# 10 TRANSFORMING WORK PRACTICES IN A COMPLEX ENVIRONMENT

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**Abstract** *Nursing work is intertwined with a number of technologies. This paper explores the work practices in a pediatric intensive care unit, and discusses some possible directions for introducing new technologies. Work in intensive care is approached as a set of complex and networked practices that are characterized by dynamism and reflexivity of situated action. We observed how, in the intensive care unit, the emerging issues and complexity of organizational action are anticipated with situational adaptability and self-ordering of action. Although the nurses are capable of adapting to rapidly changing situations, at the same time, the nursing practices are bounded by the situational rationalities, such as the information available on the patient. With new technologies, we see several opportunities for change in time-place arrangements, in coordination and communication practices, and in information sharing practices. The roles and tasks of the various actants may reformulate, and thereby possibly their skills and professional identities as well. All of this will take place when work practices, new technologies, and care processes are negotiated and made irreversible through the actions of the participants.*

**Keywords** Work practices, intensive care, nursing, actor-network theory, complexity theory

## 1 INTRODUCTION

This paper describes the work practices of nurses in a pediatric intensive care unit (ICU), which we wanted to record in order to understand how technologies and work practices relate to each other and in order to follow and document changes during and

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after the adoption of new technologies. For example, electronic patient record systems are expected to enhance nursing documentation activities and thereby the quality and traceability of care (Berg 2001). As these systems enable rearranging work and reforming work practices, they also constrain work in unanticipated ways (Orlikowski 2002).

Continuous changes and diverse and often fast-paced work tasks contribute to the organizational complexity in hospitals, where a large number of interacting bodies act together to advance patients' health. Even though computers have been in use in this hospital since 1970s, there is no integrated system that would cover all areas of care. The patchy information technology infrastructure contributes to the complexity even when it is robust and reliable in parts. We can also assume that complexity in hospitals continues to grow as the hospitals become increasingly connected (Cohen 1999; Jacucci et al. 2006; Merali 2004) with, for example, municipal health centers, private clinics, government agencies (e.g., the national electronic patient record archive currently under construction), or pharmacies (electronic prescriptions will be used from 2009 on).

In this study, nursing work practices are explored as part of a socio-technical assemblage, where shared work practices are jointly formed and reformed (Latour 2005). Barnes (2001) argues that practices do not reduce to individuals, but that any social system is characterized by a set of shared practices generated in ongoing and self-reproducing action as "socially recognized forms of activity, done on the basis of what members learn from others, and capable of being done well or badly, correctly or incorrectly" (p. 19). Understanding such shared practices means an understanding of wider cultural phenomena in a given context. In this sense, shared practices are ways to distinguish one's own working community from others, from outsiders (Latour 2005). Practices form an invisible, taken-for-granted set of attitudes and reward structures (Haythornthwaite 2006) and in this way contribute to a transparent infrastructure that is inherent to a community (Star and Ruhleder 1996). Haythornthwaite (2006) sees practices as instantiated in the technologies used to accomplish work, that is, work practices are enacted through or around some kind of social or physical technology. Our aim is to observe the transparent infrastructure of the ICU nurses, also as manifested by the use of various technologies.

## 2 CONCEPTUALIZING INTENSIVE CARE WORKING

An intensive care unit is a small component in the overall complexity of a hospital. In itself, it is a complex system, as well. It involves many collaborating groups of people such as pediatricians, surgeons, assisting physicians, anesthesiologists, nurses specialized in intensive care, supporting staff, and multiple social, physical, or electronic technologies that all contribute to the complexity (Schneider and Wagner 1993; Wiener et al. 1979). However, there is a constant struggle to simplify work practices and create routines in order to resist the complexity and reduce the effort needed in work situations. This drive for simplicity includes not only emerging uses of various technologies but also embedded organizational roles, skills, and professional identities, hospital guidelines, and situational arrangements. What we see, however, is that much of the nurses' work relies on intuition (Effken 2001; Lauri and Salanterä 1998; Salanterä et al. 2003), especially when situations demand immediate action. The organizational members of a hospital unit

form a community of self-organizing actors that interact in a dynamic, nonlinear fashion with a common history (Cilliers 1998) in this complex world.

