste. Marie, ON, Canada

³Division of Critical Care Medicine, Faculty of Medicine & Dentistry, University of Alberta, Edmonton, AB, Canada

Abstract

Health Care Providers (HCPs) in Intensive Care Units (ICUs) communicate effectively to coordinate timely patient care. HCPs rapidly switch between patient care, documentation and communication tasks such that they are completed simultaneously or nearly simultaneously, a phenomenon termed multitasking. An electronic charting tool or Critical Care clinical Information System (CCIS) may facilitate information sharing, but system related changes in multitasking have not been investigated. Trained observers followed physicians, nurses, respiratory therapists, and unit clerks in two ICUs and recorded their tasks. Observations were completed before the introduction of the CCIS at 3 and at 12 months afterward, using the Work Observation Method By Activity Timing (WOMBAT). Amounts of time HCPs spent performing multitasking before and after the CCIS introduction were compared, along with the tasks composing multitasking events. Before the CCIS introduction, respiratory therapists, nurses, and physicians spent approximately 30-40% of their time multitasking, whereas unit clerks spent less time multitasking (14%-18%). Percentages of time spent multitasking decreased to values between 10% and 25%. Documentation and communication tasks accounted for large proportions of the multitasking reduction. Cognitive burdens associated with learning new documentation methods, or constraints of charting at bedside terminals may be causes of observed reductions in multitasking. Perceptions of poorer communication, lower productivity, and less staff acceptance of the CCIS may result.

Keywords: *Critical Care Information System; Time and Motion Studies; Clinical Information System; Medical Informatics*

1 Introduction

Health Care Providers (HCPs) working in Intensive Care Units (ICUs) treat patients with highly acute or complex issues. In ICUs, effective and timely communication of patient status and care plans helps ensure coordinated care and better outcomes [1,2]. Patient charts often contain vital information for medical decision making, but documentation tasks associated with care present a burden for HCPs. To automate the transfer of bedside telemetry and laboratory data into charts,

a Critical Care clinical Information System (CCIS), or electronic charting tool, was introduced in two ICUs in Edmonton, Alberta, Canada. Systems like the CCIS sometimes reduce the proportions of time HCPs spend on documentation tasks in ICUs [3,4]. Intuitively, increased charting efficiency should make more time available for patient care, but this view may neglect the reality HCPs face in providing timely intensive care.

HCPs often contend with tight time constraints by completing tasks concurrently, work practices that are sometimes called multitasking [5-7]. HCPs often ver-

bally communicate with colleagues or complete documentation tasks when multitasking [8]. The sharing of information between HCPs alongside the completion of other tasks likely helps ensure coordinated care.

The CCIS may have far-reaching effects on HCP workflow and multitasking, but these effects are not entirely understood. As a first step in understanding how the introduction of systems like the CCIS may affect HCP productivity and therefore patient care we examined patterns of multitasking before and 3 months after a CCIS introduction to two ICUs. We used the Work Observation Method By Activity Timing (WOMBAT) method to record time spent on tasks by ICU respiratory therapists, physicians, nurses, and unit clerks. Multitasking was recorded using the WOMBAT method [5]. Percentages of time spent multitasking by physicians, nurses, and respiratory therapists decreased at 3 and at 12 months after the introduction of the CCIS. We discuss possible causes for these changes and potential implications for patient care. Amounts of time critical care providers spent multitasking before the CCIS introduction was previously reported as part of a paper from our group validating the WOMBAT method [9].

2 Methods

2.1 Research setting

Ethical approval was granted by the University of Alberta Human Research Ethics Board (File #:B-241107) and the Northern Alberta Clinical Trials and Research Centre (File #:6035) prior to data collection. Observations were performed in the General Systems Intensive Care Unit (GSICU) at the University of Alberta Hospital, and the Pediatric Intensive Care Unit (PICU) at the Stollery Children's Hospital. Both hospitals are located in Edmonton, Alberta, Canada. Both hospitals are busy academic tertiary referral centres. The GSICU has a total of 30 beds with 24 operational due to staff shortages. The PICU has 17 beds operational. The CCIS automatically captured vital sign data from bedside monitors, but did not interface with other bedside equipment, such as ventilators or laboratory data, at the time of this study. The ratio of patients to bedside nurses in the PICU is 1:1. In GSICU, the ratio is 1:1 70% of the time and 2:1 30% of the time.

