Using ANT to uncover the full potential of an intelligent operational planning and support tool (IOPST) for acute healthcare contexts

Using ANT to uncover the full potential of an intelligent operational planning and support tool (IOPST) for acute healthcare contexts

Using ANT to Uncover the Full Potential of an Intelligent Operational Planning and Support Tool (IOPST) for Acute Healthcare Contexts

Imran Muhammad, RMIT University, Melbourne, VIC, Australia & Epworth Research Institute, Epworth HealthCare, Richmond, VIC, Australia

Fatemeh Hoda Moghimi, Department of Information Systems, RMIT University, Melbourne, VIC, Australia, & Epworth Research Institute, Epworth HealthCare, Richmond, VIC, Australia

Nyree J. Taylor, Eastern Health Nursing and Midwifery Research Centre, Deakin University, Box Hill, VIC, Australia

Bernice Redley, Epworth Deakin Centre for Clinical Nursing Research, Epworth HealthCare, Richmond, VIC, Australia, & Deakin University, Melbourne, VIC, Australia

Lemai Nguyen, School of Information Systems, Deakin University, Burwood, VIC, Australia

Malte Stein, Department of Technical Computer Science, Technical University of Berlin, Berlin, Germany

Bridie Kent, School of Nursing and Midwifery, Deakin University, Burwood, VIC, Australia

Mari Botti, School of Nursing and Midwifery, Deakin University, Burwood, VIC, Australia, & Epworth HealthCare, Richmond, VIC, Australia

Nilmini Wickramasinghe, School of Business IT & Logistics, RMIT University, Melbourne, VIC, Australia, & Epworth HealthCare, Richmond, VIC, Australia

ABSTRACT

Based on initial pre-clinical data and results from focus group studies, proof of concept for an intelligent operational planning and support tool (IOPST) for nursing in acute healthcare contexts has been demonstrated. However, moving from a simulated context to a large scale clinical trial brings potential challenges associated with the many complexities and multiple people-technology interactions. To enable an in depth and rich analysis of such a context, it is the contention of this paper that incorporating an Actor-Network Theory (ANT) lens to facilitate analysis will be a prudent option as discussed below.

Keywords: *Actor-Networks, Actor-Network Theory (ANT), Acute Care, Healthcare Delivery, Nursing Informatics, Operational Planning, Patient Safety, Quality Care*

DOI: 10.4018/jantti.2013040103

INTRODUCTION

Acute healthcare settings are continually faced with a multiplicity of challenges. While there are many reasons for this, a key recurring cause relates to the volumes of disparate data and information that must be processed coupled with the multiple tasks that care givers, primarily nurses, must perform. Such a context appears to be appropriate to benefit from the design, development and use of an intelligent operational planning and support tool (IOPST). Based on results from both a pre-clinical simulation as well as from focus group studies, initial proof of concept for such a solution has been demonstrated. However, it is the contention of this paper that merely automating care planning and documentation of delivery is only a partial solution. The real benefits of such an intelligent solution lie in better understanding how it serves to augment and support various tasks that must be performed in an acute care context. To begin to explore these possibilities, it is essential to have a rigorous and systematic framework to guide such exploratory research. Thus, we have chosen to adopt Actor- Network Theory (ANT) as a suitable analytic lens to guide our research and analysis of findings. In this way, we are confident that we can in fact uncover the true potential of such a smart solution.

Further, we believe this approach can aid exploration of the "taken for granted" nature of technology by tracing the social as well as technical relations among actors and actants involved in the development, adoption, and use of a smart decision support system in acute healthcare settings (Callon, 1986; Law & Callon, 1992). Guided by the research question, "how can actor-network theory facilitate a deeper understanding of the true potential of an IOPST?", the following serves to justify the role for using ANT in such a context. We begin by framing the IOPST in terms of the constructs of ANT.

ACTOR-NETWORK THEORY

Actor-Network Theory (ANT) is based on a recursive philosophy (Latour, 2005). Its fundamental stand is that technologies and people are linked in an often complex network. ANT tries to bridge the gap between a socio-technical divide by denying the existence of purely social or technical relations. In doing so, it takes a very radical stand and goes as far as challenging many of the conventional epistemological ideas and rejecting any distinction between subject or object, nature or culture and/or technology and society.

ANT assumes that each entity (such as technologies, organisations and humans) are actors. Therefore, they have the potential to transform and mediate social relationships (Cresswell et al., 2010). Further, it emphasises that entities (Actors/Actants), regardless of their nature; whether human, technologies or process, are not fixed. Thus, they do not have any significance on their own, but rather their significance depends on the nature of their relations with other entities in the network and their role which may change as their relations change (Law, 2006). This means that neither actors nor their relations are static and permanent; they change over time and across social and political contexts (Singleton, Michael, & UK, 1993).

Actors are essentially considered heterogeneous in nature, representing negotiations at different levels (e.g. political, social, technical and or economic levels). Further, the degrees of commitment, skills, constraints and prejudice among actors also can vary. Often, these represent a mixture of one or two of social, technical or personal levels (Latour, 1993). At the technical level, the role of technology may be involved to facilitate users by giving them accurate and up-to-date information when it is needed. The accuracy (effectiveness and efficiency) of the technology would be best determined or disputed by the users (nurses,

clinicians, pharmacists and patients). To better understand relationships and how they create meaning and describe the role of different actors (e.g., the patient, nurses, different diagnostic tests, different medical technologies, different communication channels, standards, protocols and decision and policy makers), ANT suggests we should think in terms of networks of relations or actor-networks (Williams-Jones & Graham, 2003).

ACTOR-NETWORKS

Actor-networks are highly dynamic and inherently unstable in their nature. Understanding the alignment between people, technology, their roles, routines, values, training and incentives and the role of technology and how it can facilitate or negatively impact the work processes and tasks in an organization can serve to stabilize these networks (Greenhalgh & Stones, 2010; Wickramasinghe et al., 2011). Further, these networks need to be continually maintained through the engagement (e.g. a process known as enrolment in ANT) of the different actors/actants involved in the process.

At times, networks may fail and hence may need to be replaced by other networks or integrate new enrollments. The enrollment of new actors/actants leads to the reconfiguration of the networks as interests are translated to suit the needs of the wider body of actors. These actors then take part in a negotiation process to define the new identity of the actor-networks. In this process, importance is placed on the actions of actors and networks, and the interactions between different actors (e.g. social institutions, individuals, government, technology, communication channels, rules and regulations, protocols and work environment).

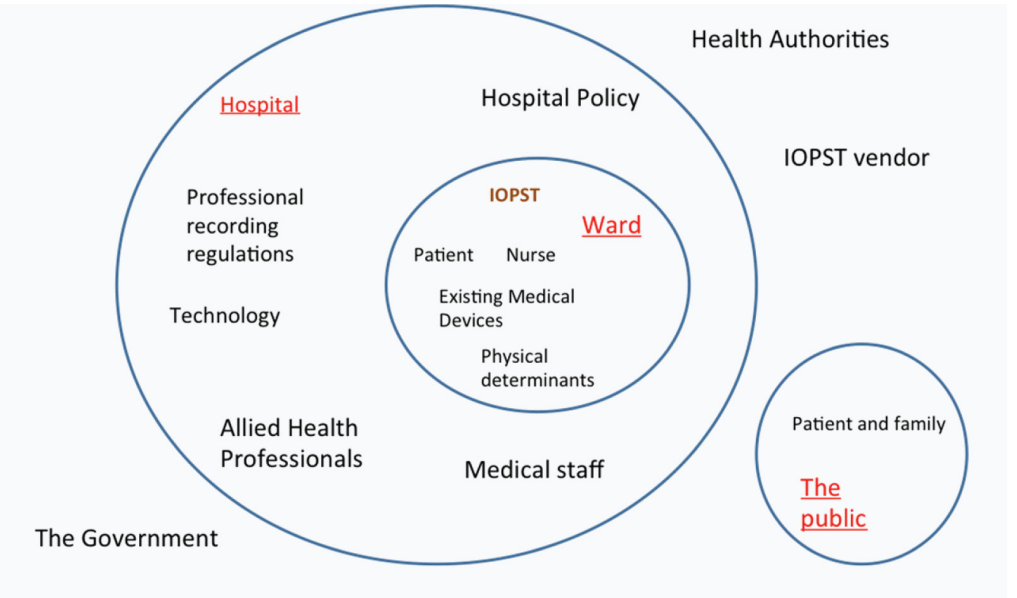
The origin of power and structures are the main source and drivers of the existence of such networks. Thus, if someone needs to understand the essential dynamics within such a network it is important to understand and consider all the components that collaborate, co-operate and compete to lead to propagation, perseverance or perishing of that network. The challenge here for ANT is how to unpack and then understand the underlying process and important components of actors and their networks that are hidden and cannot readily be seen or understood (Harding, 2004; Singleton, 1996).