In the classical systems paradigm, information systems are conceptualized as holistic, well-defined systems with clear boundaries, striving for stability. According to Merali (2004), such systems can be *complicated* in that they consist of many components. She contrasts these with *complex* systems that cannot be sufficiently understood through their components or subsystems. Merali describes technologies in organizations as facilitators of complex adaptive systems. For example, information technology can combine people, other technologies, and information in time and space in new ways. To understand how the role of various technologies is gradually formed in the pediatric ICU, we look at the intensive care unit as a complex system where changes may be nonlinear and emergent (Anderson 1999; Kim and Kaplan 2006).

Besides complexity theory, actor-network theory (ANT; Latour 1991, 2005) has been used to study and describe large and complex networks of technological innovation and change. Especially in recent theorizing, there has been considerable attention on complexity issues (Moser and Law 2006). In ANT, networks are constituted of a relevant social group of actors (Bijker 1995) that negotiate and interact with each other to solve a shared problem. While not underestimating the importance of human actors, we include also other relevant actors (or actants) such as technical artefacts, organizational rules, and scripts (Law and Callon 1995).

Howcroft, Mitev, and Wilson (2004) follow Latour (1999) by arguing that a new technology is conceived when a relatively stable heterogeneous network of aligned interests is created and maintained. Development and implementation of technologies involves building alliances between various actors, including individuals and groups, as well as other entities such as various technologies. As the actors are enrolled into a network and as the network evolves, the nature of the project and the identities and interests of the actors are themselves transformed (Law and Callon 1995). The results of the transformation process, the translation, are subsequently inscribed into technologies for immutability (Latour 2005).

A new system can have unanticipated outcomes. Latour (1999, 2005) describes how the process of translation is started when a problem of interpretation about the nature of the new technology emerges. The outcome or solution to such a problem can consist of years of development, as in Latour's (1999) example on Louis Pasteur's efforts in creating a first rabies vaccine. Equally well, the translation can be used as a metaphor to describe problem-solving on a smaller scale as, for example, when the practices of utilizing a new technology are negotiated and formed by organizational members.

When new technologies are taken into use and their utilization becomes routine, they disappear from the core of consciousness (Ciborra 2002; Orlikowski 2002), as their use no longer demands special effort and as they are embedded in the context. Latour (1999) describes the embedding of technology with the process of black boxing. Black boxing occurs when, for example, the organizational actors can use a solution or a tool although they cannot tell its inner functions. In a way, here, a complicated technical artifact or an information system can be simplified as a black box that can be utilized without special effort by the user. If the technology in use no longer meets the needs and goals of its users, the black box can be reopened and the translation process can start anew. Thus translation is a process that does not necessarily ever come to a definitive end (Latour 2005).

Similarly to ANT, in complexity theory the process of change is explained as continuous adaptation and adjusting to the changing environment. Both complexity theory and ANT deal with connected assemblages, that is, networks of interconnected nodes (Cilliers 1998; Latour 2005). According to Kim and Kaplan (2006) and Kaghan and Bowker (2001), both theories address the unexpectedness of changes influenced by the local or situational factors. The networks are relatively stable but in no way frozen in time or space. Complexity theory does not assume an end-point that can be reached. Also in ANT, the process of translation is never-ending and the multiple and complex "ordering" is never finished (Moser and Law 2006). Both theories acknowledge, however, that the networks or the actions of networks' members can be constrained by previous choices and that, in a sense, networks are constrained by a kind of path-dependency (Latour 2005; Merali 2004).

