

Exploring the Use of EPR as a Cognitive Artefact for Nursing Handover

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Abstract

Nursing handover is a complex cognitive activity that requires consolidation and sharing of distributed patient information. During handover cognitive artefacts are usually used to reduce nurses' cognitive load and ease the process of information sharing between nurses. The objective of this study is to investigate the effects of using Electronic Patient Record (EPR) as a cognitive artefact for nursing handover. A multiple case study methodology was followed to collect data from four units in two Saudi Arabian hospitals. The units differed in their EPR usage mode: 1) units with extensive EPR use, 2) units with medium EPR use and 3) units with minimal EPR use. Findings highlight the role the EPR can play within the different modes and demonstrate the role of the EPR during the two different phases of handover: handover preparation and handover meeting. The advantages and disadvantages derived from using EPR as a cognitive artefact for nursing handover are also discussed from the perspective of Distributed Cognition theory.

Keywords

Cognitive artefacts, Distributed cognition, EPR, handover, information sharing, nursing

INTRODUCTION

In clinical settings, effective sharing of patient information during handover is recognized as crucial for the delivery of safe and high quality patient care (Manser 2011; Matic 2010). Clinical handover is defined by the Australian medical Association as “*The transfer of professional responsibility and accountability for some or all aspects of care for a patient, or group of patients, to another person or professional group, on a temporary or permanent basis*”. The process of sharing patient information during nursing handover has long been seen as an important cognitive process associated with the planning, delivery and evaluation of patient care (Matic 2010). Cognitive artefacts are usually applied by nurses to assist information sharing during handover. The term “cognitive artefact” is used to refer to the potentially broad range of artefacts that provide representations of information used in support of human cognition within a particular system (Nemeth et al. 2006). Over the years, different cognitive artefacts have been widely used by nurses during handover, in a range of formal artefacts that can be either paper-based or electronic such as patients' medical records and informal artefacts created by nurses such as ‘nurses' personal notes’.

Despite an array of supportive artefacts information sharing during nursing handover is considered problematic (McCann 2007; Meißner 2007). Many studies claim that nursing handover has not yet fulfilled its primary role as a communication tool to aid the process of information sharing (Tang and Carpendale 2007) and that current cognitive artefacts used in conducting handover are not effective enough to ensure high quality sharing of information (ALTurki and Bosua 2011; Johnson 2009). Information Technology (IT) has long been recommended as one way in which handover can be improved (Peterson 1988). Recently there has been a steady interest in and update of an IT system commonly used across hospitals, the Electronic Patient Record (EPR) (Staggers et al. 2011). EPR has not been developed specifically to support information sharing during handover, but to support clinical information sharing in general. EPR is intended to aid in drug decision making and to increase coordination between different clinicians, thereby improving global quality of care (Elson and Connelly 1995). Thus, it can be expected that by using EPR during handover, the information sharing process will improve (Hayrinen and Saranto 2005). However, up to this point in time, there is a lack of empirical studies that highlight how and to what extent EPR can serve as a cognitive artefact to support information sharing during nursing handover (Staggers et al. 2011). Studies on EPR are more focused on EPR-use for the physicians' activities than those associated with nursing tasks that include handover (Flemming and Hübner 2013). In addition, the small number of studies found in literature that study EPR use for nursing handover such as (McCann 2007) are mostly quantitative studies that mainly measure the availability of information and disregard other aspects such as how EPR is used during the entire handover process, i.e. handover preparation and handover meetings. Considering this gap in the literature, it is important to study the role of EPR for nursing

handover from different perspectives, in particular how EPR is able to support specific nursing tasks and fulfil nurses' information needs during handover.

This study applies the theory of Distributed Cognition as a lens to study the use of EPR as a cognitive artefact for nursing handover by taking social and organizational contexts into account and investigating how nurses use EPR to prepare for handover and conduct handover meetings. The research questions for this study are: *How is EPR used as a cognitive artefact to support information sharing during nursing handover?* and *what are the advantages and disadvantages of using EPR as a cognitive artefact to support information sharing during nursing handover?*

To answer these research questions we explored how handover was carried out in four different units across two Saudi Arabian hospitals. A comparison between the different levels of EPR usage during handover in the different units will be explained along with a comparison between EPR and other cognitive artefacts used by nurses for handover. The next section provides a brief theoretical background on the important process of information sharing during nursing handover and the different cognitive artefacts used towards this process. The theory of Distributed Cognition is then introduced as theoretical lens to study EPR use for handover. Thereafter, the research method used for data collection and analysis is described. Next, findings of the case studies are presented, followed by a discussion, and a conclusion that highlights limitations and provides recommendations for further work.