Figure 1 provides a schematic depiction of the context for the IOPST. This figure assists us to map the actors involved in the development, use and implementation of the IOPST as well as the actor network of their engagement and some of their connections. As we can see from Figure 1, this task is complicated because the actors participate in many networks which may or may not overlap with the introduction of a technology solution into the hospital –ward environment.

Actor-networks can be thought of as being fractal and expanding all the time with each actor becoming a node for another network (Law, 1999). This complexity makes it very difficult to separate the foreground from the background; and such a network is thus challenging to analyse. To overcome this complexity, it is useful to simplify the actor-network and this can be done using the concept of punctualisation or creation of black boxes (Law, 2006).

For the purposes of analysis and despite a risk for oversimplification, networks that are stable and strong can be treated as an Obligatory Point of Passage (OPP) for a larger network. The supporting network can then be 'black boxed'. For example, within Figure 1, each box of Hospital and Ward are complex black boxes, each with its own internal network that can be further expanded or opened to create its own network. The actors of each black box not only interact with each other but also with various actors from additional external networks. Such networks are complex and dynamic in nature. For example, a change (Government funding scheme, hospital policy, introduction of a new technology) will impact different actors and their interactions from multiple aspects, and the networks will reorganise and realign as acceptance and/or resistance is manifested.

Figure 1. Key actors



ANT also advocates a focus on the multiple factors influencing the alignment of linkages between actors and their networks (Mol, 1999) but does not emphasise the specific shape or structure of the actor network. For example, in the case of a health decision support system, the technology could be different for different purposes. It may serve the purpose of its targeted audience and be accepted promptly; or not serve the purpose and be resisted strongly by other actors. Hence, it is important to understand how actors can be brought together in a network and help them to keep participating in the network. The concept of translation can assist with this task.

TRANSLATION

Translation is a vital element of ANT. This term is used to explain the process of creating actor-networks and the formation of ordering effects (Callon, 1986; Law & Callon, 1992). The translation stage provides insights into how the IOPST software system can be integrated into the very complex work environment of acute healthcare.

Translation works as a glue; it encourages actors to be involved in the formation of the network and helps the primary actor to overcome resistance. Each actor in the network is considered to be an independent entity, and regardless of its formation (e.g. a person, group, institute, company, process, hardware or software) will have its own set of diverse interests. Therefore, the network can only be held stable if the interests of different actors can easily and continually be translated (Callon, 1986).

The process of translation can also be called a process of negotiation. After the creation of a network, in the presence of many actors, a strong or primary actor would translate interests of other actors into his/her own by negotiating with them. At this stage all actors decide to be (or not to be) part of the new network; usually dependent on the perceived benefit to themselves (Wickramasinghe & Bali, 2009). Among

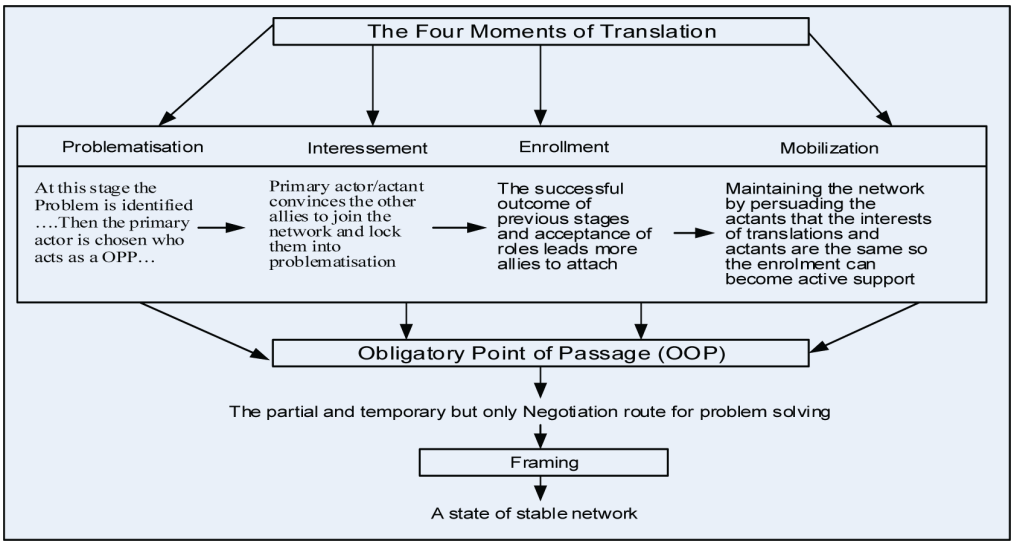
humans, the translation process is analogous to the negotiation of common interests, whereas the translation among human and non-human actors is typically negotiated through the "design of scripts" (Callon, 1986).

The process of translation of Actors/Actants interests is achieved through a series of four moments of translation: 1) problematisation, 2) interessement, 3) enrolment, and 4) mobilization as shown in the Figure 2 (Callon, 1986). For the purpose of our study, the concept of translation and its four moments are important. In particular, this aspect helps to understand how different groups of actors/actants can be brought together around a common goal and achieve successful enrolment in order to stabilise the network.

Any kind of resistance to socio-technical change can be met by re-organising the relations in actor-networks and translating their interests into common goals. Counter-claims and disagreements that arise from different actors in a network can harm the stability of the network. In the vision for the IOPST, concerns regarding care quality, safety and efficiency shaped the problematisation stage. The IOPST is the primary actor as well as the OPP between other actors. Competing roles between the incoming primary actor (IOPST) and the out-going actor (paper based nursing documentation) requires that links between the latter (paper) and other actors (e.g. nurses, medical staff, allied health professionals and patients) are weakened. In addition, the ties (interests) between the incoming actor (IOPST) and the other actors need strengthening, through interessement, to be successful. If this process succeeds, then it can facilitate the enrolment stage in which actors accept and align their positions in new networks where the actor 'paper based nursing documentation' leaves and IOPST enters. Mobilization happens when the new networks become active and stable with the new IOPST actor.

The foundation of networks is built upon the rules of interactions between actors. Therefore, continuous translation of interests at different levels is a primary source of social order. It is therefore, also important to understand the role of controlling elements and their influences and contribution (Law, 2001).

Figure 2. Moments of translation in ANT (adapted from: Muhammad, Teoh, & Wickramasinghe, 2012)



THE ACTOR-NETWORK THEORY APPROACH TO EVALUATE IT IN HEALTHCARE

To fully comprehend the successful development, implementation and use of a new IOPST technology in healthcare, it is important to investigate beyond the linear models of technology adoption, diffusion and transfer. Simple binary models are not enough because of the complex and dynamic nature of healthcare settings. The complex nature of interaction between the technology and social often renders the two inseparable (Williams-Jones & Graham, 2003).

ANT is considered an appropriate choice to analyse the IOPST evaluation study because it can be used to identify and acknowledge the impacts of human and non-human, social or policy issues within the healthcare setting (Latour 1996). Moreover, it is robust enough to accurately capture the complexities, nuances and richness of healthcare operations. In so doing, it can also be used to investigate and theorise questions about why and how networks come into existence, what sort of associations and impacts they can have on each other, how position move and change in a network, how actors enrol and leave the network and most importantly how networks can achieve stability (Doolin & Lowe, 2002; Callon, 1986; McLean & Hassard, 2004). An assumption of ANT theory is that if any new actor is enrolled or an old actor leaves a network it affects the whole network (Cresswell et al., 2010; Doolin & Lowe, 2002). The ability of actors and end-users to contest the problematisation of the technology can be affected by power structures already present in the network. These considerations are naturally relevant to the context of the IOPST in healthcare settings.