Network has been a prevailing metaphor for studies emphasizing connectedness in, for example, information science, organization science, and sociology (Castells 2000; Cilliers 1998; Latour 1999, 2005; Merali 2004). A network is dynamic, and has flexibility and adaptability to survive. In a network metaphor, interconnectivity has been described as negotiable, as voluntary or open-ended, or even as unpredictable. As such, the metaphor has fitted well to describe contemporary organizations and the changes in working life. In research, it means recognition of fragmentation and complexity (Knox et al. 2006). Still, the network metaphor has been criticized for lacking clear definitions, or for having multiple meanings (Cohen 1999; Doolin and Lowe 2002; Kaghan and Bowker 2001; Latour 2005). There is no agreement on the kinds of nodes and relations that can constitute a network. For example, power relations can be left undefined or even neglected when using the network metaphor. Moreover, Kaghan and Bowker (2001) criticize rationalist approaches in network theories as having tendencies of determinism, for example, when professionals or managers are portrayed as the "brains" that lead and regulate a change process. In this study, the actors in the intensive care unit are considered as "nodes" of their working network, and no single node is approached as the sole controller of complex interaction.

To explore the intertwined work practices and the use of technologies in intensive care, we adopt the conceptualization of both social and technical actors from ANT, as well as the process of translation that describes the co-construction or reforming of work practices and the technologies. From complexity theory, we adopt the definition of action as dynamic and nonlinear and as self-ordering or reflexive by nature. This includes the actor's adaptability to a changing situation or context while acknowledging also the path dependency on historical development and the bounded rationality of local action. Both ANT and complexity theory consider interaction and knowledge creation as emergent. The conceptual tools used in our study are discussed at length in Vuokko and Karsten (2007) and are summarized in Table 1.

# 3 RESEARCH METHODS

This study is part of a multidisciplinary research project, Louhi,[1] that aims to explore and build intelligent tools for natural language processing of medical records to support

[1]See http://www.med.utu.fi/hoitotiede/tutkimus/tutkimusprojektit/louhi/.

**Table 1. Conceptual Tools for the Study**

| | **Concepts for Studying Intensive Care Work** |
|---|---|
| Actor-Network Theory | • Actor, actant (social and technical)<br>• Network of shared interests<br>• Transformation processes (translation, black-boxing)<br>• Emergent interaction, emergent knowledge |
| Complexity Theory | • Action and interaction are dynamic and nonlinear<br>• Self-organizing or reflexivity action<br>• Adaptation to changing environment or situation<br>• Path dependency on historical development<br>• Bounded rationality of local action<br>• Emergent interaction, emergent knowledge |

nurses in an ICU. This study will form a background for evaluating the tools. We observed the nurses' work practices in a pediatric ICU in a university hospital, one of the five major teaching hospitals in Finland, with 953 beds. The pediatric ICU is one of the smallest wards, with readiness for 10 patients.

Two researchers (the first author and a research assistant) observed the daily life in the unit for 10 hours during April and May 2007. The observations concentrate on what kinds of actions took place in the unit and how various technologies participated in these (see Table 2). We carried out the observations in an environment that was new to us, and at first, it was difficult to "see" nurses' work practices. Also, we could not observe strictly according to our plans, as the situations at the ICU changed from day to day, and as we did not want to influence or hinder the work in any way. The parents of the children were usually present, and respecting their privacy led us not to do bedside observations when the patients were awake. Observing treatments to the patients, we admit, was beyond our courage.

**Table 2. Planned Outline for Observations**

| |
|---|
| Date<br>Observer<br>Others present |
| What is happening?<br>What kind of action is visible?<br>What consequences does the action have? |
| Who acts (roles)?<br>Who participates? |
| What devices are used?<br>How is technology used?<br>How is technology a part of the action? |
| What are the contextual factors?<br>What are the situational factors? |
| Special notes to consider in the future |

The observation notes were systematically written down and, later, the field diaries were organized and shared by all researchers. In addition to observations, we collected a number of different forms. The nurses completed forms for a fictional patient to illustrate various details of their work practices. We also chatted with the nurses in their common room where they also held their reporting sessions and meetings.

