The impact of an integrated electronic health record on nurse time at the bedside: A pre-post continuous time and motion study

Running title: **The NurseTime Study**

*Rachel M WALKER, PhD, RN[1], Elizabeth BURMEISTER, PhD, RN[2], Carol JEFFREY, MN, RN[3], Sean BIRGAN, MHthMgmt, RN[4], Elizabeth GARRAHY, MHthMgmt, RN[4], Jenny ANDREWS, MN, RN[5], Adriana HADA, MN, RN[5], Leanne M AITKEN, PhD, RN[6]

[1]School of Nursing and Midwifery, Griffith University & Division of Surgery, Princess Alexandra Hospital, Metro South Health, Brisbane, Australia r.walker@griffith.edu.au, +61 7 3176 5843, ORCiD 0000-0002-608988225, Twitter @RachelMWalker

[2]Nursing Practice Development Unit, Princess Alexandra Hospital and the University of Queensland, Brisbane, Australia

[3]Nursing Practice Development Unit, Princess Alexandra Hospital, Brisbane, Australia

[4]Division of Surgery, Princess Alexandra Hospital, Brisbane Australia

[5]Division of Medicine, Princess Alexandra Hospital, Brisbane Australia

[6]School of Health Sciences, City, University of London, Menzies Health Institute Queensland, Griffith University, Brisbane Australia, Twitter @Leanne_Aitken

*Corresponding author

Acknowledgments: The researchers would like to acknowledge the contribution of the nurses observed to enable this project to take place.

Abstract

Background: Evidence about the effectiveness of electronic health records in improving nursing workload efficiency is uncertain.

Aim: To measure, compare and describe nurse time spent on patient care prior to, and following implementation of an integrated electronic health record roll-out using a standardised approach.

Design: Structured, continuous observation, pre-post time and motion design.

Methods: Continuous observations took place in general wards in surgical and medical divisions of a tertiary hospital in South East Queensland from November 2015 to July 2017. Trained nurse observers independently observed and recorded patient care provided by consenting direct-care nurses over the course of an entire clinical shift in surgical wards or during medication rounds in medical wards. Care activities were timed and coded into categories (direct care, indirect care, ward related activities, documentation, personal and miscellaneous activities), and additional elements that influence nursing care. Descriptive statistics including frequency, percentages and median duration were reported for care activities with differences between pre- and post-implementation reported. **Findings:** Direct-care nurses (n = 51) were observed for the duration of an entire clinical shift or during a medication round with a total of 6,209 activities observed in both divisions. Most nursing activities occurred at the patient's bedside prior to and following the implementation of an integrated electronic health record. In the surgical division, direct care activities (such as assessing patient needs and preparing and administering ordered medications), and ward related activities (such as cleaning and clerical work) showed a significant decrease ($p = <0.001$), although both had significant increases in median duration. The number of indirect care activities (such as verbal reporting) also increased ($p = 0.010$), although there was a downward trend in their median duration ($p = 0.015$). Documentation (such as computer data entry) increased significantly in number of activities ($p = <0.001$), and median duration ($p = 0.002$). In the medical division, there were no significant changes in direct or indirect care or ward related activities or median time. However, documentation activities and associated median duration increased significantly ($p = <0.001$).

Discussion: There was a significant increase in median time for documentation activities within an 18-month period following roll-out. However, this increase occurred as a result of the integrated electronic health record roll-out. Pre-implementation training assisted nurse adaptation. Workflows may improve as clinicians become more familiar with the digital system.

Conclusion: While the move from paper-based patient records to an integrated electronic health record did not significantly change the amount of nurse time at the bedside, or for the preparation and administration of ordered medications, there was a clear and consistent trend of increased documentation time and activities following implementation of the electronic health record. This knowledge may assist nurse leaders when implementing electronic health records

Keywords

Integrated electronic health records, health informatics, nurses/nursing, observation, patient care, time-motion studies

Summary of Relevance

Problem or issue

Evidence concerning the effectiveness of integrated electronic health records in improving workload efficiencies for clinicians is mixed.

What is already known

Documentation and reporting represent a large component of providing safe and quality patient care in contemporary health settings. Integrated electronic health records are replacing paper-based records, however their effectiveness in reducing documentation workload for nurses, has not been tested in the Australian context.

What the paper adds

A standardised approach to measuring and comparing nurse-time spent in direct patient care prior to and following a hospital roll-out of an integrated electronic health record. Results show significant increase in median time for documentation activities immediately following implementation.

Background

Nurses are credited as having skills and knowledge to adapt to highly complex systems (Vardaman, Cornell, & Clancy, 2012). However nurses in acute-care settings continue to be challenged with heavier and increasingly complex workloads even where patient-to-staff ratios remain unchanged (Humphries et al., 2014). Some authors suggest disruptive work environments compromise nurses' ability to provide high quality personalised bedside care for patients, contributing to threatened moral integrity and professional burnout (Hardingham, 2004; Humphries et al., 2014).

Documentation has contributed significantly to nurses workload (Schenk et al., 2017; Schenk et al., 2018; Seto, Inoue, & Tsumura, 2014), and is described as a burden in contemporary nursing practice (Lomas, 2012). Digital management systems in healthcare settings have the potential to streamline existing operations and positively change workflow to enable better use of clinicians' time. Understanding how these digital systems impact existing workflow for nurses is therefore imperative. There is a growing body of research that evaluates the implementation of digital management systems (Baumann, Baker, & Elshaug, 2018; Nguyen, Bellucci, & Nguyen, 2014; Ross, Stevenson, Lau, & Murray, 2016; Sullivan et al., 2016), and nurses' perceptions and experiences of them (Farre, Bem, Heath, Shaw, & Cummins, 2016; McBride, Tietze, Hanley, & Thomas, 2016). However nursing literature concerning the effectiveness of digital health systems (including e-prescribing and documenting systems) in improving workload efficiencies is mixed (Boonstra, Versluis, & Vos, 2014), with some authors reporting that digital health record implementation decreases work efficiency (Boyer, Samuelian, Fieschi, & Lancon, 2010; Gephart, Carrington, & Finley, 2015; Hollingworth et al., 2007; Lee, Mills, & Lu, 2008; Poon et al., 2004; Scott, Rundall, Vogt, & Hsu, 2005; Ward, Vartak, Schwichtenberg, & Wakefield, 2011), while others identify improvements (Houser & Johnson, 2008; Katsma, Spil, Ligt, & Wassenaar, 2007; Seto et al., 2014), or no change (Hakes & Whittington, 2008; Munyisia, 2011; Munyisia, Yu, & Hailey, 2012; Smith, Smith, Krugman, & Oman, 2005). While there is emerging evidence indicating electronic health records are contributing to documentation burden with significant consequences for clinicians and patients (Earls et al., 2017; Golob, Como, & Claridge, 2016, 2018; Guo, Chen, & Mehta, 2017; Park, Lee, & Chen, 2012; Shanafelt et al., 2016), authors of a recently published systematic review reported workflows may improve over time as health staff become more familiar with digital systems (Baumann et al., 2018).

A large proportion of nursing research examining the association of workload around digital health record implementation uses observational approaches. Hence, there is a plethora of prospective before and after studies evaluating the implementation of digital data management systems in health care settings (Hakes & Whittington, 2008; Lee et al., 2008; Munyisia, 2011; Munyisia et al., 2012; Smith et al., 2005). These include time and motion studies (Hollingworth et al., 2007; Mallidou, Cummings, Schalm, & Estabrooks, 2013; Qian et al., 2012), and work sampling methods (Hakes & Whittington, 2008; Lee et al., 2008; Munyisia, 2011; Munyisia et al., 2012), that calculate how clinician time is distributed among the various types of clinical and non-clinical activities (Zheng, Guo, & Hanauer, 2011). The continuous time and motion approach is considered the preferred approach in healthcare (Finkler, Knickman, Hendrickson, Lipkin, & Thompson, 1993; Lopetegui et al., 2014; Schenk et al., 2017), due to its reliable method of quantifying clinician time utilisation and allocation to different work tasks, as compared to other methods such as work sampling and questionnaires (Zheng et al., 2011). However the design, conduct and reporting of results of time and motion studies is often deficient, reducing the validity and reliability of results (Zheng et al., 2011). Despite these past deficiencies, when rigorously conducted, time and motion studies offer the potential to provide detailed understanding of the changes associated, and benefits achieved, with the implementation of electronic health records.