Any translation may succeed or fail, but only when failures of technology and networks occur are we able to reveal the underlying reasons and embedded norms and values (Greenhalgh & Stones, 2010; Law & Callon, 1992; Williams-Jones & Graham, 2003). For example, similar to other countries, initial success of the IOPST may lead developers and company executives to be confident of the success of their system in Australia. They may not anticipate issues such as resistance to the system as our initial results and analysis of observations and focus group discussions have identified. In an ANT context, translation that has not properly incorporated the differences in social (nurse's perceptions, requirements, needs) and technology/system offerings has led to these issues arising. However, without ANT it is also easy to dismiss the user perspective as "they just do not get it" which happens frequently in the implementation of information systems into healthcare contexts.

The rationale to choose ANT then, to evaluate the IOPST system lies in itse strength to identify and explore the real and perceived complexities involved in healthcare service delivery systems in hospital wards and translate the interests of actors so that these are then incorporated correctly within the development, implementations and use of the ensuing system.

Although ANT has been applied to the implementation and adoption of different healthcare innovation studies (Berg, 2001; Cresswell et al., 2010; Cresswell et al., 2011; Bossen, 2007; Hall, 2005), it is important to note that ANT has also been criticised for its limitations (Williams, 2007; Walsham, 1997; Cresswell et al., 2010; Cresswell et al., 2011; Greenhalgh & Stones, 2010). Some of the key limitations of ANT identified in the literature include: a lack of ability to pay proper attention to broader social structures (Walsham, 1997); a lack of ability to pay attention to macro-environmental factors (McLean & Hassard, 2004); as well as inability to explain the relationship formations between actors and over changes of events in networks (Greenhalgh & Stones, 2010; Cresswell et al., 2011; Kaghan & Bowker, 2001). To overcome these limitations, many researchers have suggested that ANT can be combined with other theoretical lenses such as Structuration Theory (ST), Strong Structuration Theory (SST), Theory of Practice (ToP) and Social Shaping of Technology (SSoT) (Trudel, 2010; Cresswell et al., 2011; Greenhalgh & Stones, 2010; Walsham, 1997).

In the previous sections, we have discussed ANT and its different components as relevant to this study to explore the various interactions between different actors involved in the formations of actor-networks in a systematic fashion. In the following sections, we explore the roles of the different human and non-human actors. The technology actor (IOPST) will serve as a focal point for revealing what is happening in the actor-networks. Furthermore, the networks involved in the development, implementation and adoption of technology as part of a nursing care solution will also be examined. Tracing the path of the technological actor can help us to identify the key social, technological and organisational issues associated with health information systems development implementation, adoption and use in acute care contexts.

CURRENT SITUATION-NURSING CARE ISSUES

In order to appreciate the full potential for benefits of the IOPST, it is essential to first outline key aspects of nursing care and problems likely to be impacted by the system.

Workflow Processes in Nursing

Communication and coordination of patient care are major issues for the quality and safety of frontline healthcare delivery by nurses (Nagpal et al., 2010, 2012, Kim et al., 2011). In particular, communication between clinicians (intra and inter-professional) and across "care transitions" (between departments and care settings) is essential for continuity of care and patient safety in their care journey through the healthcare system. However, the literature indicates communication and coordination are often not streamlined processes and errors such as mis-interpreted, mis-communicated or omitted information in patient care communication can result in patient harm (Kalisch, Landstrom, & Williams, 2009; Kalisch, 2006). The nurse is a central access point in the healthcare system, one on whom other healthcare professionals rely on to communicate, coordinate, organise and transmit patient progress over time (Asaro & Boxerman, 2008; Cornell, et al., 2010). In this paper, Actor-Network Theory is used to explain the complex framework of processes and interactions that occur between nurses and other 'actors' (e,g, healthcare professionals) and elucidate the potential role for technology in service improvement (refer Figure 1).

Nursing Workflow

The nature of nursing care is complex and at times chaotic (Cornell et al., 2010). Nurses must collect and synthesize a large volume of information to inform their clinical decision making processes and deliver care (Caligtan et al., 2012, Randell et al., 2009; Currey & Botti, 2003). Few other healthcare professionals must complete the multi-layered and complex clinical activities undertaken by nurses whilst simultaneously coordinating and planning ongoing care for their patients.

Observations and description of nursing activities to understand nurses' workflow structure (Caligtan et al., 2012; Cornell, et al., 2010) has been used to construct lists of common nursing tasks; these include care planning, assessment, treatment, medication management, discharge planning and communication activities. Interestingly, communication activities have emerged as one of the most frequent activities performed by nurses. Tracking of nurses' movements over the ward over time has illustrated the repetitive nature and synchronisation of nursing work around the ward environment. Nurses repeatedly demonstrate a "back and forth" nature to their work with constant interruptions and switching of tasks (Cornell et al., 2010, p. 370; Kalisch & Aebersold, 2010). In particular, nurses have been observed to spend considerable time engaged in non-value-adding activities such as "hunting and gathering" ultimately ineffective use of valuable resources (O'Connor et al., 2012). From this example, it is easy to see how nursing workflow patterns that are subject to complex work processes, repetition, frequent

switching of tasks, interruptions, distractions and discrepancies results in high cognitive workloads for nurses and can impact on the efficiency of care delivery processes.

Interruptions, Distractions and Discrepancies

Interruptions, distractions and discrepancies have been implicated as frequently contributing to clinical errors and patient harm (Li et al., 2012; Kalisch & Aebersold. 2010; Westbrook et al., 2010a; Westbrook et al., 2010b). Interactions with other healthcare professionals have been identified as a dominant source of interruptions to nurses during clinical activities (McGillis Hall et al., 2010). The illustration of nurses' position within the acute hospital environment using ANT (Figure 1) highlights the complex relationships and interactions between nurses and other actors. Hence, an interdisciplinary approach is needed to better understand ways to improve the flow and interactions of nursing activities. Technology solutions can improve nurse work processes by supporting easy 'real time' access to information, lessening the cognitive workload, improving communication pathways to reduce the number of interruptions and tasks amidst the many complex interactions between nurses and their work environment (Levin et al., 2006).

Patient Safety and Quality of Healthcare

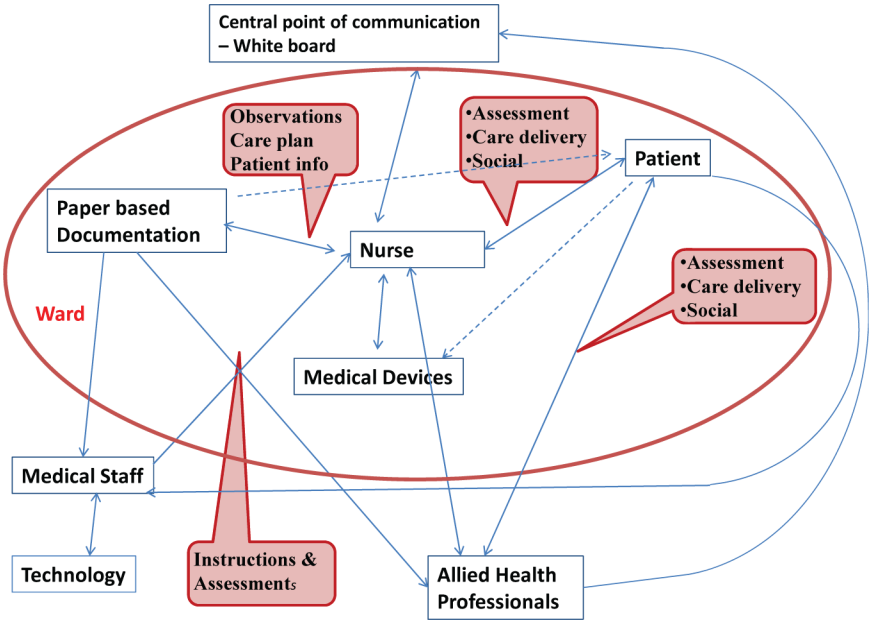
Maintaining high standards of patient safety and quality of care is of paramount concern to nursing work. Current clinical research indicates that some systems and structures to streamline care delivery can increase the risk for missed nursing care (Kalisch & Aebersold, 2010). Missed care can be classified as an error of omission (e.g. forgetting to convey information, leaving a shift without finishing a task, failure to document care delivered) (Kalisch, Landstrom, & Williams, 2009). External factors such as interruptions, multi-tasking, time pressures and high workloads increase the complexity of nursing work, affect nurse performance, stress and fatigue levels, and increase risks to patient safety such as information loss or miscommunication and missed care (Cornell, 2010).