The analysis of the data was interpretive. With the theoretical lenses provided (see Table 1), both observers coded and re-coded the data. In practice, this meant comparing our field notes, first, to find similarities in observations. We mapped out various actants and relations between them to describe relations between various staff members in and outside the ICU as well as interaction with machines and information. Physically, the ICU ward is clearly bounded, but on the level of interaction, the boundaries of the ward are more porous. For example, the ward works in close collaboration with the Intensive Care Nursery for premature infants located nearby and the adult ICU, which occasionally sends its overflow patients to the pediatric ICU.

Second, we looked through our data for all instances of adaptation or reorganizing of action to changing work situations. We discussed the possibilities and limitations for self-organizing in the ICU context, where the work tasks are regulated by diverse laws, guidelines, and standardized practices. One of our codes was exceptions: How are such situations handled in the ICU? To what extent are the nurses bound by the situation, the information, or other means they have at hand? To what extent can work in an ICU be planned in advance? In relation to this, we were interested in the nurses' means for simplifying the complex and the unpredictable.

The validity of analysis was upheld with both observers sharing similar experiences. The findings were also in line with our previous studies. We wrote a description of our observations in Finnish (Vuokko et al. 2007) in order to gather feedback from the ICU and from the Louhi project group. This resulted in a number of clarifications in details.

The resulting picture has some limitations that were caused by the relatively short observation time, by the observations being a first time experience for the researchers, and by the nature of intensive care working. Intensive care work practices showed up as being partly invisible and based on the intuition or practical experience of the nurses.

# 4 WORK PRACTICES IN THE PEDIATRIC ICU

The patients in the ICU come from the pediatric outpatient clinic, the first aid station, as transfers from other wards or other hospitals, or after demanding operations. Children in transit are admitted as well, for example, from passenger ships or airplanes. Many children are admitted during the night and many children are sent to other wards or hospitals during the afternoon. The beds are occupied 87.4 percent of the time. The patients stay on the average three days, but there is much variance. During our observations, we encountered both extremes of the patient situation: one day, all beds were occupied, and on another day, only one patient remained. During 2006, the ward cared for 638 patients. Of these, 16.3 percent required only observation, 63.1 percent required intensive care, and 20.6 percent demanded special intensive care.

Besides the pediatric nurses specialized in intensive care, the main actors we could identify included various kinds of medical specialists, especially in pediatrics, surgery, hematology, and anesthesiology. A key person was the ward secretary, acting as a broker

for information. The secretary works 8:00 a.m. to 4:00 p.m. on weekdays. The unit has its own technician and a set of reserve machines in case one breaks down. Other important actors include the laboratory and imaging unit personnel, the cleaners, and the social workers in the pediatric clinic. The medical specialists have, in addition to the twice-daily rounds, many other duties in the teaching hospital and, therefore, they are seldom seen in the ward. There appeared also to be a number of nursing students present in the unit on a regular basis. Moreover, the child patients very often had at least one parent present.

Nonhuman actants in intensive care include, for example, respirators, ventilators, oxygen saturation meters, blood gas meters (Astrup for measuring the blood pH), and other technologies as well as information in, for example, patient records and hospital guidelines for specific procedures. These actants are immobile by nature, and there seems to be a tightly ordered positioning of supporting technologies and patient information within the pediatric ICU. For example, we witnessed a situation where a patient's daily nursing documentation was misplaced and no recording could be done before the documentation was found in the medicine room after some intense searching.

*Physical environment.* The pediatric ICU is physically a small unit with the patients' beds on two sides of the operations center: the youngest patients on one side (four beds) and older children on the other (four beds), with two separate rooms for isolation (two beds). The main part of the ward is a shared, open space with a multitude of technical equipment that all seem to give sound alarms. The open space was preferred by nurses as then they would have all the heavily medicated child-patients under their constant gaze. Moreover, the open space helps the nurses to communicate with each other. On the other hand, the open space in the unit created an atmosphere of restlessness and anxiousness, with the nurses constantly moving about, carrying and pushing around technical equipment, or the monitors for patients' vital signs raising alarms among all the other humming and bleeping devices. In contrast, we have found that the two ICUs for adults we visited tend to be quiet and peaceful, with the patients unconscious or sedated.