2.2 Participants

HCPs working in the ICUs were informed of the study with posters and presentations. Unit clerks, nurses, respiratory therapists, and physicians were then approached by members of the study team. Of 215 nurses

in permanent positions, 97 agreed to participate (45%). Of 36 ICU physicians, 34 agreed to participate (94%). Of 71 respiratory therapists, 49 agreed to participate (69%). Of 17 unit clerks, 16 agreed to participate (94%). Informed written consent and completed demographic data forms were obtained from all enrolled participants.

2.3 Observations

Observers were trained for a minimum of 12 hours before collecting observational data. Trainees were initially paired with an experienced observer to simultaneously observe and record the tasks of a single participant. Inter-rater reliability was greater than 85%. Numbers of observations were evenly balanced among mid-day (07:00-19:00), mid-night (19:00-07:00), morning shift change (06:30-08:00), and evening shift change conditions (18:30-20:00). Observations were also scheduled to represent each of four types of day, mid-week (Tuesday-Thursday), weekend (Saturday-Sunday), Mondays, and Fridays. Observers recorded contextual details using field notes, including their perceptions of the general activity level of the units, the presence of students on the unit, the acuity of patients under their participants care and other details that could assist in interpreting the data. Observations were confined to the units under study, and were suspended if the person that was being observed left for any reason during their shift (e.g., breaks). Pre-CCIS observations were completed in PICU between September and November 2008, and in GSICU between January and February 2009. The CCIS was introduced in March 2009. The post-CCIS observations were completed on both units between May and July 2009 for the 3 month condition and between March and April 2010 for the 12 month condition. Across the 3 conditions, physicians were observed for 58 hours, nurses were observed for 61 hours, respiratory therapists were observed for 47 hours, and unit clerks were observed for 53 hours.

2.4 Work definitions and data collection tool

We extended work definitions provided by Westbrook and colleagues [5] to include tasks specific to respiratory therapists and unit clerks [9]. Observers carried paper copies of work definitions to assist in accurately categorizing tasks. Multitasking was scored when participants performed more than one task simultaneously. Documentation tasks were scored when a participant recorded patient information. The type of media used was recorded and could include paper, permanent patient records (including medication orders), other computers, or the CCIS. Professional communi-

cation included any work related discussion with other staff members.

Observers carried HP iPAQ Personal Digital Assistants (PDAs) running the WOMBAT software. When a participant started a task, observers could input the type of task along with the media used. The WOMBAT software allowed the observer to record the start of a second task while the first continued [5]. Both tasks were then visible on the PDA screen as the participant worked. Either or both tasks could be terminated as the participant's workload changed. An indefinite number of additional tasks could be added, but the amount of time participants were recorded completing more than three concurrent tasks was less than 1% for all roles. Data was transferred via a laptop to custom written Excel spreadsheets and R statistical software for analysis.

2.5 Statistics

Proportions of time spent on two or more concurrent tasks were calculated from each observation using the database. Percentages of time spent multitasking with either documentation or professional communication tasks were also calculated. We performed Kruskal-Wallis tests comparing the baseline, 3 month and 12 month conditions. We tested the null hypothesis that the CCIS introduction would not alter the percentages of time multitasking was recorded. Significance was set at 0.05.

3 Results

Physicians were recorded multitasking 40% of the time before the CCIS was introduced (Figure 1A; 34%-46%; values in brackets are all 95% confidence intervals). After 3 and 12 months, comparable values were 22% (18%-25%) and 20% (17%-23%) respectively ($p < 0.05$). Nurses were recorded multitasking for 37% (31%-43%) of the time before the CCIS introduction. After 3 months and 12 months, comparable values were 13% (7%-19%), and 11% (9%-14%) respectively ($p < 0.05$; Figure 1B). Respiratory therapists were observed multitasking 28% (22%-34%) of the time before the CCIS was introduced. Similar values from 3 and 12 months post-introduction were 14% (11%-16%) and 12% (9%-15%), respectively ($p < 0.05$; Figure 1C). Unit clerks were observed multitasking 16% (14%-18%) of the time before the CCIS introduction, and 17% (14%-20%), then 13% (11%-16%) of the time afterward.

