

# Intensive Care Unit Nurse Workflow During Shift Change Prior to the Introduction of a Critical Care Clinical Information System

Nicola T. Shaw<sup>1</sup>, Mark Ballermann<sup>2</sup>, Reidar Hagtvedt<sup>3</sup>, Sally Ho<sup>2</sup>, Damon C. Mayes<sup>4</sup>, R. T. Noel Gibney<sup>5</sup>

<sup>1</sup>Health Informatics Institute, Algoma University, Sault Ste. Marie, ON, Canada

<sup>2</sup>Department of Family Medicine, Faculty of Medicine & Dentistry, University of Alberta, Edmonton, AB, Canada

<sup>3</sup>School of Business, University of Alberta

<sup>4</sup>Alberta Health Services, Edmonton, AB, Canada.

<sup>5</sup>Division of Critical Care Medicine, Faculty of Medicine & Dentistry, University of Alberta, Edmonton, AB, Canada

## Abstract

*Background:* A Critical Care clinical Information System (CCIS) is an electronic charting tool which may improve informational continuity between Health Care Providers (HCPs) in Intensive Care Units (ICUs).

*Methods:* To begin to test this assertion, we examined Registered Nurse (RN) workflow at two ICUs, prior to a CCIS introduction. Research observers followed RNs and recorded tasks with Personal Digital Assistants. We report percentages of time spent on documentation tasks, patient care, and professional communication from 30 minutes before to 60 minutes after shift change. Proportions of time spent on each task were compared to overall percentages of time spent on each task category.

*Results:* We found increases above the expected percentages of time spent on documentation before morning (07:00) shift change between 06:35 and 06:40. Between 06:50 and 06:55, RNs spent increased proportions of time on patient care. Significant increases in professional communication were found during the verbal communication portion of the handoff, just after 07:00. A second increase in time spent on patient care tasks was found between 07:35 and 07:50. Surrounding evening shift changes, there were smaller, but similar increases in time spent on professional communication and patient care tasks, but not documentation tasks.

*Conclusion:* We suggest the RN workflow pattern around shift change illustrates that methods employed to ensure informational continuity may be improved.

*Future Directions:* The CCIS introduction is likely to impact workflow patterns at shift changes. Future studies will present data obtained from RNs and other health care providers following the implementation of the CCIS.

**Keywords:** Handoff, Informational Continuity, Continuity of Care, Critical Care Information System

## 1. Introduction

### 1.1. Background

Intensive Care Units (ICUs) are home to the most acute patients in the hospital setting. Patients in the ICU require treatment by specialized, scarce, and expensive personnel. These Health Care Providers (HCPs) make decisions about patient care based on information captured by other HCPs, by monitoring equipment, and by laboratory personnel who are at some distance from the patient [1,2]. This arrangement of information flow in the critical care setting has been referred to as an “information ecosystem” [3].

Coordinated care over time and across multiple HCPs is broadly thought of as a critical determinant of patient outcome, and is termed continuity of care. Continuity of care depends on the timely availability of patient information, in the hands of the appropriate HCP. One main factor in determining whether continuity of care is achieved centres around the “handoff” between an HCP at the end of their shift and an incoming replacement HCP. This “handoff” includes the verbal transfer of information to the replacement HCP, along with the updated patient chart. The incoming HCP then assumes responsibility for the patients’ care. Within the ICU environment, information flow between HCPs is of paramount importance.

### 1.2. Rationale

A Critical Care clinical Information System (CCIS) is an electronic charting tool designed for the ICU and is purported to facilitate the transfer of information between HCPs [4]. This paper is part of a larger project that will examine whether the CCIS implementation represents a positive step for ICU patient care. We are conducting an observational study of HCPs on two ICU units that introduced a CCIS in early 2009. The CCIS implementation will likely impact both the quality and availability of information in patient charts, and the HCPs’ workflow. Workflow refers to the processes associated with completing a specific task. We examine how a CCIS implementation impacts the proportions of time HCPs spend on various tasks and what interruptions they experience.

Little is currently known about HCP workflow in ICUs. This paper examines nurse workflow at shift changes. These data are particularly interesting because shift change on an ICU unit represents a time when a large amount of information rapidly changes hands. The transfer needs to be both complete and efficient for the incoming nurse to provide effective patient care. We tested the hypothesis that the proportions of time spent on documentation, professional communication, and patient care tasks significantly deviate from their overall means during shift change.

This paper provides part of a foundation for the larger project assessing the impact of the CCIS. One cited benefit of CCIS suggests that charting will become more efficient. Various studies on this have shown mixed effects, though a

meta-analysis by Poissant and colleagues has shown that the introduction of EMRs may not reduce the time spent on charting, but that the quality of the information in the charts may increase [5]. Other projects have used continuous observation to examine the overall time spent by health care providers (such as physicians) on various tasks [6]. We add to these findings, and suggest that more valid assessments of HCP workflow may be derived by focusing specifically on times when informational continuity presents a challenge, such as at shift change.