We spent much time in the operations center of the ICU. The operations center is the main station for documenting the nursing work, for sharing information about the patients, and for communicating with other facilities. On occasion, only the ward secretary is there, sitting at her computer, taking care of various administrative tasks such as attending to the telephone and the door bell, transcribing doctors' dictation, or ordering laboratory tests. There are two computers used by all; doctors seem more often to use the computer on the left and nurses read the lab results as they appear on the screen of the other. There are also monitors, phones and faxes, empty forms and folders, and maps full of hospital regulations. The patient folders are kept in a cart by the computers or, if work needs to be done on them, open on the table. Electronic mail is used to share information, for example, between units and work shifts. Orders for laboratory tests are done with one program, and for an x-ray with another one. Several other programs are in use, as well. Due to the high variety of child patients, the program used in adult wards for ordering food is not used here, but orders are written in a notebook. Thus the information environment (Lamb et al. 2003) is highly varied but centrally located.

*Three shifts*. The ICU has 31 nurses who work in three shifts. In the morning shift (7:00 a.m. – 2:00 p.m.), there are six to eight nurses working; in the evening shift (2:00 p.m. – 10:00 p.m.), there are five; and during the night shift (10:00 p.m. – 7:00 a.m.), there are four nurses. When one shift goes out and the other comes in, the outgoing

nurses write their reports and the incoming shift holds a reporting session in the common room. This is carried out in this way to help all nurses in a shift know the basic information about all patients. To coordinate between shifts, there are also other practices that have been developed in the unit. For example, in the common room, there is a copy of the planned working hours on the notice board, and a notebook on the table. These are used, for example, to inform which nurses are coming to which shift, who is responsible for which patients and tasks, and who heads the shift. The ICU can share nurses and equipment with the nearby ward for premature infants, adding to flexibility in crisis situations.

*The actual nursing work* is structured according to several contextual and situational factors. The patients are assigned to nurses according to the nurse's experience and according to what kind nursing the patient needs. The parents help with immediate care and comfort, but still the work appears to be more hands-on than at the adult ICU. When there are more patients or when the patients are demanding, most of the nurses stay by the bedside of their patients and the operations center and the common room are deserted. There are also exceptions to the "one patient, one nurse" rule. Some patients, such as severe burn cases, may require two to three nurses. For a period, one nurse can care for several patients when their nurses are preparing medications in the "medicine room." Thus the nurses appear to take the role that is needed: nurse, secretary, specialist, teacher, laboratory assistant, or confidante.

To an observer, sometimes work in intensive care appears intense and requiring rapid action. At other times, very little seems to happen. For example, when there are few patients or when most patients require only light nursing, the nurses can immerse themselves in documenting, in finding more information, in planning the nursing work, or in other organizational supporting tasks such as ordering of supplies. While analyzing the observation data, we wondered how much of the actual work practices are invisible or hidden in the routines, self-evident to specialized nurses and impenetrable to us lay observers (cf. police work, Van Maanen 1988).

A notable practice we observed several times was that when something unexpected would come up, the nurses would together construct a suitable solution for the situation: "We need to cope no matter what happens." Often this was situational assistance for a colleague with a demanding patient (or a parent). Coping was extended to cover problems with technologies as well. Another typical feature in pediatric intensive care was the practice of double checking where, for example, a nurse would ask a colleague for reassurance that a medicine dose was correctly calculated. A third one was that some actions were not only recorded in writing but also said aloud: "I have now ordered the new tubes." The nurses spoke with each other even when attending to the patients. We even witnessed some questions being shouted to overcome the noise.

The nursing documenting practices were the most visible part of the activities. Much of the nursing tasks by the bedside might look self-evident or be unnoticeable. Without documentation, they would leave no trace and evaluating the care would be difficult. This is similar to other caring tasks: you only notice them when they are not done.