BACKGROUND LITERATURE AND THEORY

During nursing handover, cognitive artefacts form an integral basis for information sharing. Thus, the content of any cognitive artefact used for handover, must be accurate and reliable to ensure continuity of safe and effective long-term patient care (Bardram 2005; Manser 2011; Tang and Carpendale 2007). This study applies the theory of Distributed Cognition (DCog) as a lens to explore the use of EPR as a cognitive artefact that supports and enable knowledge/information sharing during nursing handover. DCog is concerned with the distribution of both knowledge and information between and across representation schemes. Two types of representation schemes are identified: internal representations and external representations. Internal representations represent tacit knowledge in the form of knowledge and structures embodied in individual minds, while external representations are embedded in the form of explicit knowledge or information that exist in the external environment (Zhang 1997). The codified or explicit type of knowledge is referred to as information. Hence, this study is only focusing on explicit knowledge (or 'information') that is distributed by physical artefacts in the real world. In addition, to information that is explicated verbally (in the form of speech during handover meetings).

DCog claims that human behaviour results from their interactions with external cognitive artefacts and with other humans. In addition human's activities in concrete situations are guided, constrained, and to some extent determined by the physical, cultural, and social contexts in which they are situated (Clancey1997; Suchman 1987). Thus, the unit of analysis for distributed cognition is a distributed cognitive system composed of a group of humans interacting with external cognitive artefacts and each other. Two major principles associated with DCog are:

- i. *Knowledge is distributed between human minds and artefacts:* DCog is concerned with how knowledge is distributed across internal human minds, external cognitive artefacts and groups of people/humans, and distributed across space and time in such a way that products of earlier events can transform the nature of later events. (Hutchins and Lintern 1995; Nemeth et al. 2006).
- ii. *The role of cognitive artefacts for knowledge work:* DCog emphasizes on the information content of cognitive artefacts and the key role that cognitive artefacts play in supporting teamwork. Some of the important proprieties of cognitive artefacts as claimed by Zhang, 1997 are
 - serving as short or long-term memory aid that reduces the cognitive load on human minds,
 - providing information that can be directly perceived and used requiring minimal information processing to interpret and formulate (e.g in the form of short notes),
 - documenting information in such a way that human agents can easily recognize features and make inferences directly,
 - helping to change and determine the nature of tasks through efficient action sequences, and
 - helping to determine decision-making strategies through accuracy maximization and effort minimization. (Zhang 1997)

In the past, DCog has been applied in healthcare studies aiming to understand the unique role of cognitive artefacts (Artman and Wærn 1999), identify bottlenecks that can lead to errors in a psychiatric emergency department (Cohen et al. 2006), analyse mobile healthcare work (McKnight and Doherty 2008), study handover sheets (Randell et al. 2008) and to evaluate healthcare technology in general (Rajkomar and Blandford 2011). Considering the properties of DCog and the fact that nursing handover is a typical example of a distributed cognitive system, this theory is considered a useful lens to explore the role of EPR as a cognitive artefact for nursing handover.

Cognitive Artefacts Used for Nursing Handover

As mentioned, there is a range of different paper-based and electronic cognitive artefacts used for nursing handover. Two commonly used paper-based cognitive artefacts are nurses' personal notes and handover sheets. During handover meetings, incoming nurses typically create their own personal (manual) notes to document information shared by outgoing nurses. These notes are kept in nurses' pockets allowing easy access at any time and any location (Payne 2000). Nurses' personal notes therefore act as a 'personal workspace' that nurses use to organise their work, to remind them of their 'to do' list and inform the delivery of care along each of their shifts. Information stored using personal notes is regularly updated during shifts and might be used at the end of shifts to update the formal artefacts that form patient medical record and to support subsequent handover meetings.

Standardized paper-based handover sheets (in the form of templates) are cognitive artefacts widely used for handover in a variety of settings (Randell et al. 2008). To create such artefacts, nurses may gather information from different artefacts placed in patient medical records or/and EPR. This sheet is then used to verbally report to incoming nurses during handover meetings. The British Medical Association in its guidance on clinical handover titled "Safe-Handover-Safe Patients" recommended the use of standardised proformas in the form of handover sheets to support handovers. Also, other studies confirm that using formal handover sheets increases the amount of information shared and improves the handover activity in general (Ferran 2008; McCann 2007).

Recently EPR has been adopted in some settings as a cognitive artefact for nursing handover (Engesmo and Tjora 2006). EPR dates back to the 1960s and has been recognized as being "at the heart of the application of IT in healthcare" (Tang and Lansky 2005). According to the International Organization for Standardization (IOS) EPR is defined as "*A longitudinal collection of personal health information concerning a single individual, entered or accepted by healthcare providers, and stored electronically. The information is organized primarily to support continuing, efficient and quality health care and is stored and transmitted securely.*" Patient information is populated chronologically in EPR during patient care by different clinicians (physicians and nurse) and administrative staff (Barlach and Simonsen 2007).