### 1.3. Objective

We observed ICU nurses, and classified and recorded the time they spent on tasks using Personal Digital Assistants (PDAs) running Work Observation Method By Activity Timing (WOMBAT) software [6]. This observation method allows us to derive valid and reliable measures of HCP workflow [6]. As a first step in assessing whether this implementation of a CCIS represents a beneficial step in patient care, we quantified nurse workflow in the 2 to 6 months before the CCIS was implemented. We show changes in the amount of time spent by RNs on documentation, professional communication, and patient care tasks in the 30 minutes preceding and 60 minutes after the nominal shift change.

## 2. Methods

### 2.1. Research Setting

Approval was granted by the University of Alberta Human Research Ethics Board prior to commencement of data collection. We conducted our study in the Pediatric ICU (PICU) at the Stollery Children’s Hospital, and General Systems ICU (GSICU) at the University of Alberta hospital in Edmonton, Alberta, Canada. The PICU has 17 beds. The GSICU has 30 beds, with 24 operational due to staff shortages. These are busy critical care units in academic tertiary referral hospitals. The units operated with paper charting in place, as well as internet-enabled computers at nursing stations and throughout the unit. Laboratory data is available through these computers. The ratio of RNs to patients is 1:1 in the PICU, and 1:1 70% of the time and 1:2 30% of the time in the GSICU depending on patient acuity.

### 2.2. Participants

Members of the staff were informed of our study through presentations given by members of the research team, and by posters distributed around the units. Participants were then approached by members of the research team for their consent to be followed by observers. Out of 215 RNs in permanent staff positions, 87 consented to participate. Informed consent and demographic data (age, sex, time employed in ICU settings, number of shifts per

month, and self-assessed familiarity with computers) were obtained from participants.

### 2.3. Observations

Observers were trained for at least 12 hours before starting observations. Observers attained inter-rater reliability scores between 0.92 and 0.99. Observations were carried out for 90 minutes at a time with no advance warning to the participant. Equal numbers of observations were performed in 4 conditions: midshift during the day (07:00-19:00), midshift at night (19:00-07:00), during the morning shift change (06:30-08:00), and evening shift change (18:30-20:00). Observations were also balanced between 4 day types during the week: midweek, weekend, Mondays, and Fridays. Observers kept field notes for recording contextual information, such as their impression of how busy the unit was, whether the unit was short-staffed, and whether there were students present on the unit. When participants left the unit, or were on a break, observations were suspended, for the purposes of collecting workflow data in the unit environment where the CCIS would be put into place. The observations were carried out between September and November, 2008 in the PICU. The observations were carried out between January and February 2009 in the GSICU. In total, 61 hours of RN observations were performed. Of these, 30 hours of observations included a shift change.

### 2.4. Work Definitions

Work definitions were carried by the observers during their observations to classify tasks they observed into one of the categories in the PDA. These work definitions were provided by Westbrook et al, and were also refined to include tasks specific to the observed units. The complete work definitions are provided elsewhere [6]. Here, we show the time spent performing tasks that fall under three of the classes defined by Westbrook and colleagues [6]. Tasks related to writing, were scored as documentation. When RNs were verbally communicating with other health care providers, this time was scored as professional communication. Time spent performing patient care tasks were scored as either direct or indirect patient care. Direct patient care included communicating with the patient. The RNs spent the majority (~75%) of their time performing at least one of these three categories of tasks.

RNs often perform multiple tasks at once, and this was recorded in the PDA as multitasking. When multitasking, RNs were most often observed performing professional communication or documentation tasks [7]. Patient care was completed when multitasking, but less frequently [7]. Additional examples of scenarios where multitasking was scored have been previously published [6].

### 2.5. PDA Data Collection Tool

Observers carried Hewlett-Packard iPAQ hx2490 PDAs running WOMBAT software [8]. Data from the PDAs was extracted into Excel spreadsheets via a laptop.