Aims

The objective of this research was to describe nurse time spent in direct and indirect patient care activities, ward activities, documentation, personal and miscellaneous activities prior to, and following a hospital rollout of an integrated electronic health record (iEHR) and medication ordering management system using a standardised, replicable approach. The specific aims of the study were to observe, measure and compare:

1. nurse time over an entire clinical shift, including the preparation and administration of ordered medications (referred to as *NurseTime*), following the implementation of the iEHR in the surgical division;
2. nurse time during a morning medication round, comprising the preparation and administration of ordered medications for patients (referred to as *MedTime*), following the implementation of the medication ordering component of the iEHR in the medical division.

Design

A continuous observation time and motion approach (Lopetegui et al., 2014), where observers independently recorded patient care provided by direct-care nurses prior to and following a hospital roll-out of an iEHR data management system, was used. In this study, continuous time and motion was defined as the real-time external observation and recording of the time and activities undertaken by nurses during a clinical shift or medication round.

While the STROBE Statement has been used to report the outcomes of this continuous time-motion study (von Elm et al., 2007), the Suggested Time and Motion

Procedures (STAMP) (Zheng et al., 2011), provided a checklist for its development and implementation. The procedures were specifically developed to improve the consistency of the design, conduct and reporting of results for time-motion studies implementing electronic systems into clinical health settings. The resulting checklist comprises 29 items organised into eight key areas that outline data and information elements for researchers to consider when developing, undertaking and reporting time-motion studies (Zheng et al., 2011). An additional section titled ‘Ancillary Data’, included elements (interruption, interaction and location) identified and described by the authors as important contextual factors when evaluating the impact of digital systems in healthcare (Zheng et al., 2011). These elements can provide an insight into the spatial movements of clinicians within the physical environment of the ward.

Setting

Nursing Directors in the Divisions of Surgery and Medicine at a tertiary hospital in southeast Queensland, Australia (110,226 patient admissions in the 2016-2017 financial year), funded the study (Queensland Government, 2017). They were interested to see if the implementation of an iEHR (a comprehensive patient information system, where all elements of patient assessment, treatment and outcomes are accessible in one record) would change nurses activities related to patient care over the entire clinical shift (in the Division of Surgery) and more specifically, in the preparation and administration of ordered medication (in the Division of Medicine).

The majority of computers purchased for the iEHR roll-out were mounted onto workstations on wheels (referred to as ‘WOWs’) that could be easily moved around bed areas. Each ward in the hospital was allocated 8 to 10 WOWs to minimise workflow disruption for clinicians. Clinicians could access any computer in the ward via their work email address and password which enabled them to access the iEHR application. As the iEHR roll-out progressed, staff identification cards were programmed to enable convenient touch-on/touch-off access to the iEHR application according to scope of practice.

The rollout of the EHR was completed in two phases. This ensured clinicians had the appropriate training and support to manage the change as well as maintaining the safety of patients. Data collection was completed at time points considered optimal by the nursing executive to reflect practice changes. The study site commenced training 11 months prior to implementation of the iEHR, from January to November 2015. The period immediately following the implementation of the first and second phases (known as PowerChart and Medication, Anaesthetics and Research Support), was augmented with on-the-floor technical support appropriate to the clinical context 24-hours a day for 4-6 weeks.

Nurse participants

Direct-care nurse participants were recruited from the surgical and medical wards for each episode of observation. Nursing executive and nurse managers responsible for direct patient-care activities were notified about the study at divisional meetings. Nurse managers then disseminated information about the study including the inclusion and exclusion criteria, to direct-care nurses in their respective clinical areas via corporate email and/or staff meetings. Nurses who expressed an interest in participating in the study and met the inclusion criteria were approached by the trained nurse observer and provided with information about the study.

Eligible participants comprised full-time, part-time or casually employed direct-care nurses at the study site. External agency nurses were excluded. Once consent was provided, nurse participants were invited to complete a brief demographic survey about their role, age, gender, highest educational qualification, years of practice and work status (full-time, part-time or casual).

As identified in Figure 1, each observation of a consenting direct-care nurse was completed by a nurse observer. Continuity of direct-care nurse participants across the pre- and post-phases of the study was not possible and required additional recruitment of nurses in post-intervention phases of the study. This was due to the constant motion around shift work and 24-hour care in the health care workforce. Hence, there was constant variability of direct-care nurses working at any given time due to the high degree of part-time employment, secondment and leave (Australian Institute of Health and Welfare (AIHW), 2013; Health Workforce Australia (HWA), 2015).

Nurse observers

Nurse observers were baccalaureate-prepared registered nurses employed at the participating hospital. Observers were recruited via an expression of interest process that required the approval of their ward managers. Following recruitment, they were allocated shifts based on their availability and did not undertake observation of direct care activities in their home wards to avoid bias. While it was not possible to guarantee the same observers were available for all phases of the study, only five nurse observers were required for all data collection periods. This enabled continuity in observer training prior in each phase to ensure consistency of observation and documentation.

Prior to the commencement of each pre- and post-observation phase, observers were oriented to the study protocol and consent process before practicing data-collection for 15-minute intervals in a ward setting under the guidance of the principal investigator. Data collected during these practice sessions were compared between observers for accuracy with attention given to consistent timing and coding of activities observed. Documentation and techniques of data collection were refined, and the process repeated until data collection consensus amongst observers was achieved.

Observations consisted of one nurse observer discreetly shadowing one consenting direct-care nurse while they undertook care activities for their patients on the ward.

Using the categories from Table 1, nurse observers coded and timed each activity as it was undertaken, whilst considering additional elements such as multi-tasking and location using a customised data collection tool. A stopwatch, attached to the form, ran continuously, allowing the nurse observer to note the time and code the care activity or activities. A laminated template of the coded activities was provided as a visual guide to support observers use the tool efficiently and accurately, which nurse observers quickly memorised. Activities were measured in minutes and seconds.To limit fatigue, observers had the opportunity to rest during the observation phase by taking breaks with the participating direct-care nurses during morning-tea and lunch.(Abbey, Chaboyer, & Mitchell, 2012). Data from the collection tool were entered by the same nurse observer into an excel spreadsheet soon after the observation, and any discrepancies in the data discussed with the principal investigator.

While nurse observers could openly interact with nurse participants when needed and appropriate, strategies for identifying, responding and reporting unsafe practice were outlined. Depending on the seriousness of the observed care and the context in which it occurred, strategies included speaking discretely but candidly to the direct-care nurse, purposeful intervention in the episode of care, and/or reporting the unsafe practice to the nurse manager and/or principal investigator for follow-up. In the instance of a medical, internal and/or external emergency, nurse observers were advised to cease the observation and be guided by the senior nursing clinician on the ward to remove themselves from the area or assist in care activities and/or an evacuation.