In the literature there is a debate whether EPR provides any advantages over traditional paper-based artefacts. Most researchers agree that EPR present great potential in improving information sharing but only one study found that this potential has been achieved (Haux et al. 2002). Some studies claim that EPR decreases the number of missing pieces of patient information and decreases the time spent by nurses at handover meetings (Hertzum 2008). Others found that EPR promotes errors during information sharing rather than reduce their likelihood (Ash 2004) and that EPR does not provide adequate cognitive support for nurses and also that the information saved on EPR is incomplete, rigid and does not offer "at a glance" information, or help nurses encode information (Staggers et al. 2011).

RESEARCH METHOD

Data Collection and Analysis

The research approach for this exploratory study followed a multiple case study approach. The case study strategy is particularly useful for collecting rich data and studying practice-based problems that examine actor experiences and the context of action to critically analyse existing real life situations (Lee 1989). This is indicative of areas where there is little understanding of how and why a process or phenomenon occurs or where the experience of individuals and the context of actions are critical (Benbasat et al. 1987; Darke et al. 1998). This is in line with the theory surrounding the use of EPR as a cognitive artefact for nursing handover which is not well developed and can be considered as immature.

Multiple cases studies were conducted across two hospitals to explore and compare the nursing handover phenomena across cases. Multiple case studies allowed for a cross-case analysis to be carried out (Benbasat et al. 1987) and allowed for more generalized and robust findings to be gained (Yin 2009). Data collection methods for this study involved interviews, handover participant observations, and analyses of key cognitive

artefacts used for handover with particular focus on EPR. The case studies were conducted from January to March 2013 in Riyadh, Saudi Arabia and involved comparing two different hospital settings and contexts to investigate the use of EPR for nursing handover across the two phases of shift handover (handover preparation and handover meeting). This study reports on the data collected from four units across the two hospitals referred to as Hospital-A and Hospital-B respectively. The two units studied in each of the hospitals were the Intensive Care Unit (ICU) and the Emergency Room unit (ER). These units were carefully chosen based on their EPR mode of use for nursing handover, with the specific aim to examine and compare different modes of EPR-use during handover activity across the four units. Research ethics approval was obtained and written consent was sought from participants in the study. Twenty-four nurses were interviewed across both hospitals, each interview lasted about forty-five minutes. Interviews were audio-recorded and detailed field notes were taken during observations on how nurses used the respective EPRs and other artefacts during handover. A thematic data analysis was performed based on DCog key themes, along with coding suggestions by Miles and Huberman (1994).

Background of Case Study Organisations

Hospital-A is a large public hospital located in Riyadh, Saudi Arabia. There were two different EPRs implemented in Hospital A: an advanced EPR system named IntelliVue Clinical Information Portfolio (ICIP) has been implemented only in the ICU since 2010 and an organization wide EPR system was implemented in all other units across the hospital. When a patient is first admitted to the hospital a record for that patient is generated in either EPRs depending on which unit the patient is admitted to.

ICIP in the ICU incorporates all patient information organising different sections of information into tabs including observations, health care notes, drugs prescribed, personal data, pathology and radiology results, vital signs, medication and treatment plans. Thus, the use of ICIP provided a paperless ICU environment. ICIP was also able to perform automatic charting and sophisticated calculations of vital signs, input information, and patient infusion rates. ICIP would then present these results on the computer screen and nurses just had to click the approval button to store these results at regular intervals. Thus, nurses only needed to document their nursing notes by typing them into ICIP. A Computer On Wheels (COWs) was available in front of each patient's room in the ICU and from COWs ICIP could be accessed.

The organization wide EPR was used to store three sets of patient information: 1) personal patient information (i.e. the patient name, date of birth, gender), 2) radiology results (i.e. scans, X-rays, ultrasounds and MRI) and 3) pathology results. Other patient information was stored in each patient's paper-based medical record in the form of a file, which was composed of different paper-based artefacts. These artefacts comprised different practices, for example doctor orders, nursing notes and medication charts.

In the Emergency Room (ER) nurses had to use the mandatory handover sheet named 'Kardex. This handover sheet was a one-page document placed as the first page in a patient's medical record. Information in the handover sheet was organised in the form of a table that included personal patient information, patient medication, doctor referrals, laboratory results and procedures.

Hospital-B, a private hospital, is also located in Riyadh, Saudi Arabia. An organization-wide EPR was implemented across all units in Hospital-B. However, units differed in their EPR content and mode of use. In the ER, the EPR was fully used to store all patient information including doctors' orders, nursing notes, medications etc. The EPR could be accessed from three computers located in the ER-unit. On the contrary, in the ICU, the EPR was only used to keep personal patient information, radiology and pathology results, while all other patient information was stored in paper-based medical records.

A standardized handover sheet named the 'SBAR sheet', had to be used by all units during handover. The SBAR sheet followed the SBAR technique (Situation, Background, Assessment, Recommendations) ([Reference required here](#)). The information content in this handover sheet included personal patient information, patient medication, doctor referrals, laboratory results and procedures and future tasks that needed to be done such as tests required.