### 2.6. Statistics

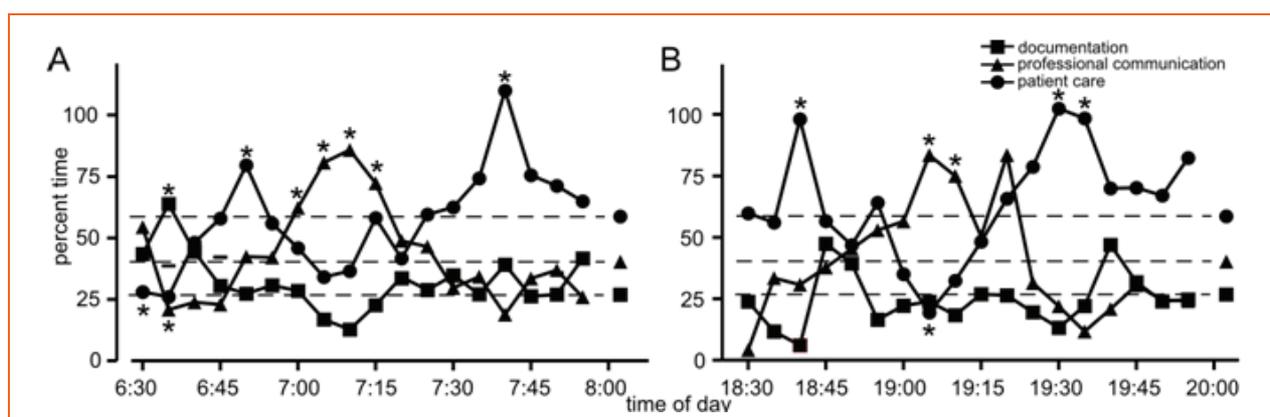
The proportions of time spent on documentation, professional communication, and patient care were calculated for each observation period. Mean proportions of time spent on those three task categories were calculated for observations sampling the entire workday. Proportions of time spent on the three tasks were also calculated from 5 minute time periods starting at 06:30 and ending at 08:00 during the morning shift change. Similar values were calculated from observation data performed during the evening shift change starting at 18:30 and ending at 20:00. We tested the null hypothesis that the time spent on the 3 task categories during the 5 minute time periods would not differ from the overall distribution of proportions of time spent on the three tasks sampled from the entire workday. Unpaired t-tests assuming unequal variances were used to compare the proportions of time spent on tasks in the 5 minute time periods at shift change to the proportions of time spent through the entire workday. The significance level was set at 0.05.

## 3. Results

Depending on the amount of time participants spent multitasking, the percentages of time spent performing the different tasks can add up to values greater than 100%.

### 3.1. Morning Shift Change

Morning shift change for the RNs on the ICU units is at 07:00. The percentage of time spent on the different categories of tasks varied during the time around the handoff (Figure 1A). RNs spent a significantly greater proportion of their time between 06:35-06:40 on documentation related tasks ( $p<0.05$ ), with a reduction in time spent on patient care tasks. A significant increase in the mean percentage of time spent on patient care tasks was found between 06:50 and 06:55 ( $p<0.05$ ). The nurse arriving for the day shift would typically arrive around 07:00, and the verbal portion of the handoff would then begin. At this point, a significant increase in the percentage of time spent on professional communication was found between 07:00 and 07:20 ( $p<0.05$ ). A statistically significant increase in time spent on patient care tasks was found between 07:40 and 07:45 ( $p<0.05$ ).



**Figure 1:** Time spent by ICU nurses on documentation (squares), professional communication (triangles), and patient care (circles) around morning shift change (A- 07:00) and evening shift change (B- 19:00). Markers represent the mean percentage of time spent on tasks per 5 minute block. \* -  $p < 0.05$  when compared to observations averaged over the entire observation period (mid-shift and shift change observations). Dashed lines with adjacent symbols represent the overall mean percentage time spent on each task category.

### 3.2. Evening Shift Change

The percentage of time spent on the different categories of tasks also varied around the evening shift change (at 19:00) as well (Figure 1B;  $p < 0.05$ ). Between 18:40 and 18:45, there was a statistically significant increase in time spent on patient care ( $p < 0.05$ ). Between 19:05 and 19:15 significantly more time was spent on professional communication, corresponding to the verbal portion of the handoff, with a statistically significant decrease in time spent on patient care ( $p < 0.05$ ). A significant increase in the percentage of time spent on patient care tasks was found between 19:30 and 19:40 ( $p < 0.05$ ).

## 4. Discussion

This paper is one of a group designed to characterize the workflow of health care providers in the ICU environment, before and after the introduction of a CCIS. We focus on a time on the unit where informational continuity is vital; shift change. During shift change, information and responsibility for patient care rapidly transfers to incoming personnel [9]. Health care providers can use formal mechanisms, such as checklists, to ensure critical information is not missed at handoff [10], but an updated patient chart remains a prerequisite for continuity of care. During the handoff, we found multiple statistically significant changes in proportions of time spent on different tasks. These changes are very likely to have practical significance in an environment such as the ICU where minutes can mean the difference between life and death. Moreover, we posit that the statistically significant changes are suggestive of challenges in informational continuity that may (or may not) be mitigated by a CCIS.