Table 1: *Major categories organised into codes, and care activities described*

Category	*Code*	*Observable care activities* (Urden & Roode, 1997; Pelletier & Duffield, 2003)
Direct care All nursing care activities performed in the presence of the patient and/or family such as assessing patient needs, hygiene cares, ambulation, administration of medications, treatments and procedures, specimen collection, nutrition, elimination, transportation of patients and interaction/communication with patients and their family for planning care, education, intervening and evaluation.	1	Assessment (of patient needs)
	2	Hygiene cares (bathing, grooming)
	3	Ambulation (patient mobility)
	4	Preparation and administration of medications (including IV fluids)
	5	Treatments and procedures
	6	Specimen collection (obtaining and testing)
	7	Nutrition (eating)
	8	Elimination (toileting)
	9	Transportation of patients
	10	Interaction/communication with patient/family (for planning care, education, intervention and evaluation) in person or via the telephone
	11	Interaction/ /communications with the multi-disciplinary team necessary for task execution (in person, by telephone, via computerized system)
Indirect care All nursing care activities done away from the patient but on a specific patient's behalf, including interaction/communication with the multidisciplinary team necessary for task execution, verbal reporting at handover, preparing medications, preparing equipment and gathering supplies,	12	Verbal reporting (handover)
	13	Preparing equipment
	14	Ward meetings
Ward related Activities related to general maintenance of the nursing unit. They are not patient specific and include duties such as attendance to ward meetings, participation in teaching and education sessions, clerical work, ordering supplies, checking equipment, cleaning and running errands.	15	Participation in teaching and education sessions (in-service)
	16	Clerical work
	17	Ordering (and re-stocking) supplies, checking equipment
	18	Cleaning
	19	Errands (out of the ward/unit)
	20	Looking for documentation (bed-side chart, health progress notes)
Documentation All activities associated with documenting, reviewing, or evaluating patient condition and care, which require correlation of interdisciplinary data and nursing judgment, and the action of documenting. These activities include looking for charts, preparing admission and discharge notes, health progress notes, bedside chart entry, computer data entry, and computer retrieval of information and results.	21	Admission and discharge notes
	22	Health progress notes
	23	Bed-side chart entry
	24	Computer data entry
	25	Computer retrieval of information and results
Personal Personal activities not related to general maintenance of the nursing unit. Activities related to meals, breaks, adjusting personal schedules, personal phone calls and socialising with co-workers.	26	Personal activities
Miscellaneous Post-implementation considerations	27	Any computer issues (difficulties logging in, calling for support to fix computer problems)

* Hand hygiene

Variables

Care activities were primarily based upon the five care categories as described by Urden & Roode (1997), which were contemporised and adapted to the health setting of interest using the work of Pelletier & Duffield (2003). *Direct cares* refer to all nursing activities performed in the presence of the patient and/or their family including assessment, hygiene care, assistance with ambulation, nutrition, elimination, preparation and administration of medications, treatment and procedures, and communication with the patient, family and colleagues. *Indirect cares* are nursing activities that take place away from the patient and include interaction/communication with the multidisciplinary team (MDT) necessary for task execution, verbal reporting at handover, preparation of medications and equipment, and gathering supplies. *Ward related* activities include general maintenance of the nursing unit, attendance to ward meetings and participation in teaching and education sessions (referred to colloquially as ‘in-service’ sessions, where information about new practices, procedures or medications is disseminated), cleaning, ordering and running errands. *Documentatio*n refers to all activities associated with documenting, reviewing, or evaluating patient condition and care, which require cross-checking with multidisciplinary data and nursing judgment, as well as writing/entering notes, retrieving information from paper sources or electronic databases and looking for paper records or a computer to enable documentation. *Personal* activities describe meal breaks, adjusting personal schedules, personal phone calls and socialising with co-workers. (Refer to Table 1.) An additional category *Miscellaneous*, was included to record episodes of hand hygiene, and to acknowledge computer-related problems.

In their STAMP guidelines, Zheng and colleagues also acknowledged *additional elements* inherent in complex health environments that may influence care activities. These included interruption (where an unplanned task disturbs the workflow of a prior task) and location (where activities took place) (Zheng et al., 2011). Nurses in fast-paced clinical settings also frequently multi-task (where two or more activities occur concurrently during an episode of clinical care (Abbey et al., 2012)), or consecutively task (undertake individual tasks in quick succession). As such, multi-tasking and consecutive tasking were included as additional elements to identify these difficult-to-observe and code workflows.

Data collection

The larger component of the study (*NurseTime*) took place in all inpatient wards in the surgical division where up to 290 patients receive care. The division caters for a large metropolitan population, with referrals from its home state of Queensland, interstate and overseas. It has 23 operating theatres, 11 inpatient wards, and a 26-bed intensive care unit.

As outlined in Figure 1, an allocated nurse observer charted the activities of a consenting direct-care nurse for an entire shift in each of the 11 surgical wards. This occurred in the pre-intervention phase prior to the implementation of the PowerChart component of the iEHR (November 2015), and the first post-observation phases following implementation of PowerChart (Post1, July-August 2016) and later, the Medication, Anaesthetics and Research Support (MARS) system (Post2, July 2017), for a total of 33 observations. Observations took place during the day shift, Monday to Friday, where staffing ratios of one nurse to four patients were legislated. The day shift commenced at 7 am and was usually eight hours in duration excluding morning-tea and lunch breaks. It is considered the busiest shift in the 24-hour period due to procedures, diagnostic testing, and nursing follow-up with the multi-disciplinary team.

In the medical division, *MedTime* observations occurred Monday to Friday during the designated morning medication round in three participating wards prior to (February-March 16, 2017) and following the implementation of the PowerChart and MARS systems (July 2017) for a total of 18 observations. As morning medication rounds can vary in time, three rounds of observations were completed (i.e., observation of a medication round each day for three days in each ward), prior to, and two following the implementation of the MARS to ensure an accurate representation (refer to Figure 1). The duration of observations varied, depending upon the number of medications ordered for patients allocated to the nurse observed.

Although *MedTime* represented the smaller component of the study, the medical division had 15 in-patient wards catering for over 290 patients, and 20 outpatient/procedural services. Three clinical settings were chosen based on their varied patient profiles, care activities and average length of stay. They included a 26-bed geriatric assessment and rehabilitation unit for long-term therapy, a 28-bed internal medicine ward specialising in patients with hypertension acute general medical conditions, and a 30-bed short-stay medical assessment and planning unit, used for the treatment of patients admitted through the emergency department.

Date	*Division of Surgery*	*Division of Medicine*
November, 2015	*Pre-PowerChart observation* 1 direct-care nurse x 1 Day shift in 11 units* (totalling 11 nurses) N = 1,961 activities	
November-December, 2015	PowerChart GO-LIVE	
July-August, 2016	*Post-PowerChart & Pre-MARS[+]observation* 1 direct-care nurse x 1 Day shift in 11 units (totalling 11 nurses) N = 1,756 activities	
February-March, 2017		*Pre-MARS* observation* 1 direct-care nurse x 3 Med rounds in 3 units (totalling 9 nurses) N = 268 activities observed
March-April 2017	MARS GO-LIVE	
July-July 2017	*Post-PowerChart/MARS* observation phase* 1 direct-care nurse x 1 Day shift in 11 units (totalling 11 nurses) N = 1,964 activities observed	*Post-MARS* observation* phase 1 direct-care nurse x 3 Med rounds in 3 units (totalling 9 nurses) N = 260 activities observed

Figure 1: Flow chart of data collection

* The same direct-care nurses were not followed for each data collection period due variability of direct-care nurses working at any given time

[+]MARS = Medication, Anaesthetics and Research Support

Data collection in both divisions involved: 1) independent observation of activities; 2) timing of observed activities; 3) categorising activities according to type and; 4) where possible, description of activity and location. Table 1 outlines the list of 1 - 27 activity codes (including an asterisk used for coding observed episodes of hand hygiene). The data collection form was updated following the implementation of the iEHR to include categories related to computer use such as computer data entry, computer retrieval of information and results and computer issues related to difficulties logging in, calling for support to fix computer problems.

Study size

In previously reported observational studies undertaken in clinical settings, 10 observations consisting of approximately 80 hours of data were reported (Abbey et al., 2012; Qian et al., 2012; Thorpe-Jamison, Culley, Perera, & Handler, 2013). This study completed an estimated total of 240 hours of observations.

Data analysis

All analyses were completed using Stata13 (Statacorp, Texas). Descriptive statistics included frequency and percentages for categorical data and medians for continuous data. Where multiple tasks were completed during the same observation, the time of each activity was calculated by dividing the recorded observed time by the number of documented activities. The number of activities was increased by one if an interruption was recorded and decreased by one if the activities were recorded as multi-tasking for each observation.