Table 1 below summarizes the case studies details including the different units studied, number of participants from each unit, the type of information stored in the used EPR and the handover sheet used in each unit.

Hospital & Unit studied	No. of participants	Type of patient information saved in EPR + Handover sheet details
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Hospital A ICU	7	An advanced EPR system (ICIP) to save all patient information (including personal data, radiology and pathology tests, vital signs, doctor orders, nursing notes, medication and treatment plans etc) -No handover sheet used
Hospital A ER	7	An EPR system that stores only patient personal information plus radiology and pathology tests. - Kardex handover sheet
Hospital B ICU	5	Same EPR system implemented in both units with different levels of use ICU- only patient personal information plus radiology and pathology tests. - SBAR handover sheet ER- All patient information (including personal data, radiology and pathology tests, vital signs, doctor orders, nursing notes, medication and treatment plans etc) - SBAR handover sheet
Hospital B ER	5	
Total	24 participants	

Table 1: Case study details across the four units that participated in the study

FINDINGS

This study considers the nursing handover activity as composed of two main operations: handover preparation operation and handover meeting operation. The *handover preparation operation*: refers to all the activities carried out by outgoing nurses in preparation for the next operation, which is *the handover meeting operation*. During the first operation outgoing nurses are concerned with collecting handover information and updating formal artefacts, such as care plans. During the second operation: outgoing and incoming nurses gather for a face-to-face meeting. Outgoing nurses take the lead and verbally share their collected handover information. Across all case sites, there were two nursing shift handovers: a morning shift and a night shift. Guided by DCog three themes were generated to analyse and present findings of this study: 1) The use of EPR as a cognitive handover artefact, 2) EPR properties that affect its use a cognitive handover artefact and 3) The handover sheet as an essential cognitive handover artefact. The following explains in detail these three themes.

- **The Use of EPR as a Cognitive Handover Artefact**

In all units studied, the knowledge/information required for handover was distributed between nurses' minds, a verity of manual artefacts and EPR. However, units differed in how they used their EPR for handover. **Hospital A's-ER and Hospital B's-ICU** only used their EPR during handover to collect radiology and pathology results. Where in **Hospital A's-ICU and Hospital B's-ER**, the EPR was the central cognitive artefact for handover since it stored all patient information. The next section explains in detail how the EPR is used in the studied unit during the two operations of handover.

(i) *Handover preparation*

In **Hospital A's-ER and Hospital B's-ICU** outgoing nurses prepared for handover by accessing EPR to collect patient pathology and radiology results if any. Nurses then collected handover information documented in nurses' personal notes and formal paper-based artefacts placed in patient medical records to update their handover sheet (Kardex/SBAR sheet). In **Hospital B's-ER**, all patient information must be stored in EPR. Thus, nurses prepared for handover by typing-in patients' information to EPR from their personal notes. Following that, nurses initiated/updated the SBAR handover sheet. In **Hospital A's-ICU**, nurses prepared for handover by typing in ICIP final nursing notes and approving any vital signs ICIP provided. There was no form or formal handover sheet used in the ICU; most nurses relied on their own paper-based personal notes to reduce their cognitive load when preparing for handover. Some of the information written on these notes was copied from ICIP. One nurse commented: "I write down on any piece of paper [from ICIP] the information that I need to hand over, it helps me gather my ideas [information]. The information on ICIP is everywhere. I need to collect them in my paper."

(ii) *Handover meetings*

In all studied units, only **Hospital A's-ICU** used EPR (ICIP) during handover meetings it was also the only unit that did not use any form of a handover sheet. Handover meetings in this unit took place in front of patient's rooms where the COWs were placed. The majority of outgoing nurses relied on their personal notes to hand over to incoming nurses and only used ICIP to present vital signs and medication dosages. Other outgoing nurses browsed through different screens in ICIP and read out handover information. Most incoming nurses while listening to handover would document some or all of the shared handover information in their own personal notes.

- **EPR properties that affected its use a cognitive handover artefact**

There were a number of EPR proprieties that affected its use by nurses for handover, which can be classified

into three major proprieties: 1) information documentation, 2) information provision and 3) accuracy and preventing the loss of documented information. All of these proprieties are discussed in detail in the following.