*Doctors' rounds*. The medical specialists do two daily rounds or inspections of the patients, one between 9:00 and 10:00 a.m. and the other one when the laboratory results have arrived, around 2:00 or 3:00 p.m. The operations center is full of people when the pediatricians, surgeons, haematologists, and anesthesiologists come to start rounds. The rounds structure the work into preparations, the actual visits at bedside, the planning of

care in a separate office, doctors' dictations, and ordering of, for example, laboratory tests, made by the nurses or the ward secretary. Each nurse appears to participate in the rounds only when her "own" child is discussed, but the head nurse attends the whole time. If the ward secretary is available, she sits in on the planning sessions and does immediate recording and ordering.

Between the rounds, the nurses attend to updating patient records, which the physicians then use to get an overview of a patient's current status. In this sense, the physicians' inspections regulate the minimum intervals when nurses update the nursing documentation. In addition to the rounds, the repetitive tests, such as blood tests, regulate or order any working day. Data and information are constantly updated from various sources. The nurses need to extract the needed information and, with personal experience and previous information, process it to knowledge in use.

*Documenting care* is very seldom done by the bedside. The assisting nurse might write down on a piece of paper some items, but the nurse assigned to the patient does the actual recording in the operations center. The daily nursing records are penned on large paper sheets officially called control forms but in practice called just "the sheet." The vital signs, the fluids in and out, the measures taken, the medications, and the like are recorded during the day, starting at 6:00 in the morning. Several different methods of emphasis (colors, circles, triangles, arrows, and the like) are used, each with a specific meaning. The data points drawn will gradually turn into a graph, easy to interpret for a professional.

The data on a control form is used to get an overall view of a patient and even, on occasion, to predict trends of the patient's possible changes of status. For the nurses coming to the next shift, the data collected on the sheet provides quick and easy access to the current status of a patient, an overview (Robinson 1992). The control forms are not only for recording activities and test results but they also provide an important means for information exchange between nurses, doctors, and ward secretaries. Thus the control form is an example of black boxing when existing technology and routines are tied together in a way that, to us, seemed difficult to reopen or retranslate.

With the paper documents, it is also easy to place the documents side by side for comparison. This also has disadvantages, as small slips of paper, for example from the ultrasound or the Astrup machine, can easily float to the floor, and documents cover other documents. As physical pieces of paper of many sizes, they make an untidy bundle inside the folder.

Within the ICU, daily work takes place in a complex and interlaced network of interaction. Human actors are readily observable, and they can also explain the logic behind their actions. Still, other types of actants cause various actions and adaptations in ICU nursing work. These include the immaterial agency of information in forms, tables, notes, and other documents, and the technological actants, such as media for monitoring and test taking.

*Preparing devices for a new patient*. In the ICU, the pursuit of simplification can be observed in routine uses of technology. For example, when the nurses prepare to take a new patient into the unit, they start the preparations by collecting needed equipment and vitality monitoring devices by the bed for the new patient. The nurses know how to secure and attach the devices to the correct sensors and how to initialize the monitors according to the age of the patient. Only the breathing machine and the mechanical ventilator require adjustment by a physician; the nurses take care of the other machines.

In addition to patient monitoring, the nurses prepare and monitor the IV fluids. Other preparations are possible if the transfer information sheet implies such a need. Adjusting various machines is part of the routine, and the nurses are at most concerned with the right calculations but not on the functions of these machines. When more understanding about their inner function is needed, the nurses call for the support staff in charge of the technology.

*Alarms*. The vitality monitoring technology is so embedded in the routines that the nurses claim to be able to identify not only which device gives the alarm, but also why it alarms. In reality, as one device has one alarm sound, a nurse interprets from other situational features why the alarm goes off. For example, the nurse might have been already waiting for the alarm to sound so that the IV bag could be changed for a new one. On the other hand, when a patient is especially restless, such as a typical meningitis case, the nurse knows that the monitors give more alarms than needed. If the nurse becomes uncertain regarding the vitality monitors, a colleague is readily consulted and a solution is formed together. An instance of slight uncertainty occurred, for example, when a nurse came to work and started to prepare for a new patient. As one of the ducts in a vitality monitor had been replaced with a duct of a different color, she became uncertain of how the device should be connected to the sensors. The problem was quickly solved by asking the other nurses for information.