The time taken, and number of activities observed were summed for each of the pre- and post-intervention observation phases. Significance of differences between the pre and post-intervention observation phases for the numbers of activities were estimated using chi-squared or exact tests and for the time taken to complete activities, estimated using a nonparametric K-sample test on the equality of medians. To reduce the possibility of false-positive findings, multiple testing between data collection periods was not conducted. A 0.05 level of significance was used for all analyses.

Ethical considerations

Ethics approvals were received from the Metro South and Griffith University Human Research Ethics Committees (HREC/15/QPAH/619, GU/2015/812). There were no anticipated risks of harm to direct-care nurse as a result of their participation. Nurses who provided informed consent were advised that they could withdraw from the study at any time, and that withdrawal would not jeopardise their relationship with the hospital or researchers.

Similarly, there was no anticipated risk of harm to patients or their proxy/family members as a result of their indirect involvement. They were not the focus of the study and, no data were collected from them. The nature of the research design required a nurse observer to unobtrusively observe a direct-care nurse undertake their care activities of four or more patients located in an individual room, a two or four-bed bay or a combination of these. It was therefore not practical to obtain patient or family member consent without potentially interrupting nurse workload and care priorities and compromise the quality of the observation obtained. However, this did not prevent the direct-care nurse, patients or family members speaking to or asking questions of the nurse observer.

At all times the health and well-being of patients and their proxy/family member were a priority for both the direct-care nurse caring for them, and the nurse observer respected and maintained patient confidentiality at all times during the observation, as per their overarching professional and ethical responsibilities as mandated by the Nursing and Midwifery Board of Australia and the Australian Health Practitioner Regulation Authority. Where appropriate, the nurse observer also ensured the physical privacy of patients during their observation activities.

Findings

Fifty-one direct-care nurses were observed for the duration of an entire clinical shift or during a medication round with a total of 6,209 activities observed in both divisions. There were no reported incidences of harm to patients, direct-care nurse participants or unsafe practice. Thirty-three direct-care nurses were observed in 11 in-patient surgical wards (i.e., one nurse per ward) at three separate data-collection time points (Pre, Post1, Post2) for 5,681 observed activities. Eighteen direct-care nurses were observed on three occasions in three wards (i.e., one nurse per medication round) at two data-collecting time points (Pre and Post) in the medical division for a total of 528 observed activities (refer to Figure 1).

Nurse participants were mainly female (n = 48, 94%), between the ages of 26 and 35 years (n = 31, 60%), with a Bachelor’s degree (n = 40, 78%), and 5 to 10 years of clinical practice experience (n = 29, 57%). Work status was equally distributed with 43% (n = 22) full-time and 55% (n = 28) part-time employees (refer to Table 2).

Table 2: *Characteristics of direct-care nurse participants*

Characteristic	Total *n* = 51	NurseTime (DOS*) *n* = 33	MedTime (DOM**) *n* = 18
Role - *n* (%)			
Registered Nurse	42 (82)	31 (94)	11 (61)
Clinical Nurse	6 (12)	2 (6)	4 (22)
Endorsed Enrolled Nurse	3 (6)	-	3 (17)
Age (categorised in groups) - *n* (%)			
20-25 years	5 (10)	3	2
26-30 years	16 (31)	14	2
31-35 years	15 (29)	7	8
36-40 years	5 (10)	2	3
50-55 years	2 (4)	2	-
60-65 years	1 (2)	-	1
Missing data	7 (14)		
Gender – *n* (%)			
Female	48 (94)	31	17
Male	3 (6)	2	1
Highest education qualification – *n* (%)			
Certificate	1 (2)	-	1
Diploma	3 (6)	2	2
Bachelor’s Degree	40 (78)	25	14
Graduate Certificate	1 (2)	1	-
Master’s Degree	6 (12)	5	1
Years of practice (categorised in groups) – *n* (%)			
0.5-4 years	10 (19)	7	3
5-10 years	29 (57)	18	11
11-16 years	4 (8)	4	-
20+ years	5 (10)	2	3
Missing data	3 (6)		
Work status – *n* (%)			
Full-time	22 (43)	17	5
Part-time	28 (55)	16	12
Casual	1 (2)	-	1

*Division of Surgery,**Division of Medicine

The majority nursing activities in the division of surgery, occurred at the bedside prior to (n = 1,170, 60%) and following the implementation (Post1 n = 1,047, 60%, Post2 n = 1,194, 61%). This was somewhat replicated in the division of medicine, with bedside activities comprising 60% (n = 161) of nurses’ time Pre-iEHR and 47% (n = 123) Post-iEHR with increased time in the medication room (n= 40, 15%) to integrate the scanning of prescribed medications into the workflow. Consecutive tasking was observed in 4-9% of tasks in the surgical division and 55% of preparation and administration of ordered medication tasks in the medical division. In the surgical division, multi-tasking was observed in 22-31% of activities, and interruption in 6-11% observed episodes of care. In the medical division, multi-tasking and interruption were observed in 7% of observed care activities.

In the surgical division, frequency of direct care activities (such as assessing patient needs and preparing and administering ordered medications) and ward related activities (such as a participation in teaching and education sessions, ordering supplies and checking equipment, cleaning, and looking for documentation or a computer) decreased significantly (p = <0.001). However, the median duration of these activities increased significantly, particularly for the Post1 data collection period (refer to Table 3), although levelled-out for some activities in Post2. The number of activities for indirect care (such as verbal reporting/handover, preparing equipment and ward meetings) also increased, although there was a downward trend in their median duration in Post2. Documentation increased significantly in the number of Post2 activities and median duration in Post1 (p = <0.001). although there was no real change between the Pre- and Post2 periods, again suggesting a levelling-out (Personal activities are reported with observable care activities - refer to Table 4.)

Table 3: Association between the phase of observed care in surgical wards and the number and median duration taken to complete activities[a], by care group

	Pre (n=3642)	Post1 (n=3312)	Post2 (n=3452)	P value[1]	Pre	Post1	Post2	P value[2]
Activity	Number (%)				Median time in minutes			
Direct care	2446 (62)	2312 (70)	2073 (60)	<0.001	1.16	1.37	1.17	<0.001
Indirect care	228 (6)	190 (6)	285 (8)	0.010	1.03	1.16	0.49	0.015
Ward related	182 (5)	126 (4)	112 (3)	<0.001	0.44	1.03	0.55	0.004
Documentation	453 (12)	431 (13)	650 (19)	<0.001	0.58	1.21	0.59	0.002

[1]p value estimated using chi^2 test, [2] p value estimated using median test of total duration of grouped activities
[a] Number of activities completed during total observed duration (1 nurse observed during 8-hour day shift on 11 surgical wards)

Table 4: Frequency, percentage[a] and duration to complete activities on surgical units during day shift[b] ; 1) pre implementation of the electronic health record; 2) post implementation of the integrated Electronic Health Record (iEHR), (PowerChart)and 3) post introduction of the Medication, Anaesthetics and Research Support (MARS) system