(i) *Information documentation*

In Hospital A-ER and Hospital B-ICU nurses did not document any information in their EPR. Instead, all patient information was documented in paper-based artefacts. Nurses in **Hospital A-ICU and Hospital B-ER** had to document *all* patient information in their EPR. Nurses in **Hospital A-ICU** found documenting in ICIP easy and fast. Since ICIP automatically generated most patient information, nurses just needed to approve information displayed in ICIP. Nurses also had to add their nursing notes in ICIP. Hospital A-ICU nurses stated that ICIP eased stress and they spent less time documenting patient information using ICIP compared to earlier times when everything had to be documented using paper-based artefacts: *“Now with ICIP we have less stress. Documenting on papers was a pain for the fingers and a pain for the brain. ICIP changed my work in the sense that documenting is now faster. When we now hand over I can guarantee that the basics [information] are there.”* ICU nurses were confident that ICIP stored the most recent and complete patient information: *“Patient information stored in ICIP is always accurate and updated. The information you receive at handover is reliable”*

Hospital B-ER nurses complained about the time-consuming process of documentation information in the EPR - nurses had to manually copy all their documented patient shift information from their personal notes into EPR as one nurse stated: *“I prefer the olden days when we documented on paper, it was faster. Now it is like we are documenting twice, it is very time consuming. Sometimes I have to stay extra hours to type down the information in the EPR.”*

Only three computers were available in Hospital B-ER and nurses had to take turns using these computers to document their information into EPR. Due to the long documentation process and lack of computers in the unit, information stored in EPR was not always up to date as one nurse commented: *“To be honest, the information is not always there [EPR]. I think it’s a very daunting process of documenting twice, which is why the information is not always updated. If the ER-unit provides a personal computer for each one of us then I will love using the EPR.”*

(ii) *Information provision*

Across all units, nurses found it easy to conduct keyword-related searches to retrieve information stored in each EPR, particularly historical information. In addition, time nurses spent to collect handover information across the units were varying, and depended on the amount of patient information stored in each EPR. E.g, in **Hospital A-ER and Hospital B-ICU** outgoing nurses prepared for handover by collecting patient pathology and radiology results from EPR. Other patient information had to be collected from paper-based artefacts. Handover preparation therefore required much effort and time from outgoing nurses as a nurse from Hospital B-ICU stated: *“Our files are very big filled with different forms. It is not easy going through these papers to collect handover information and it is also time consuming.”* On the contrary, handover preparation using EPR in Hospital A-ICU was quick and easy as all patient information was stored in ICIP as one Hospital A-ICU nurse commented: *“I can quickly go into ICIP and check all the documentation of a particular patient. ICIP has greatly improved handover; it makes handover easy. For example, I can tell immediately what patient medication has been given and were not given.”*

There were also times when nurses had to hand over pieces of historical information, e.g. ‘a dosage of a certain medication a patient was on three months ago’. In units that relied mostly on paper-based artefacts historical information that had to be accessed from old archived paper-based artefacts. These searches were time-consuming for nurses as indicated by a Hospital B-ICU nurse: *“When a patient file gets big and heavy because of the many papers involved, we have to take them out and keep them in the archive. The problem occurs when we have to find these old records. It takes us hours to locate the required information.”*

However, occasionally EPR crashed which forced nurses to urgently contact medical labs and/or radiology departments to get specific results for handover, as a Hospital A-ER nurse commented: *“When the computer [EPR] goes down, we aren’t able to gain lab results to hand over and this causes delays in treating patients.”* This problem was more severe in units that stored comprehensive patient information in the EPR, e.g. in Hospital A-ICU, ICIP crashes forced nurses to revert back to paper-based artefacts. Later nurses had to duplicate through manual documented information into ICIP, as one nurse commented: *“Many times the system [ICIP] just shuts down, then unfortunately we have to go back to paper that is why we still keep our old forms. Once it [ICIP] gets back we [need to] type everything again.”*

(iii) *Accuracy and preventing the loss of documented information*

Hospital A's nurses were provided with a user name and password allowing them to access EPR. In the ICU, any editing nurses performed on information stored in ICIP, was shown by tracking changes. In comparison, Hospital B nurses only needed their initials to access EPR. Also, nurses could easily edit information stored in the EPR while prior edits were not visible. This contributed to security problems causing nurses to feel uncomfortable using EPR as one nurse stated: *"I don't feel safe using EPR, any one can use my initials to access the EPR and change the work I have documented."*

Furthermore, all EPR studied across the units were able to prevent the loss of patient information as it is a feature of most EPR to securely back up and saved all patient information stored within it, one nurse from Hospital A-ICU mentioned: *"The advantage of it [ICIP], you cannot lose information, where in the old days with the papers it will be a big file placed in a cupboard and you might lose very important information. Some papers went missing; it is now safer for the patient."*

- **The handover sheet as an essential cognitive handover artefact**

Nurses in **Hospital A-ER, and Hospital B-ER and ICU** appreciated the use of handover sheets (the Kardex and SBAR sheet). Handover sheets provided nurses with a standard and structured information-set as one Hospital A-ER nurse commented: *"During handover we don't have to think on which information to handover, everything [information] we need to handover is on the Kardex."* Another Hospital B-ER nurse claimed: *"SBAR sheet is important, it tells me what information the next nurse taking my place needs to know about our patients."* A Hospital B-ICU nurse confirmed this aspect: *"It is nice to have SABR sheet. It gives us [nurses] the piece of mind that we need at handover, it tells us what we need to handover for the next nurse and in which order this information should be shared."* Handover sheets also served as reminders for incoming nursing tasks as one Hospital B-ER nurse mentioned: *"The handover sheet reminds me on what I need to do, it is easy to carry around. I don't have to go to the computer to know the required tasks."* Another nurse from Hospital A-ER commented: *"It is great that we have Kardex. It organises our handover meetings by providing a unified structure to follow."*