To explore changes in tasks performed during multitasking, we examined amounts of time spent on documentation multitasking, where one task was a documentation task. Before the CCIS introduction, physi-

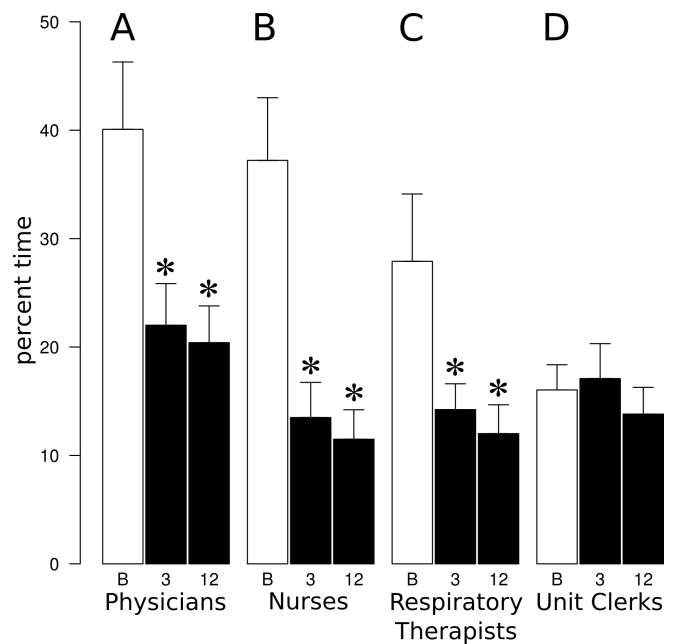


Figure 1: Percentages of time spent on multitasking by four HCP roles working in ICUs before the CCIS was introduced (white bars) and after (black bars). Mean percentages of time recorded multitasking is shown for physicians (A), nurses (B), respiratory therapists (C), and unit clerks (D) +/- 95% C.I. B=baseline, 3=3 month data, 12=12 month data. Error bars represent 95% confidence intervals. *= $p < 0.05$

cians were recorded performing documentation multitasking 14% (8%-20%) of the time (Figure 2A). At 3 and 12 months, this value decreased to 6% (3%-9%) and 4% (3%-6%) respectively ($p < 0.05$). Nurses spent 13% (10%-16%) of their time multitasking alongside documentation tasks before the CCIS was introduced (Figure 2B). At 3 and 12 months, this value decreased to 2.5% (1.8%-3.2%) and 2.4% (1.6%-3.2%), respectively ($p < 0.05$). Respiratory therapists spent 8.8% (4.8%-12.8%) of their time performing documentation multitasking before the CCIS was introduced. At 3 and 12 months, this value decreased to 2.9% (2.0%-3.8%) and 3.0% (2.0%-4.1%), respectively ($p < 0.05$). Unit clerks spent 3.6% (2.2%-5.0%) of their time performing documentation multitasking before the CCIS introduction. At 3 and 12 months, unit clerks spent 2.9% (1.9%-3.9%) and 3.0% (1.9%-4.2%) of their time performing documentation multitasking after the CCIS introduction. The care providers we observed spent negligible amounts of time multitasking when using the CCIS. Multitasking was most often observed when care providers performed documentation tasks using paper.

HCPs frequently performed professional communication tasks concurrently alongside other tasks. Physicians spent 37% (30%-44%) of their time performing multitasking alongside a professional communication task before the CCIS introduction (Figure 3A). At 3

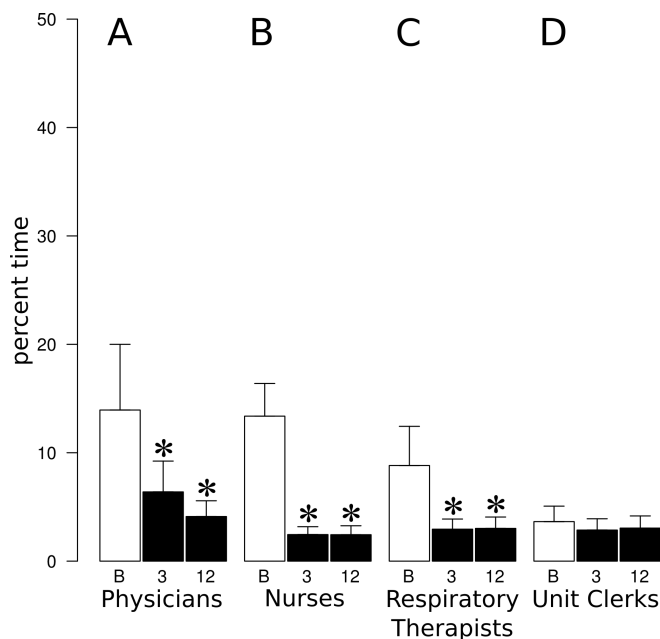


Figure 2: Percentages of time spent on multitasking with documentation as at least one of the tasks before the CCIS was introduced (white bars) and after (black bars). Mean percentages are shown for physicians (A), nurses (B), respiratory therapists (C), and unit clerks (D) +/- 95% C.I. B=baseline, 3=3 month data, 12=12 month data. *= $p<0.05$