	Surgical								
	Total	Pre (n = 1899)	Post1 (n = 1756)	Post2 (n=1888)	P value[1]	Pre	Post1	Post2	P value[2]
Activity		Number (%)				Median time in minutes			
1 = Assessment of patient needs	574 (10)	241 (12)	177 (10)	156 (8)	0.001	0:46	1:03	1:02	0.02
2 = Hygiene cares	218 (4)	62 (3)	80 (5)	76 (4)	0.09	1:27	1:06	1:05	0.66
3 = Ambulation	202 (4)	69 (4)	70 (4)	63 (3)	0.44	0:58	1:16	1:16	0.14
4 = Preparation and admin of medications	949 (17)	332 (17)	305 (17)	312 (16)	0.46	0:59	0:55	0:45	0.01
5 = Treatment and procedures	213 (4)	85 (4)	57 (3)	71 (4)	0.20	1:35	1:38	1:03	0.43
6 = Specimen collection	37 (1)	15 (1)	16 (1)	6 (0.3)	0.05	1:31	1:20	1:59	0.16
7 = Nutrition	77 (1)	30 (2)	28 (2)	19 (1)	0.18	0:56	1:04	0:48	0.56
8 = Elimination	98 (2)	32 (2)	35 (2)	31 (2)	0.58	0:17	0:55	0:50	0.01
9 = Transportation of patients	41 (1)	12 (1)	18 (1)	11 (1)	0.19	3:24	2:07	5:20	0.29
10 = Interaction/communication with patient/family, in person or via the telephone	2081 (37)	721 (37)	689 (39)	671 (34)	0.01	0:50	0:58	0:54	0.03
11 = Interaction/communications with the MDT team necessary for task execution	2341 (41)	847 (43)	837 (48)	657 (33)	<0.001	0:49	1:02	0:51	<0.001
12 = Verbal reporting	257 (5)	76 (4)	84 (5)	97 (5)	0.23	2:11	1:35	1:15	0.03
13 = Preparing equipment	443 (8)	150 (8)	106 (6)	187 (10)	<0.001	0:52	0:59	0:44	0.04
14 = Ward meetings	-	-	-	-	-	18:39	No obs	No obs	
15 = Participation in teaching and education sessions	40 (1)	26 (1)	9 (1)	5 (0.3)	<0.001	0:48	2:49	28:42	0.003
16 = Clerical work	20 (0.4)	11 (1)	5 (0.3)	4 (0.2)	0.14	1:00	1:07	1:12	0.37
17 = Ordering, restocking supplies, checking equip.	43 (1)	5 (0.3)	17 (1)	21 (1)	0.01	1:19	1:03	0:49	0.27
18 = Cleaning	255 (4)	106 (5)	71 (4)	78 (4)	0.05	0:35	1:07	0:56	<0.001
19 = Errands (out of the ward/unit)		3	0	0		2:02	No obs	No obs	
20 = Looking for documentation or computer	59 (1)	31 (2)	24 (1)	4 (0.2)	<0.001	0:55	0:44	0:32	0.21
21 = Admission and discharge notes	16 (0.3)	7 (0.4)	7 (0.4)	2 (0.1)	0.17	1:22	3:06	3:52	0.28
22 = Health progress notes	117 (2)	52 (3)	28 (2)	37 (2)	0.06	1:38	2:54	2:38	0.42
23 = Bed-side chart entry	501 (9)	378 (19)	122 (7)	1 (0.1)	<0.001	0:52	0:50	0:34	0.60
24 = Computer data entry	462 (8)	9 (0.5)	163 (9)	290 (15)	<0.001	0:34	1:24	0:58	<0.001
25 = Computer retrieval or information and results	435 (8)	7 (0.4)	111 (6)	317 (16)	<0.001	1:31	1:14	0:43	<0.001
26 = Personal activities	285 (5)	70 (4)	82 (5)	133 (7)	<0.001	4:13	3:33	1:20	0.001
27 = Computer problems	77 (1)	15 (1)	53 (3)	9 (0.5)	<0.001	1:07	1:24	1:14	0.54
28 = Hand hygiene	562 (10)	250 (13)	118 (7)	194 (10)	<0.001	0:20	0:28	0:28	<0.001

[a] Number of activities completed during total observed duration (1 nurse observed during 8-hour day shift on 11 surgical wards); [b] Commencing on most wards/units from 7am

[1] p value estimated using chi^2 or Fisher's exact test, [2] p value estimated using median test of duration

In the medical division, there was a decrease in direct and ward related care activities with a non-significant increase in the number of observed episodes for indirect care. Documentation had significant increases in number of activities (p = <0.001), with a corresponding increase in median duration (p = 0.001) (refer to Table 5). (Personal activities reported with observable care activities – refer to Table 6.)

Table 5: Association between the phase of observed care during medication rounds and the number and median duration taken to complete activities[a], by care group.

Activity	Pre (n = 593)	Post (n = 597)	P value[1]	Pre	Post	P value[2]
	Number (%)			Median time in minutes		
Direct care	389 (66)	370 (62)	0.62	1:26	1:57	0.10
Indirect care	33 (6)	37 (6)	0.52	1:04	0:58	0.81
Ward related	31 (5)	15 (3)	0.018	0:40	0:41	1.00
Documentation	80 (13)	125 (21)	<0.001	0:54	1:33	0.001

[1]p value estimated using chi^2 test, [2] p value estimated using median test of total duration of grouped activities

[a] Number of activities completed during total observed duration (3 nurses observed completing medication rounds on 3 medical wards prior to and after the introduction of the MARS)

Observable care activities in the surgical division such as assessment of patient needs, interaction with family, elimination care and hand hygiene increased in duration from pre-implementation of the iEHR to post-implementation (refer to Table 4). Activities that decreased in duration included the preparation and administration of ordered medications, verbal reporting, computer retrieval of information and personal activities related to meals, breaks, adjusting personal schedules, personal phone calls and socialising with co-workers (Pelletier & Duffield, 2003; Urden & Roode, 1997). Activities with inconsistent duration across the two post implementation periods included ambulation, treatment and procedures, specimen collection, transportation of patients, interaction with the MDT, preparing equipment, participation in teaching and education sessions, ordering and restocking supplies, cleaning, computer data entry, retrieval of information and results, and computer problems. Activities with no change in duration included hygiene care activities, clerical work, looking for documentation or a computer, admission, discharge and health progress notes as well as bedside chart entry.

The main care activities of direct-care nurses observed during medication rounds in the medical division were interaction and communicating with patients, followed by the preparation and administration of ordered medications. Ambulation of patients increased in

the number of activities and significantly in time following the implementation of the MARS system (refer to Table 6). The activity with the longest duration was verbal reporting.
The greatest difference before and after the introduction of the MARS in the medical wards was that bed-side chart entry activities decreased from 24% to 0.4% while computer data entry (4% to 26%) and computer retrieval of information and results increased significantly (2% to 22%). Similarly, for direct-care nurses on the surgical wards, the percentage of bed-side chart entries dropped from 19% to 0.1% and computer data entry increased from 0.5% to 15% over time (refer to Table 4). Approximately 80% of activities involved interaction with patients or with members of the MDT during medication rounds in the medical wards, or during a complete shift in surgical wards. Activities that decreased or did not occur at all during the medication round included nutrition, specimen collection, transport participation in teaching and education sessions, admission, progress and discharge notes and ward related errands.

Discussion

Direct-care nurses undertaking 33 shifts of care in surgical wards and 19 medication rounds in medical wards were observed using a structured observation tool prior to and following the phased implementation of an iEHR. As anticipated, bed-side paper-based chart-entry declined significantly following the implementation, and computer data-entry significantly increased in both divisions. The reduction in the number of referral and documentation points that characterised the pre-iEHR context, where clinicians referred to multiple sources to collect and report information may also explain both the increase in computer data entry and decreased computer retrieval of information and results post-iEHR implementation.

Findings suggest rapid adaptation to the iEHR by clinicians. This is particularly evident in the division of surgery data which demonstrated significant changes in median times for direct care, ward related and documentation activities in Post1 before levelling in Post2. Significant increases or decreases in some direct care activities and median times are therefore understandable within the context of iEHR roll-out. For example, the number of interactions/communications with MDT decreased significantly post-iEHR, while their median duration increased in both divisions. Given all members of the MDT could

Table 6: Frequency, percentage and duration to complete activities[a] on medical units during medication rounds, pre- and post- the introduction of Powerchart andMARS.