The proposed IOPST solution has potential to assist nurses communicate and coordinate patient care delivery. Figure 3 illustrates opportunities for how the IOPST can reduce demands on the nurse and consequently reduce workload. For example, by replacing paper-based documents, the IOPST can provide convenient access to patient information and enhance communication between care providers (and the patient) about care delivery; it can alleviate some of the cognitive and administrative demands on nurses time to release more time for direct patient interactions and care delivery. ANT can assist with understanding and influencing the transition process to using the IOPST as a replacement for paper based documentation within the complex and dynamic acute healthcare environment.

TECHNOLOGICAL ACTOR: THE INTELLIGENT OPERATIONAL PLANNING AND SUPPORT TOOL (IOPST) SOLUTION

The addition of an IOPST to acute hospital environment has the potential to improve nurses' work processes and flow. Using the latest touch technology and physically placed in convenient locations, such as the patient's bedside (bedside unit) and the nurses' station (Nurse Managers' Unit), this electronic tool can be used to access a range of patient information, plan, prompt and document care delivery in 'real time' on an inpatient ward. The Nurse Managers' Unit tool supports the Nurse Manager to monitor staff workloads and allocate patient care to either individual or teams of nursing staff. At this central location the Nurse Manager can also review nursing care plans, identify planned, completed and missed care activities and tasks, as well as monitor workload and patient health progress during the shift. In addition, the bedside units can be used by nurses at the frontline of care delivery to access patient information, plan,

Figure 3. High level actor interactions



monitor and document their care delivery in real time throughout the 24 hour cycle without the need to leave the patient. The sensor technology and intelligent forms can recognise the patient and staff member, provide immediate visual alerts (e.g. allergies, falls risk) and reminders (e.g. missed or imminent care needs) as well as prompt the collection of specific information often missed using paper documentation (e.g. detailed risk assessment on positive risk screening). While the IOPST is nursing support tool, it allows other healthcare professionals to access up to date information in real time supporting an integrated and coordinated approach to patient care. By providing access to information commonly used by nurses and reminders in real time at the beside, the IOPST assists with reducing nurses cognitive demands and streamlining essential nursing processes. The IOPST can output data usually stored in paper form in multiple combinations and formats to better supports in accurate and timely clinical decision making. The use of prompts can communicate justification for changes or deviation in care processes to other clinicians. Flagging important patient care details and reminders about essential care can minimise the risk for errors of omission such as missed care.

BACKGROUND FOR THE STUDY

This paper provides a discussion of ANT in relation to findings of the first two stages of a longitudinal study. Data collection for the first stage involved four focus groups with 60 nurses purposefully selected from medical and surgical wards at two hospitals in Victoria, Australia. The focus groups were audio recorded and transcribed verbatim for analysis. The data were analysed using two methods; content analysis and thematic analysis. The outcome was a rich description of nurses' reactions to the proposed IOPST in relation to various nursing issues (e.g. information needs, nursing process, complexity and clinical environment) that highlighted the importance of involving nurses during

subsequent cycles of the system development and evaluation.

The second stage was an evaluation of a proof of concept prototype of the IOPST during ten 3 hour sessions over two weeks within a simulated 4-bed ward in a training facility. Participants were 20 volunteer nurses recruited from the same two hospitals used in stage one. The nurse participants were invited to use the prototype IOPST to perform common nursing tasks (patient admission, assessments, care planning, document delivery of wound care and medication administration, handover care to another nurse, respond to an unexpected event and discharge the patient) with actor patients. The actor patients, also volunteers, were provided with a script providing details about a standard patient scenario to guide their interaction with the nurse and assist them respond to questions. After each simulation the nurses participated in a focus group discussion and completed a survey. Observation field notes and video data were collected during all simulated care sessions and focus group discussions were audio recorded and transcribed for analysis. Descriptive statistics were used to analyse the survey data and qualitative field notes, video and transcript data were independently analysed (content and thematic analysis) by researchers from three different disciplines (nursing, health information management and design science) and the findings integrated. The following section reports the findings of the data analysis through the lens of ANT.

ANT ANALYSIS

Common themes that emerged from observations and focus group data were:

1. Actors' interactions through the IOPST Solution;
2. Actors and normative values;
3. Perception and cognition;
4. Organisational change;
5. Competence.

ACTORS' INTERACTIONS THROUGH IOPST SOLUTION

As discussed, Figure 1 depicts the actors' interactions through the IOPST solution using ANT. The Public black box consists of the internal actors of Patient and Family. Hospital refers to the adopting organisation and the Hospital black box includes multiple internal actors. Medical staff and Allied Health Professionals are actors that indirectly interact with the system. Hospital Policy, Professional recording regulations and Technology also indirectly interact or influence the system. For simplicity, these black boxes are not open in the overview. Technology represents the Hospital's existing technologies, policy and management practices.

The actor Ward refers to the acute inpatient wards in the hospital where the system is to be introduced; another black box with internal actors. The actors in the Ward include the Patient, Nurses, Existing Medical Devices, Physical Determinants and the Documentation System. Physical Determinants is used to describe physical objects such as the bed, the bedside table, the patient locker, the bed location in the ward; all of these will have direct impact on the introduction of the technology into the inpatient ward.

Figure 3 depicts nursing practice before introduction of the IOPST, the actants, their relations and tokens passed between them. Pre-introduction of the IOPST, the Ward black box has paper-based documentation. For simplicity, the Physical Determinants actor is excluded from this diagram as its relationship with other actors is not yet essential. The actor 'Central point of communication white boards' is inside the Hospital black box but external to the Ward. It is included in this diagram as it is important to understand its role in communication and information flow between the Ward and the external actors. The directional arrows show the path of information flow.

The focus groups conducted in stage one of the longitudinal study were useful for problem investigation; analyses revealed actual

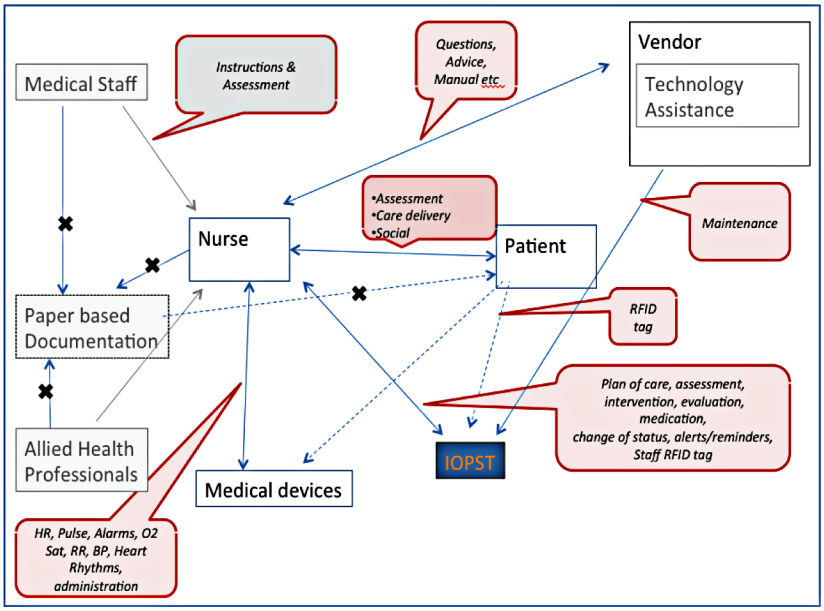
and potential problems generated by nurses' initial reactions to the proposal that smart technology (IOPST) replace the actant 'Paper based Documentation'. The participating nurses expressed concerns about possible impacts on their professional autonomy, trust in the new actor, their skills to use the IOPST, flexibility of the IOPST to respond to their work needs and complex care tasks, accessibility to information that support their decision-making, and how the IOPST will interface with other existing actors (Doctors, Medical Devices and existing systems). Some suggested such a tool was long overdue.