*Transfer of a patient.* As an example of the more complicated routines, we present here the transfer of a patient to another hospital as this was very visible in the total infrastructure with all the activities involved. The different work practices of the other hospital units would push in to the ICU, and a need to address and explicate carefully the details of the transfer situation emerged from these interactions. The transferring practices are coordinated by the transfer information sheet with a collection of patient information. The information is collected from various paper-based and electronic sources, and the sheet is filled in by hand. When the transfer time approaches, the last control tests are taken, and the patient is washed and otherwise prepared. The nursing documentation sheets concerning the patient are updated, and the patient's folder is checked when the physician's final dictation is attached to other documents. The patient's original diagnosis, all operations and major steps concerning the patient, detailed information of the patient's medication and the like are written on the transfer sheet. When a patient is transferred to another hospital, the nurse also fills in a form for travel expenses to be reimbursed for parents following the patient.

When the patient and all the needed documentation as well as the escorting nurse are ready, the patient is detached from the vitality monitors and the physical transfer takes place. The patient document folder remains in the ICU and only the transfer forms leave the unit at that time. When the escorting nurse comes back, she or he checks the patient as having moved out of the unit. The ward secretary makes sure that the status of the patient is changed also in the electronic hospital administration system. Even though the procedure for transfer is well described, the actual situation that occurred during the observations seemed hectic and almost chaotic, as two nurses were needed to prepare the patient. The child's own nurse, together with the ward secretary and helped by the head nurse, finalized the patient documentation and filled in the travel form for the accompanying parents. The preparations for transfer made small measures as well as nursing documenting practices visible. On top of that, the situation revealed how, in problematic situations, patient security and professional ethics guide what is done. The work prac-

tices in ICU were about sharing not only information but also responsibility for the patients.

# 5 DISCUSSION

In any action, when there is a multitude of actors and units of actors, the action itself is bound to add to the overall complexity of the situation. For example, in this paper we simplified the situation where work practices are carried out by listing only a few components of work practices, with actors, technologies, and information as influencing the situation. Changes in chosen areas influence other areas as well. We were interested in how new technologies might affect the work practices and division of actors or information. Such changes can be initiated also by minor issues such as varied interpretations of information, lack of technical support, or inflexibility of work practices. In the ICU, these emerging issues and the complexity of organizational action were anticipated with situational adaptability and self-ordering of action within the unit.

During the observations, we noted that working in the intensive care requires taking dynamic action as the work consists of adaptations to unexpected situations. There seemed to be constant changes as a variety of patients were transferred in and out of the unit. To an extent, the nurses were able to predict these changes by relying on their experience. Although the nurses are capable of adapting to rapidly changing situations, at the same time, the nursing practices are bounded by the situational rationalities, such as the information available on the patient and the time of day. In addition, selecting a specific technology meant emergence of path dependent features such as integration problems. The experience levels and organizational roles also set boundaries to decision making and action taking. For example, a nurse can be responsible for medicine orders, but the unit pediatrician is the one responsible for "ordering" or negotiating the patient transfers. Not only work practices are defined by organizational roles; documenting practices also are based on the task divisions.

In the pediatric ICU, transforming work practices and reinterpreting technology are anticipated to take place when, for example, the current work practices no longer respond to the technical tools in use. The need to change work arrangements can be a short-term situation, as in cases when some of the staff members of the pediatric ICU are called away from the unit to take care of a CPR alarm. A more stable change is needed when, for example, new features such as new information or new tools are introduced into the working environment. A new technology is embedded and fitted into the existing practices and routines by interpreting its beneficial usage in the given context. Through the adaptation to changing situations, not only is the technology being taken into use but at the same time, new work practices as well as new contextual knowledge may emerge.