	Medical					
	Pre (n = 268)	Post (n = 260)	P value[1]	Pre	Post	P value[2]
Activity		Number (%)			Median time in minutes	
1 = Assessment of patient needs	41 (15)	31 (12)	0.26	1:12	1:31	0.15
2 = Hygiene cares	1 (0.4)	1 (0.4)	0.98	0:45	1:11	1.00
3 = Ambulation	16 (6)	20 (8)	0.43	0:44	1:31	**0.01**
4 = Preparation and admin of medications	101 (38)	99 (38)	0.93	0:59	1:13	0.16
5 = Treatment and procedures	1 (0.4)	4 (2)	0.17	2:08	2:57	0.82
6 = Specimen collection	0	0				
7 = Nutrition	11 (4)	4 (2)	0.08	0:54	0:47	0.67
8 = Elimination	4 (1)	3 (1)	0.73	0:29	0:46	0.74
9 = Transportation of patients	0	0				
10 = Interaction/communication with patient/family, in person or via the telephone	123 (46)	116 (45)	0.77	0:52	1:12	**0.02**
11 = Interaction/communications with the multi-disciplinary team necessary for task execution	91 (34)	92 (35)	0.73	0:53	0:54	0.94
12 = Verbal reporting	12 (4)	14(5)	0.63	8:07	6:18	0.69
13 = Preparing equipment	21 (8)	23 (9)	0.68	0:29	0:40	0.55
14 = Ward meetings	0	0				
15 = Participation in teaching and education sessions	0	0				
16 = Clerical work	4 (1)	1 (0.4)	0.19	0:29	0:41	0.82
17 = Ordering, restocking supplies, checking equip.	2 (0.8)	0 (1)	0.16	2:42		
18 = Cleaning	20 (7)	12 (5)	0.17	1:08	1:19	0.72
19 = Errands (out of the ward/unit)	0	0				
20 = Looking for documentation or computer	5 (2)	2 (1)	0.27	0:55	0:57	0.55
21 = Admission and discharge notes	0	0				
22 = Health progress notes	0	0				
23 = Bed-side chart entry	64 (24)	1 (0.4)	**<0.001**	1:01	0:58	0.99
24 = Computer data entry	11 (4)	67 (26)	**<0.001**	1:08	1:27	1.00
25 = Computer retrieval or information and results	5 (2)	57 (22)	**<0.001**	3:20	2:00	1.00
26 = Personal activities	3 (1)	4 (2)	0.67	1:13	0:32	0.74
27 = Computer problems	1	1		0:33	0:52	
28 = Hand hygiene	56 (21)	45 (17)	0.30	0:51	1:04	0.50

[a] Number of activities completed during total observed time (3 nurses observed completing medication rounds on 3 medical wards prior to, and after the introduction of the MARS); [1] p value estimated using chi^2 or Fisher's exact test, [2] p value estimated using median test of duration.

simultaneously access all elements of a patient's record from any computer in the hospital at any time, the need for frequent, short interactions (such as cross-checking information, making verbal requests or 'chart-chasing') were no longer necessary. Where interactions/communications did occur, they may have been enhanced and longer in duration given team members had easier access to comprehensive patient information due to their digital integration. This centralisation of data may therefore explain workflow changes and reallocation of time where activities such as assessment of patient needs, interaction with family, assistance with elimination and hand hygiene in the division of surgery, and ambulation in the division of medicine, increased in duration.

Interventions related to documentation in paper-based health systems have traditionally taken the most time for nurses. However, there is also some evidence that documentation via digital health records is time consuming. In their time and motion study of digital health records Schenk and colleagues reported a significant increase in the total percentage of time nurses spent on documentation with 18.8% spent prior to and 21.3% following the rollout ($\chi 2$ =9.9, P= .002) (Schenk et al., 2018). These findings are supported in the literature (Baumann et al., 2018; Earls et al., 2017; Golob et al., 2018; Park et al., 2012), that identify issues such as delayed or incomplete documentation (Golob et al., 2016; Park et al., 2012), frequent interruption/distraction (Shanafelt et al., 2016), and poor user-interface that requires more clicks to access relevant data and pages (Guo et al., 2017). The culmination of these factors is clinical dissatisfaction and burnout among clinicians. (Earls et al., 2017; Golob et al., 2016; Guo et al., 2017; Park et al., 2012; Shanafelt et al., 2016), and a perceived shift away from a fundamental interaction with patients (Henry, 2017; Shanafelt et al., 2016). However there is recent evidence that clinicians can adapt to digital health record systems, resulting in decreased documentation burden over a longer period of time (Baumann et al., 2018).

In the context of this study, there was a focused and long-term schedule of training for effective use of the iEHR for all clinicians at the participating hospital, an approach supported in the literature (Nguyen et al., 2014; Rantz et al., 2011). Training commenced 11 months prior to rollout of the iEHR, with on-the-floor technical support 24-hours a day during the implementation, and ongoing permanent support post-implementation. Trainers were clinicians who were able to translate and contextualise the iEHR with existing workflow and documentation practices to direct-care nurses and other members of the MDT. This training and support strategy may have contributed to the increase in median time of activities, some of which were significant (interaction and communication with the multidisciplinary team, cleaning, and computer data entry), reinforcing the initial adaptation to the digital platform which levelled-out in the second phase of the roll-out, six to seven months later. Nguyen and colleagues (Nguyen et al., 2014), attribute this adaptation to effective training and technical assistance prior to and during implementation in their evaluation of iEHR implementation.

Time efficiencies at the bedside may have also resulted from this focused readjustment of workflow and a decrease in interruptions and multi-tasking. Some authors report direct-care nurses spend about 25% of their time communicating with members of the health team (Chaboyer et al., 2008). Interruptions in nursing are therefore viewed negatively due to their effect on mental workload (McCurdie, Sanderson, Aitken, & Liu, 2017), and potential impact on patient safety (McCurdie, Sanderson, & Aitken, 2018), particularly in relation to critical tasks such as the preparation and administration of ordered medication (McCurdie, Sanderson, & Aitken, 2017). However there is no evidence that these communication efficiencies that decrease interruptions and multi-tasking benefited patients directly (Nguyen et al., 2014).

There are increasing calls for greater clinician involvement in the development of digital health systems, to allow them to be tailored to context and existing workflows (Golob et al., 2016; Topaz et al., 2017), and promote alternative design options such as mobile devices (Guo et al., 2017). Other strategies include an advanced care team model where members of the MDT work together in decision-making and coordinate care to share the workload associated with electronic documentation (Shanafelt et al., 2016). Health Informatics should also be included in health curricular for undergraduate and post-graduate students within health disciplines (Habibi-Koolaee, Safdari, & Bouraghi, 2015), which may promote adaptation behaviours. However recent anecdotal evidence from the participating hospital indicates that graduate clinicians adapt easily to the iEHR but require training on how to use paper-based assessment tools and orders during digital downtimes.

Strengths and limitations

Nurses practise within established professional and evidence-based guidelines. However, individual clinicians undertake care activities differently, finding meaning in situations and acting with, and on behalf of their patients in unique ways, based on their personal beliefs, experiences and qualifications (Henry, 2017). It is extremely difficult to generalise the specific findings of this study to other clinical contexts due to complexities resulting from this myriad of settings and people within them. However, hospitals and health setting within the Australian context and beyond, may be able to benefit from this study.

Observations of nursing work, including continuous time and motion studies are also difficult to compare due to lack of a standardised approach (Schenk et al., 2017). However the adaptation of Zheng and colleague's Suggested Time and Motion procedure checklist (Zheng et al., 2011), enabled a standardised approach to measure, compare and describe nurse time spent in direct patient care prior to, and following the roll-out of the EHR, thereby making a valuable contribution to workflow analysis (Lopetegui et al., 2014). While we did slightly adapt their approach to include consecutive tasking, we felt this was relevant to context and enabled observers to code fast-paced activities while using paper-based data collection tools and stopwatches.

While a strong emphasis was placed upon seeking consensus regarding observation and coding of clinical practice and significant time training observers prior to each data-collection phase to ensure consistency, inter-rater reliability analyses of observation and documentation were not completed. This may have led to data measurement bias. Furthermore, some nurse observers may have become more proficient at recording observations reducing the number of consecutive observations over time and increasing the number of individually timed activities.