Figure 4 illustrates the actor network and their relations to each other evident in the preclinical trial conducted for the purpose of proof of concept of the IOPST. The trial was set in a simulated ward, where a number of volunteer nurses used the IOPST prototype to conduct a pre-determined set of simulated nursing tasks while interacting with patient-actors. The Vendor participated in the trial by providing technical assistance to the nurses and maintenance of the (IOPST) system.

Data (focus group, survey and video) analyses revealed nurses' reactions to introduction to the IOPST and factors that influenced their acceptance and usability in the simulation setting. The small set of actors involved in the study is illustrated in Figure 4; they included the Nurse, the Patient, the IOPST and limited Medical Devices under observation. In this study, the IOPST actor was not connected with other actors such as Medical Staff, Allied Health, and the technologies existing in the ward; therefore these actants are illustrated using grey boxes.

IOPST is the new technology non-human actor (actant) and the 'Paper based Documentation' (non-human actant) was the out-going actor. Relationships between these actants with other actors were examined in detail and illustrated in in Figure 4. The relationship between the Patient and Paper based Documentation is a weak relationship as the Patient is not authorised to access their clinical information in hospital records. This relationship will be broken with the introduction of the new IOPST. Similarly, the relationship between the Nurse and the

Figure 4. ANT actor interaction with IOPST



out-going actor Paper based Documentation is replaced with the relationship Nurse-IOPST. The tokens (paper forms, observation notes, handover notes, information patient records etc) were replaced with electronic formats. In addition, sensor (RFID) signals were passed from actors (the Nurse and Patient) to the IOPST.

Figure 4 models the changes to from the earlier diagram (Figure 3) in Nurses' tasks, roles and interactions as Nurses' reacted to the new actant (the IOPST). Nurse interactions can be examined in more detail by creating a black box of actors: Nurse, and/or examine the technology actant, the IOPST, by making it a black box with internal actors such as Terminals, Nursing Station, and Server. Each of these internal actors has its own set of functionality visible to different Nurses' roles (users).

Close examination of the involved actors and their interactions in the simulation trial reveals greater complexity that expected for a simple 'replacement' of actors. This is attributed to the legacy of the out-going 'Paper-based Documentation' where actors left behind old behaviours (old practice, habits, documentation behaviours) and faced challenges and opportunities not yet explored and realised by the Nurse actor.

ACTORS AND NORMATIVE VALUES

Health information technologies are not simply flaccid entities developed by software developers and used by healthcare staff and patients. These technologies can shape and be shaped by human behaviour, relations, and society. However, this is just part of a wider set of socio-technical and psycho-social issues, the effects of which are discussed in the literature. For example, how healthcare service providers deal with the complexities of information generated by health information systems (Skolnik, 2011; OECD, 2010; Ash, Berg, & Coiera, 2004; Berg, 2001), how information can affect their decision making process (Carpenito-Moyet, 2008; Devettere, 2009; Fulcher & Kaukinen, 2004; Ohs, 2008) and how can information systems affect daily routines (Ash, Berg, & Coiera, 2004; Campbell et al., 2006; Lewis et al., 2012; Wu et al., 2006; Yusof, Kuljis, Papazafeiropoulou, & Stergioulas, 2008) are important questions.

Applying an ANT analysis and thinking to the IOPST as actor in a network expands the scope of issues to be considered. As with other technologies (e.g. Computers, television sets), there are normative values embedded in the scripts of health information technologies (e.g. the IOPST) which define how these systems should be implemented and used. On the other hand, users (the Nurses) have their own set of values embedded in their behaviours, practices, attitudes and beliefs. The transformation from the present system (e.g. paper-based documentation system) where nurses like to do things in a particular way, on their terms and in their best interests will not be easy to achieve.

It was observed during the trial that the normative values concerning nursing documentation was challenged with the IOPST. One example is quick access to different sections of nursing information, traditionally using a tab system found in hospital paper-based documentation was challenged with the new user interface of the IOPST. Instead nurses needed to use clicks, different windows, different ways to search and access digital information using the IOPST. Another example was that the 'flexible' post-hoc practice of documentation was challenged by real time documentation. This resented a significant change to nurses' usual workflow patterns. The way professional autonomy (the Nurses' decision-making) and care safety could be investigated, supported and improved when documenting nursing information through the system (using alerts, warning, data validation) is yet another example.

The normative value for nurses is their inclination towards patient care and health outcomes where they feel the system is a big hurdle for this task as explained by one nurse:

My feeling was that I was ignoring the patient, because I was so busy trying to navigate the system and going oh my God, that is not the way we've been taught and used to work.

They reported the system changing the way they interacted with the patient; for example one nurse during the focus group highlighted her concerns in these words:

I usually write notes after I finish with the patent but with the system it is hard to write notes while you hold the iPad in one hand and try to write something and pay intention to the patient. Sometimes you have to go to the bed side where you can put down your system and write. By doing so, sometimes the patient is not exactly in your sight. I feel sometimes I am physically there but mentally not there.

For the new actor, the IOPST, to successfully act as OPP and negotiate with and convince the other actors (the Nurse) at the stage Interessement (and subsequently Enrolment), it should support their normative values while at the same time add new value to address the concerns (care safety, quality, efficiency) identified during Problematisation.

PERCEPTION AND COGNITION

Perception allows humans to sense, isolate and acknowledge physical input, whereas cognition refers to higher level of mental functions including language, information processing, strategic planning and development of rules, learning and knowledge gaining and judgment (Hasler, 1996; McFarland & Cacace, 1999; Sawyer, 1997). During the video debriefing sessions it was observed that the majority of nurses reflected both mixed and positive opinions that the system can improve patient care and can help them with their daily tasks of documentation. On day 1 of the trial one nurse 1 stated:

Journals are not clear - need to have more clear way of putting nursing notes but overall it's good and I am excited about this system. [Nurse 1]

It was also expressed as concern that technology can and will radically change every aspect of patient care and is a must have next step. Such first impressions are critical, they shape people's attitudes towards the system based on its initial functionality and ease of use. Similarly, frustrations also play a critical role in the decision making process and can lead to rejection when expectations are not met; problems are not resolved effectively and in a timely manner, or support is not available when needed. Examples were observed in all video data and supported by nurses in focus group interviews with comments such as:

I find this system very autonomous; we are not used to working with a system like this and put things in the iPad. Secondly, I am very used to having a plan where I can tick things on a white board so it would be better if the system would give us a task activity where we can tick off tasks and they need to be personalised or something like that feature. [Nurse 2]

Another nurse expressed similar opinions and reflected that the system was very hard to use and the learning curve too big for her to overcome:

I find it really hard to find the overall picture of what is happening with the patient. I could not find the patient summary, patient diagnosis, reason for the admission. I could open up the admission paperwork to try to get the understanding and then it really could not give me the Braden assessment and get the score. I understand this system is a prototype but it gave me no score. I have to go to each question. This is important when you get into a scenario if someone has put any alert on that

patient and you would like to know their score. It is important to identify the patient and their medical history and some sort of clinical summary would be helpful and this system, at the moment does not offer this. [Nurse 3]

Nurses perceptions regarding the usability of the system had a very strong impact on their acceptably of the system. For acceptability of this system, it is important to translate user interest into system offerings so the users can be enrolled into the network successfully. Finally, ease of use, user friendliness of the system interface, fast and accurate processing of information and flexibility of data entry and retrieval were the common themes among nurse participants.

PROCESS RE-ENGINEERING AND CHANGE MANAGEMENT

Health information system implementations are said to enhance work flow and speed up care process in wards (Mort et al., 2009; McLaughlin & Kaluzny, 2006; Wickramasinghe & Schaffer, 2010). But such interventions are neither simple nor easy. Rather, they need very thoughtful and well planned applications of process reengineering and change management. Users can and will resist any change in the form of a new technology implementations. In the case of the IOPST, the nurses were frustrated because of poor problematisation. At this stage, the problem was not properly identified even though the actors were identified; their interests were not identified nor properly framed. Therefore, it was observed that identifying the primary actor was very difficult. Further, the system was slow, increased user tasks, and had a poor synergy with 'real life' nursing work flow. All levels of nursing staff indicated it was very difficult to maintain positive attitudes about the IOPST system and move forward with the system use. Nurses attributed slow interaction between users and iPads to the system design. Moreover, they distrusted the system and thought it would not add any significant improvement to their work process in the current state. In addition, it was observed that during the initial trials, data entry and information retrieval was very slow because of the difficulty for users in finding the correct screen, selecting the correct charting place, a difficult/ unfamiliar user interface, multiple screens, differences in terminologies between paper charts and journals and the format of the IOPST charts and journals.