The theoretical tools given by ANT appear to be well suited to describe and analyze a small, closed entity such as a hospital ward. Many other ANT studies focus on small entities, as well (Aanestad 2003; Latour 1991, 1999; Law and Callon 1995; Moser and Law 2006). Taking into consideration the whole hospital or the hospital district is more difficult. With this bracketing, it might be difficult to see whose interests are pulling a translation. New technologies might be introduced because of reasons not visible on the level of work practices. Even when use is mandated, enrollment is necessary for reducing problems with the change.

Also, tools given by complexity theory are well suited to study a small unit as they focus on networking systems with a shared set of practices, mediating information, and expertise. Merali (2004) argues that as complexity theory emphasizes dynamisms of interaction and is well suited for studying contemporary organizations. However, we noted some difficulties in implementing complexity theory concepts (see Anderson 1999; Desai 2005; Jacucci et al. 2006). First, some of the conceptualizations originated in positivist research in laboratory environments, and translating them for use in qualitative studies of social systems seems to require compromises. Second, complexity theory implies macro studies (Merali 2004) as it considers the environment of the system a crucial factor of development. Complexity theory emphasizes the actions of the agents within a network to the point where, at times, these agents become "heroes" in the survival of the fittest. Third, complexity theory is partly based in language studies (Cilliers 1998) and technologies emerge to the picture only through the meanings given by the organizational members.

When compared to ANT, complexity theory assumes that the networked relations imply power relations. Complexity theory implies that all organizations and systems are hierarchal, and that power issues are embodied in organizational relations (Merali 2004). Still, the organizational members have possibilities for reflective action and continued adaptation through feedback loops. In the ICU environment, such feedback is made possible in various meetings and gatherings as well as in formal documenting and evaluation of work. Through feedback and reflection among the organizational actors, possible changes in work practices.

Complexity theory also attempts to describe how local diversity emerges through various interpretations and reflective actions, whereas in ANT, the network attempts to achieve a shared translation. Room for possible variations was later given with interpretive flexibility. In complexity theory, the time line of the change or the study description is not always apparent. There seems to be no clear vision of whether social complexity studies should concentrate on describing past, present, or future action—or to combine all of these. In the ANT studies, historical development is often clearly described or the change is portrayed in time.

While the idea of studying hospital informatics as a complex—and not only complicated—system is still appealing, the limitations of complexity theory as understood in organizational studies are still considerable. The combination with ANT worked well, and this might be a direction to take in future studies, especially as ANT addresses technologies in a more sophisticated way. Seeing the ward as a part of a larger whole would seem to presuppose a societal level theory, such as structuration theory (Jones and Karsten 2008).

# 6 FUTURE RESEARCH

Working in the pediatric ICU is expected to change when the planned organizational implementation of an electronic patient record system takes place during the winter of 2007–2008. One goal with the new system, as stated in the hospital board decision, is that the nurses could prioritize more of the work time spent at the patient's bedside. This would be possible by receiving data from various vital monitoring systems directly into the new patient record system and by placing computers at the foot of every bed, like they are in the adult ICU.

In the future, it is anticipated, nursing documenting will demand less effort, and the nurses will be able to better concentrate on the practical treatments at the bedsides. The quality of the electronic patient records is expected to be improved with more accuracy and better readability (Bowles 1997). However, the quality might also deteriorate with the practice of cut and paste (e.g., Thielke et al. 2004) or with blind belief in the numbers given on the screen. There is still a long way to go for before electronic patient records can be shown to support decision-making in critical care (Bucknall and Thomas 1997).

To sum up, in the pediatric ICU we observed, we see several opportunities for change in time–place arrangements, in coordination and communication practices, and in information sharing practices. Documenting the care plans and the care given will change radically when direct connections between the monitors, the laboratory and imaging results, and the electronic patient record are established. The roles and tasks of the various actants will reformulate, and thereby possibly also their skills and professional identities.

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