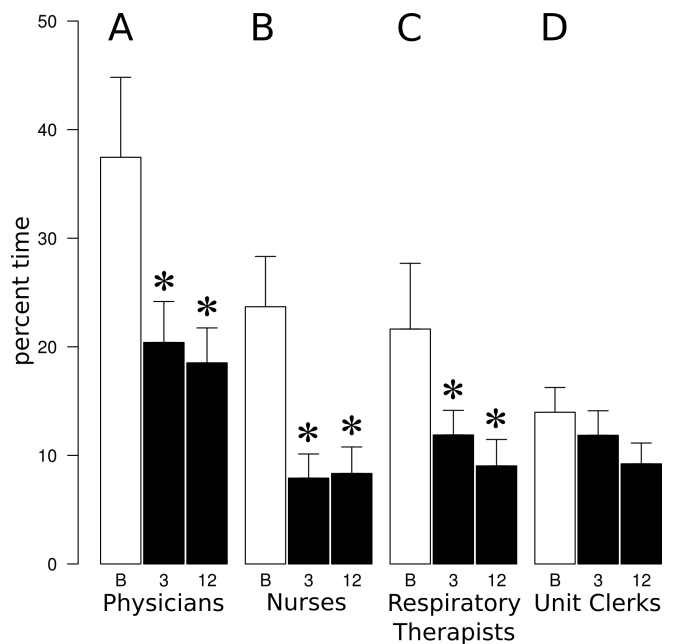


Figure 3: Percentages of time spent on multitasking with professional communication as at least one of the tasks before the CCIS was introduced (white bars) and after (black bars). Mean percentages are shown for physicians (A), nurses (B), respiratory therapists (C), and unit clerks (D) +/- 95% C.I. B=baseline, 3=3 month data, 12=12 month data. *= $p<0.05$

and 12 months, physicians spent 20% (16%-24%) and 19% (15%-22%) of their time on professional communication multitasking, respectively ($p<0.05$). Nurses spent 24% (19%-29%) of their time performing multitasking with professional communication before the CCIS introduction (Figure 3B). At 3 and 12 months, these values decreased to 7.9% (5.9%-9.9%) and 8.3% (5.9%-10.8%) respectively ($p<0.05$). Respiratory therapists performed multitasking alongside a professional communication task 22% of the time (16%-28%) before the CCIS introduction (Figure 3C). At 3 and 12 months, this value decreased to 12% (10%-14%) and 9% (6.6%-11.5%) respectively ($p<0.05$). Unit clerks performed multitasking while performing a professional communication task 14% (12%-16%) of the time before the CCIS introduction (Figure 3D). At 3 and 12 months, this value decreased to 12% (10%-14%), and 9% (7.3%-11%) respectively (Figure 3D).

4 Discussion

We found decreased proportions of time spent multitasking among physicians, nurses, and respiratory therapists working in two ICUs after the introduction of a CCIS. Decreases in the amounts of time spent multitasking while performing professional communication and documentation tasks accounted for large proportions of the overall decrease in multitasking. Multitasking by unit

clerks did not show the same decrease observed in the other roles. As unit clerks spent very little time working with the CCIS application, this finding is consistent with the hypothesis that CCIS introduction caused the changes in time spent multitasking by the other roles.

Several explanations for HCPs spending less time multitasking after a CCIS introduction are plausible. Learning to use a new documentation system may be more cognitively demanding for HCPs than using paper charting. At three months after the CCIS introduction, HCPs were likely still learning all the aspects of the system and may not have felt comfortable conversing with colleagues while completing documentation tasks. Consistent with this, we found lower percentages of time spent multitasking while completing documentation tasks using the CCIS itself. Alternatively, the physical configuration of CCIS workstations may account for some of the observed changes. Respiratory therapists and nurses have been encouraged to complete their documentation tasks at bedside workstations. Reduced flexibility in the locations where documentation tasks occur may constrain and reduce verbal communication. If the cognitive demands of learning new methods of charting are at the root of the observed reductions in time HCPs spend multitasking, future observations may show a return to pre-CCIS levels of multitasking, particularly in HCPs who have been working with the CCIS for longer periods of time. Alternatively, charting at

fixed terminal locations may prevent the return of the previously seen levels of multitasking.