These issues slowed down the nursing care and led to dislike of the system right from the beginning, creating uncertainty and poor clinical documentation.

As described by one nurse:

Maybe like if you click on their photo or name and some kind of drop down menu something might be there. Nurse 3 date of admission, main presenting practices, and I even could not find where their past history is. I find nursing journal to be very composite because there are so many different pieces of information. This would be ok if you are there for short period of time like 24 hours. I imagine if you gonna be there for longer period of time the longer that list gonna get it will get very complex and if it says nursing notes this will start getting more complex and probably you are going to skip them. There are many tabs and they were not standing out they need to be differentiate themselves from each other. [Nurse 4]

When asked "do you think it was difficult to use this system?" one nurse responded:

I don't know. I think the time line needs to be simple and give choices to nurse what she wants to see in the time line. Mostly, important features are not there, if they are then there is no coordination between different screens. For example, I saw the alerts were orange telling me that blood pressure has not been done but when I went to the patient I found it was actually done but there was no coordination between alerts and blood pressure information. [Nurse 3]

Nurses were both positive and negative about their changing roles. New nurses appeared to be somewhat more positive about the system and its potential for useability after proposed changes to the system user interface and additional functionality. They believed the system would be easier to accept and use once it is learned properly:

I think once you learn the system it is a lot quick and you can see everyone is up to date and under control which we were not able to do before. [Nurse 5]

When asked "do you think it would have an impact?" this nurse answered:

Hard to tell because I was just trying to focus on my clinical role but there are many administrative things this system has to consider but overall I think it will add to the ease of the role I honestly believe it would add some value" [Nurse 5]

Alternatively, experienced nurses were somewhat critical about the system in its current state, as one senior nurse expressed:

The system is changing the way we interact with the patient. ... For example I usually write notes after I finish with the patent but with the system it is hard to write notes while you hold the iPad in one hand and try to write something and pay attention to the patient. [Nurse 3]

WORKABLE SYSTEM AND SYSTEM SUPPORT

During the trial of the IOPST system it was observed that availability of technology support staff was the most critical factor for the system use. Nurses were observed much of the time to become stuck with system any not know how to use it, requiring help. Sometimes finding a feature or information was very difficult. Problem resolution was also a significant concern and was discussed in every debriefing after the simulation. When the system was not working properly or was not understood by nurses it was seen as hindered care processes. Nurses spent extended time browsing the system to find information and adding new information while ignoring their patients.

COMPETENCE

Initial and ongoing training was a prominent theme identified in both observations and focus group debriefings. Participants expressed how important training and practice are in learning and using new systems as expressed by one of the nurses:

I think it's just practice and education. Practice and training is needed to get used to the system.

Further, the nurses indicated that while initially it might be hard, once they learn and understand the system it would become easy to use. Another nurse explained her concerns as:

Overall, too challenging but I can see that it is good, when you get used to it, it's a new thing, it about find information and how to use it.

DISCUSSION AND CONCLUSION

Simulation and focus group results strongly supported the merits of the IOPST solution. However, after applying the lens of ANT, we can see a much more complex environment. Specifically, we noted that implementation strategies must address the common themes that emerged from the focus group and simulation observations namely: Actors' interactions through the IOPST solution, Actors and normative values, Perception and cognition, Organisational change and System competence. Further, the IOPST would be best prepared for a successful implementation by aligning its interests with the normative values of its users and increasing nurse initial satisfaction with the use of the technology.

Developing a requirements framework to shape perception and cognition may also help with a successful implementation strategy. The initial results indicate that user requirements were not studied properly during the system development processes which are likely to lead to decreased satisfaction of nursing staff.

Strategies to manage change associated with implementation need to be developed. In addition, there needs to be close alignment between the new system offerings and current nursing practices for a smooth workflow and successful transition to ensue. Any mismatch will likely lead to uncertainty and denial. This in turn can lead to misuse of the system, workarounds and negative attitudes of the users. Finally, system design and user interface issues were also of concern to the nurses.

This paper has served to show the benefits of applying an ANT lens of analysis to a preclinical testing of a new technology developed for the acute healthcare setting in order to further understand the richness and potential challenges, complications and complexities of interactions. We note that while simulation provides an important and necessary context for obtaining pre-clinical data they often do not facilitate the gathering of more complex contexts as the preceding discussion has uncovered. Data from real clinical settings is also essential if a true and rich picture of the context is to be appreciated and ascertained. In contrast without such understanding, high failure is likely. We believe incorporation of an ANT analysis has provided essential and rich data and important learnings to guide the subsequent stages of technology implementation. We have illustrated this with the example of the IOPST study. Our next steps include a 'real life' clinical trial to provide realistic mapping of the IOPST within the rich and complex clinical environment This approach will ultimately enable the most appropriate approach to design, development, implementation and adoption of the IOPST solution.

REFERENCES

Asaro, P. V., & Boxerman, S. B. (2008). Effects of computerized provider order entry and nursing documentation on workflow. *Academic Emergency Medicine*, *15*(10), 908–915. doi:10.1111/j.1553-2712.2008.00235.x PMID:18785946.

Ash, J. S., Berg, M., & Coiera, E. (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), 104–112. doi:10.1197/jamia.M1471 PMID:14633936.

Berg, M. (2001). Implementing information systems in health care organizations: Myths and challenges. *International Journal of Medical Informatics*, *64*(2-3), 143–156. doi:10.1016/S1386-5056(01)00200-3 PMID:11734382.

Bossen, C. (2007). Test the artefact – develop the organization: The implementation of an electronic medication plan. *International Journal of Medical Informatics*, *76*(1), 13–21. doi:10.1016/j.ijmedinf.2006.01.001 PMID:16455299.

Caligtan, C. A., Carroll, D. L., Hurley, A. C., Gersh-Zaremski, R., & Dykes, P. C. (2012). Bedside information technology to support patient-centered care. *International Journal of Medical Information, 81*(7), 442-451. doi: S1386-5056(11)00265-6 [pii] 10.1016/j.ijmedinf.2011.12.005

Callon, M. (1986). Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. In J. Law (Ed.), *Power, action and belief: A new sociology of knowledge?* (Vol. 32, pp. 196–233). London, UK: Routledge & Keagan Paul.

Callon, M., & Law, J. (1995). Agency and the hybrid collectif. *The South Atlantic Quarterly*, *94*(2), 481–505.

Campbell, E. M., Sittig, D. F., Ash, J. S., Guappone, K. P., & Dykstra, R. H. (2006). Types of unintended consequences related to computerized provider order entry. *Journal of the American Medical Informatics Association*, *13*(5), 547–556. doi:10.1197/jamia.M2042 PMID:16799128.

Carpenito-Moyet, L. J. (2008). *Nursing diagnosis: Application to clinical practice*. Lippincott Williams & Wilkins.

Cornell, P., Herrin-Griffith, D., Keim, C., Petschonek, S., Sanders, A. M., & D'Mello, S. et al. (2010). Transforming nursing workflow, part 1: The chaotic nature of nurse activities. *The Journal of Nursing Administration*, *40*(9), 366–373. doi:10.1097/NNA.0b013e3181ee4261 PMID:20798619.

Cresswell, K., Worth, A., & Sheikh, A. (2011). Implementing and adopting electronic health record systems: How actor-network theory can support evaluation. *Clinical Governance: An International Journal*, *16*(4), 320–336. doi:10.1108/14777271111175369.

Cresswell, K. M., Worth, A., & Sheikh, A. (2010). Actor-network theory and its role in understanding the implementation of information technology developments in healthcare. *BMC Medical Informatics and Decision Making*, *10*, 67. doi:10.1186/1472-6947-10-67 PMID:21040575.

Currey, J., & Botti, M. (2003). Naturalistic decision making: A model to overcome methodological challenges in the study of critical care nurses' decision making about patients' hemodynamic status. *American Journal of Critical Care*, *12*(3), 206–211. PMID:12751394.

Devettere, R. J. (2009). *Practical decision making in health care ethics: Cases and concepts*. Georgetown University Press.