However, if Kardex/SBAR sheets were not updated, this resulted in information sharing gaps about patients during handover meetings as a nurse from Hospital B-ICU mentioned *"There is no point of using SBAR sheet if the information on it is not updated."* Another problem nurses experienced with handover sheets and other paper-based artefacts were difficulty to read illegible handwritten information documented in these artefacts as one Hospital A-ER claimed: *"Some nurses' handwriting is awful. I cannot read what they write on Kardex, other nurses are complaining about my handwriting too."*

On the other hand, in **Hospital A-ICU** nurses suffered the absence of a handover sheet. Most nurses found it hard to prepare of handover using ICIP. Nurses were overwhelmed with the massive amount of information stored in ICIP and some were not sure which information should be shared at handover, as mentioned by one nurse: *"Sometimes we miss out some things [information] at handover although everything is in ICIP, because when it is time to hand over there is so much information in ICIP you get lost and you don't know where to start."* Nurses also complained that they got lost listening to verbal handover, as each nurse followed their own sequence of shared verbal information. A nurse commented: *"I sometimes get confused listening to handover. Some nurses don't have an effective method of sharing information. Their way [of sharing information] is different to mine. Some nurses start with the patient's temperature then medications then back to blood pressure. She should have mentioned all the vital signs at once. We are missing the flow at handover meetings. They can be very confusing."*

DISCUSSION

This exploratory study followed a qualitative research method to explore the use of EPR as a cognitive artefact for nursing handover. Unlike most studies on handover that focus only on information shared verbally during handover meetings, this study explored EPR-use for handover information sharing, i.e. the handover preparation and handover meeting operations. The study was guided by DCog theory, which deepened our understanding of EPR as a cognitive artefact that support and enables nursing handover practices during the two mentioned operations. Specifically, different levels of EPR use for handover were investigated, by taking the vantage point of explaining, comparing and analysing EPR use across different hospital units and the extent of EPR use considering the presence of a manual handover sheets.

We did not come across any unit that did not use EPR for handover. This suggests that nowadays, EPR is widely used and can be considered necessary for handover in clinical settings. Findings suggest that there were three different modes in which EPR was used for nursing handover across the two hospitals: *minimal EPR-use*, *medium EPR-use* and *extensive EPR-use* as shown in Table 2. The use mode classification is determined by the extent of EPR information stored in each EPR, whether each EPR is used during handover preparation and handover meeting or both, and whether the EPR-use during handover was complemented by a handover sheet.

Hospital unit	EPR use for handover		The majority of patient information is stored in		Use of handover sheet	EPR use mode
	Handover preparation	Handover meeting	Paper based artefacts	EPR		
Hospital A-ER	✓	x	✓	x	✓	Minimal
Hospital A-ICU	✓	✓	x	✓	x	Extensive
Hospital B-ER	✓	x	x	✓	✓	Medium
Hospital B-ICU	✓	x	✓	x	✓	Minimal

Table 2: Classification of EPR use mode

Both Hospital A-ICU and Hospital B-ER had *minimal EPR-use* for nursing handover. In both units minimal EPR-use was characterised by minimal patient information stored in the EPR i.e. only pathology and radiology results. These results were updated by pathology and radiology departments at times when patient results became available. Therefore, this minimal EPR-use did not fully support human cognition for handover and required complementary cognitive artefacts to be used *in conjunction with* EPR to enable handover preparation and handover meeting. A variety of complementary manual artefacts were required for effective and efficient handover. These artefacts were in the form of nursing notes, vital sign sheets and medication sheets amongst others. This *minimal type of EPR-use* indicated that EPR alone was not sufficient for handover since EPR was not comprehensively populated with appropriate information for successful handover. This placed an additional cognitive load on nurses to carefully and extensively populate and document their thoughts and other relevant information using a variety of additional artefacts. These artefacts were not standardised across the different units. Therefore, these artefacts had to be used in conjunction with the EPR to guide nurses' cognition during handover preparation and meetings.

The second EPR-use mode, *medium EPR-use*, was apparent in the ER unit of Hospital B. The unit's EPR stored all/comprehensive patient information, but nurses did not use EPR during handover meetings and instead used the SBAR handover sheet only. Medium EPR-use required more documenting from nurses e.g. information had to be documented first in nurses' personal notes then at the end of the shift the information from personal notes was copied into EPR, Hospital A - ICU *extensively* used their EPR (ICIP). All patient information was stored in ICIP and nurses used ICIP in both phases of handover.