4.1 Significance

These findings may have implications for the operations of the ICUs. Multitasking may reduce cognitive performance [10], but has not been studied in great depth in healthcare settings. Less time spent multitasking may correlate with lower cognitive demands, and thus less chance for error [11]. Observational studies of HCPs working in emergency departments suggest that demands for timely care result in care providers appropriately prioritizing their workload [8,12,13] and actively managing interruptions [14]. Multitasking ability assessments have been proposed for emergency department physicians, as it is considered a vital skill [15]. HCPs in ICUs may similarly depend on documentation and professional communication multitasking to ensure all members of a patient's care team are kept updated on patient status and care plans. The introduction of a CCIS may make this communication more difficult. We conducted focus groups and interviews with HCPs in the month after the CCIS introduction. Some participants expressed concerns that "patient interventions were not being done in as timely a manner" after the CCIS introduction as they were with paper charting (unpublished observations). HCPs maintain continuity of information around their patients. If the CCIS interferes with achieving informational continuity, the system may be less accepted as a result. The decreases we found in time spent multitasking represents evidence suggesting that the introduction of electronic documentation methods to ICUs can be disruptive to patterns of care provider work. As multitasking is likely to be cognitively demanding, the potential exists that this disruption may be beneficial for patient safety. Multitasking may also permit the more rapid completion of simple tasks important for patient care. In this respect, reductions of multitasking among care providers may be detrimental to timely care and therefore patient outcomes. Examining patient outcome measures and qualitative data of HCP perceptions of the CCIS will provide valuable complements to the results in this paper, to definitively answer whether this CCIS introduction represents a positive step for patient care.

4.2 Strengths and weaknesses

This study applies the WOMBAT method to unit clerk and respiratory therapist roles in addition to nurse and physician roles, to show a more complete picture of possible CCIS-related influences on workflow. We report

the first use of the WOMBAT method to quantify HCP work in ICUs [9]. This method has not been validated by other groups in ICUs, which may be a potential weakness of our study. Secondly, although care providers were observed at 12 months after the introduction of the CCIS, some participants mentioned that they were still not entirely comfortable working with the system. In one instance, the integration of an electronic health record into clinical practice – measured by the reduction in use of a comparable legacy system – took 2 years [16]. We would therefore caution the reader that these results may have limited applicability to critical care environments where a CCIS is fully integrated into critical care providers' workflows.

5 Conclusion

We posit that reductions in HCP multitasking during transitions to electronic documentation methods are evidence of disrupted workflows. These disruptions may be eased if systems are easy to learn, and the devices or workstations used by care providers facilitate verbal communication during documentation tasks. It is likely that improvements to systems that take into account these principles will be more likely to be accepted by critical care providers. The use of time-motion approaches to studying care provider work may lead to novel insights to assist with the design of systems that fit better with care provider work.

6 Acknowledgements

We gratefully acknowledge the assistance of the staff and management of the University of Alberta GSICU, and Stollery Children's Hospital PICU, Audrey See-hagen and Kelly Arbeau for editorial assistance, and research observers Tineke Chattaroon, Sara Belton, Kelly Speer, Deb Jandura, Sally Ho, Aireen Wingert, Ashwini Kulkarni, Kelly Arbeau and Amber Ostevik. Funding support was provided by Alberta Health Services, and a Partnership in Health System Improvement Grant from the Canadian Institutes of Health Research (PHE 91423). Michela Brown, Johanna Westbrook, and Krish Thiru contributed to early versions of the research work plan.

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Correspondence

Nicola T. Shaw, FBCS, CITP, PhD
ESRI Canada Health Informatics Research Chair
Health Informatics Institute Scientific Director
Health Informatics Institute. Room BT303.,
Algoma University. 1520 Queen Street East.,
Sault Ste. Marie, Ontario. Canada P6A 2G4
phone: +1 (705) 949-2301, Ext. 4751

nicola.shaw@algonau.ca