Doolin, B., & Lowe, A. (2002). To reveal is to critique: actor-network theory and critical information systems research. *Journal of Information Technology*, 69–78. doi:10.1080/02683960210145986.

Fulcher, C. L., & Kaukinen, C. E. (2004). Visualizing the infrastructure of US healthcare using Internet GIS: a community health informatics approach for reducing health disparities. *Studies in Health Technology and Informatics*, *107*(Pt 2), 1197–1201. PMID:15361002.

Greenhalgh, T., & Stones, R. (2010). Theorising big IT programmes in healthcare: strong structuration theory meets actor-network theory. *Social Science & Medicine*, *70*(9), 1285–1294. doi:10.1016/j.socscimed.2009.12.034 PMID:20185218.

Hall, E. (2005). The 'geneticisation' of heart disease: A network analysis of the production of new genetic knowledge. *Social Science & Medicine*, *60*(12), 2673–2683. doi:10.1016/j.socscimed.2004.11.024 PMID:15820579.

Harding, S. G. (2004). *The feminist standpoint theory reader: Intellectual and political controversies*. Routledge.

Hasler, R. A. (1996). Human factors design--what is it and how can it affect you? *Journal of Intravenous Nursing: The Official Publication of the Intravenous Nurses Society*, *19*(3Suppl), S5–S8. PMID:8716331.

Kaghan, W., & Bowker, G. (2001). Out of machine age? Complexity, sociotechnical systems and actor-network theory. *Journal of Engineering and Technology Management*, *18*, 253–269. doi:10.1016/S0923-4748(01)00037-6.

Kalisch, B. J. (2006). Missed nursing care: A qualitative study. *Journal of Nursing Care Quality*, *21*(4), 306–313. doi:10.1097/00001786-200610000-00006 PMID:16985399.

Kalisch, B. J., & Aebersold, M. (2010). Interruptions and multitasking in nursing care. *Joint Commission Journal on Quality and Patient Safety*, *36*(3), 126–132. PMID:20235414.

Kalisch, B. J., Landstrom, G., & Williams, R. A. (2009). Missed nursing care: Errors of omission. *Nursing Outlook*, *57*, 3–9. doi:10.1016/j.outlook.2008.05.007 PMID:19150261.

Kim, C. S., Calarco, M., Jacobs, T., Loik, C., Rohde, J., McClish, D., ... Campbell Jr, D. A. (2012). Leadership at the front line: A clinical partnership model on general care inpatient units. *American Journal of Medical Quality, 27*(2), 106-111. doi: 1062860611413257 [pii] 10.1177/1062860611413257

Latour, B. (1993). *We have never been modern*. Harvard University Press.

Latour, B. (1996). On actor-network theory: A few clarifications. *Soziale Welt*, 369–381.

Latour, B. (2005). *Reassembling the social: An introduction to actor-network theory*. Oxford, UK: Oxford University Press.

Law, J. (1999). After ANT: Complexity, naming and topology. In J. Law, & J. Hassard (Eds.), *Actor network theory and after* (pp. 1–14). Oxford, UK: Blackwell Publishers/The Sociological Review.

Law, J. (2001). *Networks, relations, cyborgs: On the social study of technology (draft).* Lancaster University: Centre for Science Studies and the Department of Sociology. Retrieved December 1, 2012, from http://www.comp.lancs.ac.uk/sociology/soc042jl.html

Law, J. (2006). *Networks, relations, cyborgs: On the social study of technology.* Retrieved from http://oro.open.ac.uk/21394/

Law, J., & Callon, M. (1992). The life and death of an aircraft: A network analysis of technical change. In W. E. Bijker, & J. Law (Eds.), *Shaping technology-building society: Studies in sociotechnical change*. Cambridge, MA: MIT Press.

Levin, S., France, D., Mayberry, R. S., Stonemetz, S., Jones, I., & Aronsky, D. (2006). The effects of computerized triage on nurse work behaviour. *AMIA Annual Symposium Proceedings* (pp. 1005).

Lewis, D., Hodge, N., Gamage, D., & Whittaker, M. (2012). Understanding the role of technology in health information systems. *Pacific Health Dialog*, *18*(1), 144. PMID:23240349.

Li, S. Y., Magrabi, F., & Coiera, E. (2012). A systematic review of the psychological literature on interruption and its patient safety implications. *Journal of the American Medical Informatics Association*, *19*(1), 6–12. doi:10.1136/amiajnl-2010-000024 PMID:21946236.

McFarland, D. J., & Cacace, A. T. (1999). Defining perception and cognition. *The Behavioral and Brain Sciences*, *22*(03), 385–385. doi:10.1017/S0140525X99432029.

McGillis Hall, L., Ferguson-Pare, M., Peter, E., White, D., Besner, J., Chisholm, A., & Hemingway, A. (2010). Going blank: factors contributing to interruptions to nurses' work and related outcomes. *Journal of Nursing Management*, *18*, 1040–1047. doi:10.1111/j.1365-2834.2010.01166.x PMID:21073575.

McLaughlin, C. P., & Kaluzny, A. D. (2006). *Continous quality improvement in health care: Theory, implementations, and applications*. Jones & Bartlett Learning.

McLean, C., & Hassard, J. (2004). Symmetrical absence/symmetrical absurdity: Critical notes on the production of actor-network accounts. *Journal of Management Studies*, *41*(3), 493–519. doi:10.1111/j.1467-6486.2004.00442.x.

Mol, A. (1999). Ontological politics. A word and some questions. In J. Law, & J. Hassard (Eds.), *Actor-network theory and after* (pp. 74–89). Oxford, UK: Blackwell Publishers/The Sociological Review.

Mort, M., Finch, T., & May, C. (2009). Making and unmaking telepatients: Identity and governance in new health technologies. *Science, Technology & Human Values*, *34*(1), 9–33. doi:10.1177/0162243907311274.

Muhammad, I., Teoh, S. Y., & Wickramasinghe, N. (2012). Why using actor-network theory (ANT) can help to understand the personally controlled electronic health record (PCEHR) in Australia. *International Journal of Actor-Network Theory and Technological Innovation*, *4*(2), 44–60. doi:10.4018/jantti.2012040105.

Nagpal, K., Arora, S., Vats, A., Wong, H. W., Sevdalis, N., Vincent, C., & Moorthy, K. (2012). Failures in communication and information transfer across the surgical care pathway: Interview study. *BMJ Quality Safety, 21*(10), 843-849. doi: bmjqs-2012-000886 [pii] 10.1136/bmjqs-2012-000886

Nagpal, K., Vats, A., Ahmed, K., Smith, A. B., Sevdalis, N., & Jonannsson, H. et al. (2010). A systematic quantitative assessment of risks associated with poor communication in surgical care. *Archives of Surgery*, *145*(6), 582–588. doi:10.1001/archsurg.2010.105 PMID:20566980.

O'Connor, P., Ritchie, J., Drouin, S., & Covell, C. L. (2012). Redesigning the workplace for 21st Century healthcare. *Healthcare Quarterly*, *15*(Special Issue), 30–35. PMID:22874444.

OECD. (2010). *OECD health policy studies improving health sector efficiency the role of information and communication technologies: The role of information and communication technologies*. OECD Publishing.

Ohs, J. E. (2008). *Health-care decision making at the latter end of the lifespan*. ProQuest.

Randell, R., Mitchell, N., Thompson, C., McCaughan, D., & Dowding, D. (2009). From pull to push: Understanding nurses' information needs. *Health Informatics Journal*, *15*(2), 75–85. doi:10.1177/1460458209102969 PMID:19474221.

Sawyer, D. (1997). *Do it by design - An introduction to human factors in medical devices*. WebContent. Retrieved December 24, 2012, from http://www.fda.gov/medicaldevices/deviceregulationandguidance/guidancedocuments/ucm094957.htm

Singleton, V. (1996). Feminism, sociology of scientific knowledge and postmodernism: Politics, theory and me. *Social Studies of Science*, *26*(2), 445–468. doi:10.1177/030631296026002010.

Singleton, V., & Michael, M. (1993). Actor-networks and ambivalence: General practitioners in the screening programme. *Social Studies of Science*, *23*, 227–264. doi:10.1177/030631293023002001.

Skolnik, N. S. (2011). *Electronic medical records: A practical guide for primary care*. Springer. doi:10.1007/978-1-60761-606-1.