Findings indicate that there were many advantages associated with handover preparation when EPR use mode was medium or extensive. Since all patient information is combined collectively into EPR, this improves access to patient information (Patterson 2004), eliminates the need to regather information and solves problems associated with the potential "lost artefact" that occurred in units with minimal EPR usage. However, the major problem associated with EPR was its downtime. When EPR was not available, this had a deeper affect on nurses more in units with extensive and medium EPR-use mode, than units with a minimal EPR-use mode.

Although in both Hospital A-ICU and Hospital B-ER, EPR served as central cognitive artefacts, nurse experiences in these two units related to EPR use for handover, were different. This is due to the different properties associated with the implemented EPR. For example, one of the nurse's tasks was to document patient information along the shift. Thus, when it was time to prepare for handover nurses collected some of this information that was integral to be shared with the next shift. This process of documenting patient information in Hospital-A's ICU was supported by ICIP that automatically generated some patient information. This resulted in storing up-to-date information and ultimately reduced nurses' cognitive load. On the other hand, in Hospital B's-ER, their EPR-use was not practical, there were only three computers in the unit that could be used to access the EPR and nurses only documented patient information in the EPR towards the end of shifts. Thus, information stored in EPR was not always up to date. Another EPR property proven to be vital on how nurses perceived the use of EPR was the accuracy of information stored in EPR. Nurses in Hospital B-ER did not find the information stored in EPR reliable since information could be edited easily while prior edits were not visible.

This study demonstrates the efficacy of using standardised handover sheets. The features afforded by the handover sheet such as: displaying relevant handover information and forcing nurses to structure information in a certain manner, can contribute to more effective information sharing. Furthermore, a quick glance to a standardized handover sheet at the beginning of each shift provides incoming nurses with an overview of key events that have occurred during the prior shift, handover sheets also provided incoming nurses with guidance in terms of the tasks that are expected of them during the shift. Hospital A-ICU suffered an absence of a handover sheet, it was assumed that ICIP would be enough to act as a cognitive handover artefact for the nurses to use during handover. However, nurses found that ICIP lacked the characteristics otherwise found in handover sheets and thus heavily relied on their personal notes during handover, which resulted in a lack of standard structure and information-set that could be followed.

It can be concluded that EPR advantages when used as a cognitive artefact to support information sharing at nursing handover cannot be generalised. It depends on the properties of the implemented EPR and the practical use of EPR. However, it can be concluded that EPR provides better opportunities than paper-based artefacts for nurses when *preparing for handover*. However, EPR alone does not play a key role in enabling *handover meetings*. Information saved in EPR is not adequately formatted for handover. There is a therefore need to compliment EPR with a supportive, standardized, formal handover sheet. When relying on only EPR alone to hand over, key information may often /or could often be overlooked.

CONCLUSION

Studying EPR as a cognitive artefact for handover has not been fully investigated by previous studies. The aim of this paper is to explore EPR as an artefact used for nursing handover. This exploratory study identified how and to what extent EPR support and enable handover. The study identified three EPR use modes and contributes to an increased understanding of nurses' perception on the use of EPR for handover and how it affects their handover performance. Based on evidence found, EPR has many advantages when used for handover, yet there are some disadvantages that hinder its use for handover. It is hoped that the findings provided in this study could assist hospital management teams in understanding the potential advantages expected when using EPR for handover and the barriers of adopting this as a cognitive artefact that support handover. EPR developers may also benefit from having a concrete definition of the requirements of EPR to meet nurses' needs to conduct successful information sharing during handover.

There were limitations to the study. The sample of interviewed nurses was relatively small and covered only four units of two hospitals. Thus, it would be inappropriate to claim that the findings of this study reflect all nurses' perceptions of the use of EPR for handover in general. Studies with larger samples are required to verify findings of this study and to make more general claims. In addition, results of this study are based on hospitals in Saudi Arabia alone. Further research is needed to examine whether these study findings apply to different settings and other countries.

REFERENCES

- ALTurki, N., and Bosua, R. 2011. "Assessing Nurses' Knowledge Sharing Problems Associated with Shift Handover in Hospital Settings,").
- Artman, H., and Wærn, Y. 1999. "Distributed Cognition in an Emergency Co-Ordination Center," *Cognition, Technology & Work* (1:4), pp 237-246.
- Ash, J.S. 2004. "Some Unintended Consequences of Information Technology in Health Care: The Nature of Patient Care Information System-Related Errors," *Journal of the American Medical Informatics Association* (11:2), p 104.
- Barlach, A., and Simonsen, J. 2007. "Which Parts of a Clinical Process Epr Needs Special Configuration," *MEDINFO 2007, Proceedings of the 12th World Congress on Health (Medical) Informatics*: IOS Press.
- Benbasat, I., Goldstein, D.K., and Mead, M. 1987. "The Case Research Strategy in Studies of Information Systems," *Mis Quarterly*), pp 369-386.
- Cohen, T., Blatter, B., Almeida, C., Shortliffe, E., and Patel, V. 2006. "A Cognitive Blueprint of Collaboration in Context: Distributed Cognition in the Psychiatric Emergency Department," *Artificial intelligence in medicine* (37:2), pp 73-83.
- Darke, P., Shanks, G., and Broadbent, M. 1998. "Successfully Completing Case Study Research: Combining Rigour, Relevance and Pragmatism," *Information systems journal* (8:4), pp 273-289.
- Elson, R.B., and Connelly, D.P. 1995. "Computerized Patient Records in Primary Care. Their Role in Mediating Guideline-Driven Physician Behavior Change," *Archives of family medicine* (4:8), p 698.