The presence of an observer, also a nurse employed at the study hospital, may have inadvertently resulted in a change in the behaviour of the nurse participants being observed, resulting in a Hawthorne Effect (Lopetegui et al., 2014). However, field notes taken by the nurse observers indicated that following an initial period of acute awareness of being watched, nurse participants soon carried out their patient care activities without apparent discomfort.

Conclusions

This research enabled real-time continuous time and motion observation and timing of activities undertaken by nurses during an episode of care where direct patient-care was provided. Findings suggest effective implementation of the digital platform from paper-based records to integrated electronic records in the context of interest. While there was no evidence the implementation of the iEHR increased nurse time at the bedside during an entire clinical shift or specifically during a medication round, it did show a significant trend of increased medium time for documentation and care activities following the implementation of the iEHR.

Often the largest group of health workers using iEHR and considered super-users, nurses should be included in decision-making about iEHR during development, implementation and evaluation phases.

The application of the STAMP provided an effective and standardised approach to guide design and the conduct of this study. Hence, this study contributed to workflow analysis within dynamic environments whilst simultaneously providing rich data on the impacts of implementation of an iEHR on nursing care. As such, it is hoped this study may contribute to the growing body of health research involving digital innovation.

Acknowledgements

The authors would like to thank the nurses who participated in the study: both the observers and the observed.

Funding

Participating divisions supported this study by providing in-kind time availability for the nurse observers.

Conflict of interest

No conflict of interest has been declared by the authors

References

Abbey, M., Chaboyer, W., & Mitchell, M. (2012). Understanding the work of intensive care nurses: A time and motion study. *Australian Critical Care, 25*(1), 13-22. doi:http://dx.doi.org/10.1016/j.aucc.2011.08.002

Australian Institute of Health and Welfare (AIHW). (2013). *Work characteristics of nurses and midwives*. Retrieved from Canberra: http://www.aihw.gov.au/workforce/nursing-and-midwifery/work-characteristics/

Baumann, L. A., Baker, J., & Elshaug, A. G. (2018). The impact of electronic health record systems on clinical documentation times: A systematic review. *Health Policy, 122*(8), 827-836. doi:https://doi.org/10.1016/j.healthpol.2018.05.014

Boonstra, A., Versluis, A., & Vos, J. F. (2014). Implementing electronic health records in hospitals: a systematic literature review. *BMC Health Serv Res, 14*, 370. doi:https://doi.org/10.1186/1472-6963-14-370

Boyer, L., Samuelian, J. C., Fieschi, M., & Lancon, C. (2010). Implementing electronic medical records in a psychiatric hospital: A qualitative study. *Int J Psychiatry Clin Pract, 14*(3), 223-227. doi:https://doi.org/10.3109/13651501003717243

Chaboyer, W., Wallis, M., Duffield, C., Courtney, M., Seaton, P., Holzhauser, K., . . . Bost, N. (2008). A comparison of activities undertaken by enrolled and registered nurses on medical wards in Australia: An observational study. *International Journal of Nursing Studies, 45*(9), 1274-1284. doi:https://doi.org/10.1016/j.ijnurstu.2007.10.007

Earls, S. T., Savageau, J. A., Begley, S., Saver, B. G., Sullivan, K., & Chuman, A. (2017). Can scribes boost FPs' efficiency and job satisfaction? *J Fam Pract, 66*(4), 206-214.

Farre, A., Bem, D., Heath, G., Shaw, K., & Cummins, C. (2016). Perceptions and experiences of the implementation, management, use and optimisation of electronic prescribing systems in hospital settings: protocol for a systematic review of qualitative studies. *BMJ open, 6*(7). doi:https://bmjopen.bmj.com/content/6/7/e011858

Finkler, S. A., Knickman, J. R., Hendrickson, G., Lipkin, M., Jr., & Thompson, W. G. (1993). A comparison of work-sampling and time-and-motion techniques for studies in health services research. *Health Serv Res, 28*(5), 577-597.

Furlong, K. E. (2015). Learning to Use an EHR: Nurses's stories. *Can Nurse, 111*(5), 20-24.

Gephart, S., Carrington, J. M., & Finley, B. (2015). A Systematic Review of Nurses' Experiences With Unintended Consequences When Using the Electronic Health Record. *Nurs Adm Q, 39*(4), 345-356. doi:10.1097/NAQ.0000000000000119

Golob, J. F., Jr., Como, J. J., & Claridge, J. A. (2016). The painful truth: The documentation burden of a trauma surgeon. *J Trauma Acute Care Surg, 80*(5), 742-745; discussion 745-747. doi:10.1097/ta.0000000000000986

Golob, J. F., Jr., Como, J. J., & Claridge, J. A. (2018). Trauma Surgeons Save Lives-Scribes Save Trauma Surgeons! *Am Surg, 84*(1), 144-148.

Guo, U., Chen, L., & Mehta, P. H. (2017). Electronic health record innovations: Helping physicians - One less click at a time. *Health Information Management, 46*(3), 140-144. doi:https://doi.org/10.1177/1833358316689481

Habibi-Koolaee, M., Safdari, R., & Bouraghi, H. (2015). Nurses readiness and electronic health records. *Acta Informatica Medica, 23*(2), 105-107. doi:10.5455/aim.2015.23.105-107

Hakes, B., & Whittington, J. (2008). Assessing the impact of an electronic medical record on nurse documentation time. *CIN: Computers, Informatics, Nursing, 26*(4), 234-241. doi:doi: 10.1097/01.NCN.0000304801.00628.ab.

Hardingham, L. (2004). Integrity and moral residue: nurses as participants in a moral community. *Nurs Philos, 5*(2), 127-134. doi:10.1111/j.1466-769X.2004.00160.x

Health Workforce Australia (HWA). (2015). *Nursing Workforce – Retention and Productivity Program*. Retrieved from https://www.hwa.gov.au/our-work/boost-productivity/nursing-retention-and-productivity-program

Henry, D. (2017). Rediscovering the Art of Nursing to Enhance Nursing Practice. *Nursing Science Quarterly, 31*(1), 47-54. doi:https://doi.org/10.1177/0894318417741117

Hollingworth, W., Devine, E. B., Hansen, R. N., Lawless, N. M., Comstock, B. A., Wilson-Norton, J. L., . . . Sullivan, S. D. (2007). The impact of e-prescribing on prescriber and staff time in ambulatory care clinics: a time motion study. *J Am Med Inform Assoc, 14*(6), 722-730. doi:10.1197/jamia.M2377

Houser, S. H., & Johnson, L. A. (2008). Perceptions regarding electronic health record implementation among health information management professionals in Alabama: a statewide survey and analysis. *Perspect Health Inf Manag, 5*, 6.

Humphries, N., Morgan, K., Conry, M. C., McGowan, Y., Montgomery, A., & McGee, H. (2014). Quality of care and health professional burnout: narrative literature review. *Int J Health Care Qual Assur, 27*(4), 293-307. doi:10.1108/ijhcqa-08-2012-0087

Katsma, C. P., Spil, T. A. M., Ligt, E., & Wassenaar, A. (2007). Implementation and use of an electronic health record: measuring relevance and participation in four hospitals. *International Journal of Healthcare Technology and Management, 8*(6), 625-643. doi:doi:10.1504/IJHTM.2007.014194

Lee, T. T., Mills, M. E., & Lu, M. H. (2008). Impact of a nursing information system on practice patterns in Taiwan. *CIN: Computers, Informatics, Nursing, 26*(4), 207-214. doi:doi: 10.1097/01.NCN.0000304807.69240.9e.