Trudel, M. C. (2010). *Challenges to personal information sharing in interorganizational settings: Learning from the Quebec health smart card project*. The University Of Western Ontario.

Walsham, G. (1997, May 31st–June 3rd). Actor-network theory and IS research: Current status and future prospects. In *Proceedings of the IFIP TC8 WG 8.2 International Conference on Information Systems and Qualitative Research*, Philadelphia, PA (pp. 466–81).

Westbrook, J. I., Coiera, E., Dunsmuir, W. T., Brown, B. M., Kelk, N., Paoloni, R., & Tran, C. (2010b). The impact of interruptions on clinical task completion. *Quality & Safety in Health Care*, *19*(4), 284–289. doi:10.1136/qshc.2009.039255 PMID:20463369.

Westbrook, J. I., Woods, A., Rob, M. I., Dunsmuir, W. T., & Day, R. O. (2010a). Association of interruptions with an increased risk and severity of medication administration errors. *Archives of Internal Medicine*, *170*(8), 683–690. doi:10.1001/archinternmed.2010.65 PMID:20421552.

Wickramasinghe, N., & Bali, R. K. (2009). The S'ANT imperative for realizing the vision of healthcare network centric operations. *International Journal of Actor-Network Theory and Technological Innovation IJANTTI*, *1*(1), 45–58. doi:10.4018/jantti.2009010103.

Wickramasinghe, N., Tatnall, A., & Goldberg, S. (2011). The advantages of mobile solutions for chronic disease management. In *Proceedings of the PACIS 2011*. Retrieved from http://aisel.aisnet.org/pacis2011/214

Williams, R. (2007). Managing complex adaptive networks. In *Proceedings of the 4th International Conference on Intellectual Capital, Knowledge Management & Organizational Learning* (pp. 441–452).

Williams-Jones, B., & Graham, J. E. (2003). Actor-network theory: A tool to support ethical analysis of commercial genetic testing. *New Genetics & Society*, *22*(3), 271–296. doi:10.1080/1463677032000147225 PMID:15115034.

Wu, S., Chaudhry, B., Wang, J., Maglione, M., Mojica, W., & Roth, E. et al. (2006). Systematic review: Impact of health information technology on quality, efficiency, and costs of medical care. *Annals of Internal Medicine*, *144*(10), 742–752. doi:10.7326/0003-4819-144-10-200605160-00125 PMID:16702590.

Yusof, M. M., Kuljis, J., Papazafeiropoulou, A., & Stergioulas, L. K. (2008). An evaluation framework for Health Information Systems: human, organization and technology-fit factors (HOT-fit). *International Journal of Medical Informatics*, *77*(6), 386–398. doi:10.1016/j.ijmedinf.2007.08.011 PMID:17964851.

Imran Muhammad (Masters in Business (ERP Systems), Masters in Business Information Systems) is a PhD student at Royal Melbourne Institute of Technology (RMIT University), Australia. His primary research interests are in the area of business information systems especially in the area of healthcare information systems management and electronic health records (EHR). He has more than five years of teaching and research experience in different areas of business information systems and management.

Fatemeh Hoda Moghimi is currently a PhD student in Information Systems from the RMIT University. Trough her work experience in different industries as a system developer and analysis, she has acquired skills in fields such as implementing Business Intelligence, Data Mining, data warehouse as well as IT solution selection for enterprises. Her academic research interests are in the area of health informatics, intelligent solutions and e-services, focusing on data science techniques and design science methods. She published some national and international conference papers through HICSS, AMCIS, PACIS, BLED, IITA, ICTM & EGMM and journal papers through international journals of Health & Technology, Economic & Management as well as Knowledge Management. She is also recipient of IPRS (international postgraduate research scholarship) in 2010 as well as Australian postgraduate award in 2011.

Nyree J. Taylor is a Registered Research Nurse working for the Nursing Research Unit at Eastern Health. Nyree has worked for many years in clinical practice (cardiac) whilst simultaneously working with tertiary institutions studying Nursing Research. She holds her Honours degree in Nursing and recently participated in a return to practice program as a means of extending her appreciation of clinical and operational activities in Nursing. She was the leading Project Officer in a research project funded by the Department of Health Victoria, which looked the value of Mature workers in the workforce. She is here today to talk of her experience in research with a focus on her experience in coordinating the "Sharing the Wisdom" project. She is motivated and excited with the opportunity to gain insight and extend understanding through strategies which benefit the wider Nursing Profession.

Bernice Redley is a Senior Research Fellow in the Epworth Deakin Centre for Clinical Nursing Research, a partnership between Deakin University and Epworth Healthcare. She has over 25 years experience working across hospital, university and government settings. She has excellent knowledge of acute hospital and emergency department care, health system models of care and performance and delivery of clinical care. Her research interests include quality and safety in the delivery of clinical care, health service and system improvement, interprofessional communication and team performance and use of new technologies for improving healthcare delivery.

Lemai Nguyen has a broad range of research interests including health informatics, creative problem solving in business requirements analysis, and social informatics. In health informatics, her research focuses on information needs and information behaviours of the patients, their family carers and healthcare professionals, and on the introduction and evaluation of the impact of nursing information systems on healthcare service provision. Lemai's research is widely published in international scholarly journals, book chapters, and fully referred conferences. She has been Program Chair / Track Chair for a number of academic conferences. Lemai is Secretary of Special Interest Group in Aged Care Informatics of Health Informatics Society of Australia, Member of Association for Information Systems, and Member of Australian Computer Society.

Malte Stien received his masters degree in Technical Computer Science at the Technical University of Berlin/Germany where he specialised in the fields of process automation and robotics. Malte devoted the following four years to research in the healthcare sector, more precisely in the field of surgical robotics, at the Charite. There he received a PhD for his work on graphical simulation and monitoring of robot-assisted surgical interventions. He is the author of a number of publications in this field. Shortly after, Malte moved to Australia where he worked for the Australian National University and Roads and Traffic Authority on a safety-critical systems engineering project. In 2006 he founded his own company developing software code generation technology and providing consultancy services. Amongst others, Dr Malte Stien worked for the Australian Research Council, where he was key to the successful development of the Research Management System. He joined SmartWard in 2010 where he is now the company's CTO.

Bridie Kent gained a PhD in Nursing in 1998 and has held both clinical and academic appointments, resulting in extensive experience in quality improvement, practice change, and health services education and research. For the last 18 years she has played a leading role in evidence-based practice uptake and implementation in the UK, New Zealand and Australia. Her research interests focus on knowledge translation and practice improvement, primarily in acute care settings. She is the Director of the JBC Deakin Centre for Quality and Risk Management in Healthcare and Chair of Nursing at Eastern Health. Bridie is also an editor for Implementation.

Mari Botti was appointed the Epworth Deakin Chair of Nursing in 2004, and has held academic appointments for over 20 years. Professor Botti co-ordinates the Bachelor of Nursing (Honours) program, is Chair of the Deakin University Human Research and Ethics Committee, and a member of the Epworth Human Research and Ethics Committee. She also leads the Epworth Deakin Centre for Clinical Nursing Research. Her specific research and clinical interests are in postoperative pain management, investigation of models of care that encourage patient engagement in their care, safety and wellbeing, and the use of data to improve quality and safety in healthcare.

Nilmini Wickramasinghe (PhD, MBA, Grad DipMgtSt, BSc, AmusA (violin) AmusA (piano)) Epworth Chair Health Information Management, researches and teaches within the information systems domain with particular focus on developing suitable models, strategies and techniques grounded in various management disciplines to facilitate more effective design, development and implementation of IS/IT solutions to effect superior, patient centric healthcare delivery. She has collaborated with leading scholars at various premier healthcare organizations throughout Australasia, US and Europe. She is well published with more than 300 referred scholarly articles, more than 10 books, numerous book chapters, an encyclopaedia and a well-established funded research track record. Professor Wickramasinghe is the editor-in-chief of two scholarly journals published by InderScience: Intl. J. Biomedical engineering and Technology *(www.inderscience.com/ijbet) and* Intl. J Networking and Virtual Organisations*(www.inderscience.com/ijnvo). As of Dec 2009 she has been a professor at the school of Business IT and Logistics at RMIT University, Australia and a core member of the Health Innovation research Institute(HIRi) at RMIT.*