- Ferran, N.A. 2008. "Standardised Proformas Improve Patient Handover: Audit of Trauma Handover Practice," *Patient safety in surgery* (2), p 24.
- Flemming, D., and Hübner, U. 2013. "How to Improve Change of Shift Handovers and Collaborative Grounding and What Role Does the Electronic Patient Record System Play? Results of a Systematic Literature Review," *International journal of medical informatics*.
- Haux, R., Ammenwerth, E., Herzog, W., and Knaup, P. 2002. "Health Care in the Information Society. A Prognosis for the Year 2013," *International journal of medical informatics* (66:1), pp 3-21.
- Hayrinen, K., and Saranto, K. 2005. "The Core Data Elements of Electronic Health Record in Finland," *Studies in health technology and informatics* (116), pp 131-136.
- Hertzum, M. 2008. "Positive Effects of Electronic Patient Records on Three Clinical Activities," *International journal of medical informatics* (77:12), p 809.
- Hutchins, E., and Lintern, G. 1995. *Cognition in the Wild*. MIT press Cambridge, MA.
- Johnson, J.K. 2009. "Improving Clinical Handovers: Creating Local Solutions for a Global Problem," *BMJ. British medical journal* (18:4), p 244.
- Lee, A.S. 1989. "A Scientific Methodology for Mis Case Studies," *Mis Quarterly*), pp 33-50.
- Manser, T. 2011. "Minding the Gaps: Moving Handover Research Forward," *European Journal of Anaesthesiology* (28:9), p 613.
- Matic, J. 2010. "Review: Bringing Patient Safety to the Forefront through Structured Computerisation During Clinical Handover," *Journal of clinical nursing* (20:1-2), p 184.
- McCann, L. 2007. "Passing the Buck: Clinical Handovers at a New Zealand Tertiary Hospital," *New Zealand medical journal* (120), p 56.
- McKnight, J., and Doherty, G. 2008. "Distributed Cognition and Mobile Healthcare Work," *Proceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction-Volume 2*: British Computer Society, pp. 35-38.
- Meißner, A. 2007. "Nurses' Perception of Shift Handovers in Europe—Results from the European Nurses' Early Exit Study," *Journal of advanced nursing* (57:5), p 535.
- Nemeth, C., O'Connor, M., Klock, P.A., and Cook, R. 2006. "Discovering Healthcare Cognition: The Use of Cognitive Artifacts to Reveal Cognitive Work," *Organization studies* (27:7), pp 1011-1035.
- Patterson, E.S. 2004. "Handoff Strategies in Settings with High Consequences for Failure: Lessons for Health Care Operations," *International journal for quality in health care* (16:2), p 125.
- Payne, S. 2000. "Interactions between Nurses During Handovers in Elderly Care," *Journal of advanced nursing* (32:2), p 277.
- Rajkomar, A., and Blandford, A. 2011. "Distributed Cognition for Evaluating Healthcare Technology," *Proceedings of the 25th BCS Conference on Human-Computer Interaction*: British Computer Society, pp. 341-350.
- Randell, R., Woodward, P., Wilson, S., and Galliers, J. 2008. "Public yet Private: The Status, Durability and Visibility of Handover Sheets," *Computer-Based Medical Systems, 2008. CBMS'08. 21st IEEE International Symposium on*: IEEE, pp. 500-502.
- Staggers, N., Clark, L., Blaz, J.W., and Kapsandoy, S. 2011. "Why Patient Summaries in Electronic Health Records Do Not Provide the Cognitive Support Necessary for Nurses' Handoffs on Medical and Surgical Units: Insights from Interviews and Observations," *Health informatics journal* (17:3), pp 209-223.
- Tang, C., and Carpendale, S. 2007. "An Observational Study on Information Flow During Nurses' Shift Change," in: *Proceedings of the SIGCHI conference on Human factors in computing systems*. San Jose, California, USA: ACM, pp. 219-228.
- Tang, P.C., and Lansky, D. 2005. "The Missing Link: Bridging the Patient–Provider Health Information Gap," *Health Affairs* (24:5), pp 1290-1295.
- Yin, R.K. 2009. *Case Study Research: Design and Methods*. Sage Publications.

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