This study shows a statistically significant increase in the percentages of time RNs spend on documentation related tasks in the time leading up to the morning shift change. This is consistent with the RNs making sure that the information in the patients' charts is complete. The percentage of time spent on patient care increases in the time before the shift change. This increase could be caused by RNs getting 'caught up' on patient care after getting the chart updated. This increase could also be the result of RNs anticipating the verbal portion of the handoff, and attempting to complete patient care tasks. A second statistically significant increase in the percentages of time spent on direct patient care follows the verbal handoff. The nurse assuming responsibility for the patient's care may be starting off behind on important tasks due to the time spent handing off. Together these findings suggest that the current mechanisms transferring information between the two nurses involved in signing over a patients care can be improved. The CCIS may provide such an improvement. The work pattern we observed is consistent with RNs ensuring that information in the patient chart is current and appropriately transferred to their incoming counterpart, but that this successful information transfer takes time away from patient care. The RNs appropriately compensate for this by spending more time on patient care related tasks once the charts are current, during the times before and after the verbal communication portion of the "hand-off". After shift change, RNs also perform patient assessments. This likely contributes to the second increase in time spent on patient care tasks around this time.

A somewhat contrasting situation occurs around evening shift change. There was no significant increase in the time spent on documentation tasks between 18:30 and 19:00. Patient charts were likely updated at this time as afternoon rounds typically start on the unit between 16:00 and 17:00.

RNs would have finished reporting to physicians rounding on the unit, and would have had less time to fall behind in their charting. There were still increases in time spent on patient care and professional communication around the time of the evening shift change, but these changes were somewhat smaller. Together, these changes are suggestive of a smoother transition of information to the night shift for the RNs.

#### 4.1. Significance

Our findings have implications for the ICU as a whole. One problem with the current paper charting system may be that as a result of the time spent during handoff, RNs are placed into a situation where they are attempting to catch up just as they arrive for a shift. This possible sense of 'feeling behind' at the start of a shift could contribute to lowered morale, and staff turnover, which tends to be high in ICUs [11]. Additionally, unit meetings on the unit start at 08:30, with unit intensivists and residents rounding on the patients afterward. Obtaining information from RNs before unit meetings is likely to be difficult while they catch up on patient care tasks. Staff physicians on the unit rotate on Monday mornings, and provide a verbal report to the incoming physicians at the unit meeting. The physicians signing out would frequently be seen gathering information, largely by reading charts prior to Monday morning report. They would then disseminate this information to all members of the health care team at the Monday morning unit meeting. RNs may find it difficult to communicate with other health care providers, such as physicians while the RNs perform more patient care between 07:30 and 08:00.

#### 4.2. Limitations

The observational techniques employed in our paper have been used in other hospital environments [6,8], but not in ICU settings. We are only somewhat able to assess the extent to which our findings apply to other ICUs (including those at non-teaching hospitals) or general hospital ward settings.

### 5. Conclusions

We posit that HCP workflow observation surrounding shift changes reveals a systemic difficulty with the use of paper charting in general. This difficulty may be resolved or aggravated when the CCIS is implemented [12]. Further we posit that this observation method represents a valid way to assess the extent to which a CCIS improves or possibly impairs the continuity of information in the critical care environment. The pattern of workflow we report here may be suggestive of potential problems for health care staff and informational continuity surrounding ICU patients. This study provides important baseline informa-

tion for evaluating current methods of informational continuity in ICUs.

The larger CCIS project aims to assess whether the CCIS provides a benefit for informational continuity in critical care. If the CCIS facilitates an enhancement of patient care, by decreasing the effort required to provide information to incoming HCPs after shift change, we may expect to see fewer and/or small spikes in proportions of time spent on documentation. The fluctuations in time spent on patient care should also decrease. Alternatively, if the CCIS does not facilitate enhanced communication, we may expect increased fluctuations in the proportions of time spent on patient care and other tasks.

Shift change represents a time when clinicians may achieve informational continuity using the tools they are provided. In this stressful environment, clinicians are expected to ensure the continuity of information. To assess whether the CCIS is a helpful tool for clinicians, future evaluations employing workflow measures should specifically focus on times when informational continuity is challenged. Future evaluations of electronic charting methods should lead to better integration of electronic charting into clinical practice in ICUs.

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### Author Contributions

NTS is the senior author on the CCIS research study. She designed the study, and provided editorial advice. MAB coordinated the observations, wrote the manuscript, and performed the data analysis. RH and DCM provided statistical and editorial advice. SH assisted with data collection. NTS, MAB, SH, DCM and RTNG provided direction and input into the project design.

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## Correspondence

Dr. Nicola T. Shaw FBCS CIP  
Algoma University  
Health Informatics Institute  
Room SH 500  
1520 Queen Street East  
Sault Ste. Marie, ON P6A 2G4

Phone: +1-705-949-2301  
Fax: +1-705-949-6583  
nicola.shaw@algonau.ca