Lomas, C. (2012). The burden of bureaucracy. *Nursing standard, 26*(30), 22-24. doi:doi: 10.7748/ns2012.03.26.30.22.p7892

Lopetegui, M., Yen, P.-Y., Lai, A., Jeffries, J., Embi, P., & Payne, P. (2014). Time motion studies in healthcare: What are we talking about? *Journal of Biomedical Informatics, 49*, 292-299. doi:https://doi.org/10.1016/j.jbi.2014.02.017

Mallidou, A. A., Cummings, G. G., Schalm, C., & Estabrooks, C. A. (2013). Health care aides use of time in a residential long-term care unit: A time and motion study. *International Journal of Nursing Studies, 50*(9), 1229-1239. doi:http://dx.doi.org/10.1016/j.ijnurstu.2012.12.009

McBride, S., Tietze, M., Hanley, M. A., & Thomas, L. (2016). Statewide Study to Assess Nurses' Experiences With Meaningful Use-Based Electronic Health Records. *Comput Inform Nurs*. doi:10.1097/cin.0000000000000290

McCurdie, T., Sanderson, P., & Aitken, L. M. (2017). Traditions of research into interruptions in healthcare: A conceptual review. *International Journal of Nursing Studies, 66*, 23-36. doi:https://doi.org/10.1016/j.ijnurstu.2016.11.005

McCurdie, T., Sanderson, P., & Aitken, L. M. (2018). Applying social network analysis to the examination of interruptions in healthcare. *Applied Ergonomics, 67*, 50-60. doi:https://doi.org/10.1016/j.apergo.2017.08.014

McCurdie, T., Sanderson, P., Aitken, L. M., & Liu, D. (2017). Two sides to every story: The Dual Perspectives Method for examining interruptions in healthcare. *Applied Ergonomics, 58*, 102-109. doi:https://doi.org/10.1016/j.apergo.2016.05.012

Munyisia, E. (2011). Does the introduction of an electronic nursing documentation system in a nursing home reduce time on documentation for the nursing staff? *International Journal of Medical Informatics, 80*(11), 782-792. doi:doi: 10.1016/j.ijmedinf.2011.08.009.

Munyisia, E., Yu, P., & Hailey, D. (2012). The impact of an electronic nursing documentation system on efficiency of documentation by caregivers in a residential aged care facility. *Journal of Clinical Nursing, 21*(19/20), 2940-2948. doi:https://doi.org/10.1111/j.1365-2702.2012.04157.x

Nguyen, L., Bellucci, E., & Nguyen, L. T. (2014). Electronic health records implementation: an evaluation of information system impact and contingency factors. *Int J Med Inform, 83*(11), 779-796. doi:10.1016/j.ijmedinf.2014.06.011

Park, S. Y., Lee, S. Y., & Chen, Y. (2012). The effects of EMR deployment on doctors' work practices: a qualitative study in the emergency department of a teaching hospital. *Int J Med Inform, 81*(3), 204-217. doi:10.1016/j.ijmedinf.2011.12.001

Pelletier, D., & Duffield, C. (2003). Work sampling: Valuable methodology to define nursing practice patterns. *Nursing & Health Sciences, 5*(1), 31-38. doi:10.1046/j.1442-2018.2003.00132.x

Poon, E. G., Blumenthal, D., Jaggi, T., Honour, M. M., Bates, D. W., & Kaushal, R. (2004). Overcoming barriers to adopting and implementing computerized physician order entry

systems in U.S. hospitals. *Health Aff (Millwood), 23*(4), 184-190. doi:doi: 10.1377/hlthaff.23.4.184
Qian, S.-Y., Yu, P., Zhang, Z.-Y., Hailey, D., Davy, P., & Nelson, M. (2012). The work pattern of personal care workers in two Australian nursing homes: a time-motion study. *BMC health services research, 12*(1), 305. doi:https://doi.org/10.1186/1472-6963-12-305
Queensland Government. (2017). Princess Alexandra Hospital: About us. Retrieved from https://metrosouth.health.qld.gov.au/princess-alexandra-hospital/about-us
Rantz, M. J., Alexander, G., Galambos, C., Flesner, M. K., Vogelsmeier, A., Hicks, L., . . . Greenwald, L. (2011). The use of bedside electronic medical record to improve quality of care in nursing facilities: A qualitative analysis. *CIN - Computers Informatics Nursing, 29*(3), 149-156. doi:10.1097/NCN.0b013e3181f9db79
Ross, J., Stevenson, F., Lau, R., & Murray, E. (2016). Factors that influence the implementation of e-health: a systematic review of systematic reviews (an update). *Implement Sci, 11*(1), 146. doi:https://doi.org/10.1186/s13012-016-0510-7
Schenk, E., Schleyer, R., Jones, C. R., Fincham, S., Daratha, K. B., & Monsen, K. A. (2017). Time motion analysis of nursing work in ICU, telemetry and medical-surgical units. *J Nurs Manag, 25*(8), 640-646. doi:https://doi.org/10.1111/jonm.12502
Schenk, E., Schleyer, R., Jones, C. R., Fincham, S., Daratha, K. B., & Monsen, K. A. (2018). Impact of Adoption of a Comprehensive Electronic Health Record on Nursing Work and Caring Efficacy. *CIN: Computers, Informatics, Nursing, 36*(7), 331-339. doi:10.1097/CIN.0000000000000441
Scott, J. T., Rundall, T. G., Vogt, T. M., & Hsu, J. (2005). Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study. *BMJ, 331*(7528), 1313-1316. doi:10.1136/bmj.38638.497477.68
Seto, R., Inoue, T., & Tsumura, H. (2014). Clinical documentation improvement for outpatients by implementing electronic medical records. *Stud Health Technol Inform, 201*, 102-107. doi:doi: 10.3233/978-1-61499-415-2-102
Shanafelt, T. D., Dyrbye, L. N., Sinsky, C., Hasan, O., Satele, D., Sloan, J., & West, C. P. (2016). Relationship Between Clerical Burden and Characteristics of the Electronic Environment With Physician Burnout and Professional Satisfaction. *Mayo Clin Proc, 91*(7), 836-848. doi:10.1016/j.mayocp.2016.05.007
Smith, K., Smith, V., Krugman, M., & Oman, K. (2005). Evaluating the impact of computerized clinical documentation. *Comput Inform Nurs, 23*(3), 132-138.
Sullivan, C., Staib, A., Ayre, S., Daly, M., Collins, R., Draheim, M., & Ashby, R. (2016). Pioneering digital disruption: Australia's first integrated digital tertiary hospital. *Med J Aust, 205*(9), 386-389. doi:doi: 10.5694/mja16.00476
Thorpe-Jamison, P. T., Culley, C. M., Perera, S., & Handler, S. M. (2013). Evaluating the impact of computer-generated rounding reports on physician workflow in the nursing home: a feasibility time-motion study. *Journal of the American Medical Directors Association, 14*(5), 358. doi:10.1016/j.jamda.2012.11.008
Topaz, M., Ronquillo, C., Peltonen, L.-M., Pruinelli, L., Sarmiento, R. F., Badger, M. K., . . . Lee, Y.-L. (2017). Nurse Informaticians Report Low Satisfaction and Multi-level Concerns with Electronic Health Records: Results from an International Survey. *AMIA Annu Symp Proc., 2016*, 2016-2025.
Urden, L. D., & Roode, J. L. (1997). Work Sampling : A Decision-Making Tool for Determining Resources and Work Redesign. *The Journal of nursing administration, 27*(9), 34-41. doi:10.1097/00005110-199709000-00009
Vardaman, J. M., Cornell, P. T., & Clancy, T. R. (2012). Complexity and change in nurse workflows. *J Nurs Adm, 42*(2), 78-82. doi:10.1097/NNA.0b013e3182433677
von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., Vandenbroucke, J. P., & for the, S. I. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting Observational Studies. *PLoS medicine, 4*(10), e296. doi:10.1371/journal.pmed.0040296

Ward, M. M., Vartak, S., Schwichtenberg, T., & Wakefield, D. S. (2011). Nurses' perceptions of how clinical information system implementation affects workflow and patient care. *Comput Inform Nurs, 29*(9), 502-511. doi:10.1097/NCN.0b013e31822b8798

Zheng, K., Guo, M. H., & Hanauer, D. A. (2011). Using the time and motion method to study clinical work processes and workflow: methodological inconsistencies and a call for standardized research. *J Am Med Inform Assoc, 18*(5), 704-710. doi:10.1136/amiajnl-2011-000083