

22 KNOWLEDGE WORK IN HOSPITALS

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Abstract

Slogan-like arguments from knowledge management literature suggest that reuse of externalized knowledge is fundamental for improved efficiency, reduced costs, and reduced dependency on individual know-how. Rather than considering knowledge as a specific thing, the paper relates knowledge to the work people do. The aim of the paper is to identify conditions for sharing and reuse of knowledge in large organizational contexts. The paper analyses how knowledge reuse is influenced by complexity of contexts, trust, and uncertainty. Based on the findings, the paper also makes suggestions for information systems design. Empirically, the paper draws on different medical contexts at the University Hospital of Northern Norway.

1 INTRODUCTION

A common argument today is that many organizations have become so complex that their knowledge is fragmented, difficult to locate and share, and therefore redundant, inconsistent, or not used at all (see, for instance, Zack 1999). There are also arguments about increased market competition, which make it necessary for organizations to focus on knowledge as an important resource. According to these arguments, knowledge creation, representation, and diffusion are key mechanisms in ensuring modern companies' and organizations' competitive advantages (Blackler 1995; Davenport and Prusak 1998).

Aligned with a relatively high share of the knowledge management literature, this knowledge is associated with so-called knowledge-intensive firms

and their knowledge workers (see, for instance, Alvesson 1995). In this way knowledge is considered a property of the firm or a specific entity (Blackler 1995) that typically is stored in large databases as externalized and codified know-how. At a later stage, it is assumed that this knowledge will be readily reused in various contexts associated with the firm.

Considering the knowledge concept as outlined above is both narrow and too optimistic. Several studies have reported the shortcomings of such a perspective and pinpointed that it is essential to take an alternative or broader approach (Atkinson 1995; Hunter 1991; Knorr-Cetina 1999). From this point of view, it is insufficient to focus on knowledge as a thing; the focus must rather be on what people do and *how* they create knowledge. Atkinson (1995, p. 45), for instance, places emphasis on medical knowledge production as work. This work is achieved not only through the content of collegial talk, but also through the form of that talk. Thus the knowledge creation and translation process is not only based on journals and textbooks (ibid, pp. 90-91) but also includes talks between colleagues such as clinical lectures, ward rounds, morbidity reviews, and a surgeon's comments to juniors and students.

The study reported in this paper focuses on physicians' work producing discharge letters in four different contexts at the University Hospital of Northern Norway (UNN). In contrast with the traditional view on knowledge work (Alvesson 1995) clinical work, especially as practiced at large hospitals like UNN, is highly specialized. It is characterized by state-of-the-art knowledge, high levels of education, and organizational complexity. As knowledge originates from a myriad of different contexts and information sources, a large part of knowledge work in hospitals involves summing up and thus reusing previous information (Berg 1998, p. 298). This is particularly the case when physicians sum up patient stays through dictating discharge letters. At UNN, the discharge letters are an important part of the hospital's electronic patient record, accordingly placing this study at the core of the hospital's most critical information system.

Regularly summing up cases also makes the medical context relevant in a broader perspective—for complex organizations in general, and for the general question of how and when knowledge is reusable and in what shape. A critical indicator of how externalized knowledge is useful is the degree of *reuse*. Thus the aim of this paper is to identify the conditions for when sharing and reuse of knowledge is productive and subsequently to make suggestions for information systems design. More specifically, the analysis is pursued along three themes.

First, I analyze how the degree of reuse is influenced by the multiplicity and complexity of contexts. As large hospitals are both highly specialized and reflect a complex division of labor (Atkinson 1995, p. 7; Blume 1991, p. 17), it affects the extent knowledge is reusable from one context to another. One expression

of the complexity of the various contexts is the number of information sources involved, another is that new technologies increasingly are used to link different contexts together, and accordingly affect shared meanings among the participants involved (Ruhleder and Jordan 2001, p. 132).

Second, I analyze how the degree of reuse is influenced by the trust attributed with the knowledge sources. Atkinson (1995, p. 127) points out that “Not all knowledge is treated as having equal value. It has different sources, and has different weight attached to it, and may be regarded as more or less warranted.” This corresponds with Cicourel (1990, p. 222) when he argues that “the perceived value of medical information is related to the perceived credibility of the source.” This means that trust in knowledge might fluctuate with who has produced it, where it is produced, and how it is produced.

Third, I spell out how the degree of reuse is influenced by uncertainty and unpredictability of medical work (Atkinson 1995, p. 111; Hunter 1991, p. 28). Medical work is hectic and has to deal with a lot of emergency cases as well as patients with complicated, uncertain diagnosis and prognosis. The documents produced in the patient record are shaped accordingly: they reflect what the physicians know at a given moment. This means that what is considered knowledge today may be irrelevant tomorrow.

The remainder of this paper is organized as follows: the next section elaborates more thoroughly on the theoretical foundation and is followed by a reflection on the research design. Four case vignettes, which illustrate physicians’ work in different departments, are then presented. The last two sections contains the analysis and the conclusion. The analysis focuses on the conditions for reuse along the themes presented above and the conclusion contains implications for information systems design.

2 THEORY

2.1 Knowledge, Knowledge Organizations and Knowledge Workers

Some of the information technology (IT) literature categorizes knowledge into *data*, *information*, and *knowledge*. From this viewpoint, data is a set of objective facts with no associated purpose (Davenport and Prusak 1998, p. 2). Information is more value-oriented. Knowledge is considered to possess key properties like experience, truth, and judgement, and is typically associated with so-called knowledge-intensive firms (Alvesson 1995, p. 6). It is further argued that such companies, including their knowledge workers, are characterized by frequent problem solving, creativity, reliance of individuals, high levels of

education, and a high degree of professionalism. This is an aspect of knowledge that falls into a category that Blackler (1995, p. 1023) denotes as “embrained” and promotes knowledge as a specific entity that is tradable (p. 1033).

IT is considered to have a central role in organizing knowledge, both in order to enable sharing and collaboration, and more explicitly through the storing and categorizing of different knowledge units which can later be retrieved and presented as meaningful across contexts. This kind of knowledge is generally described as explicit and is possible to codify. Tacit knowledge, on the other hand, is individual and context-specific and is accordingly hard to formalize (Nonaka and Takeuchi 1998, p. 218). Enabling the transition from tacit to explicit knowledge both in order to enable collaboration as well as to make it conform more to IT is considered to be a major challenge.

In software engineering, there also is an extensive comprehension about using IT as a means for sharing and reuse of knowledge. In these contexts, however, reuse of knowledge translates into constructing new programs from existing program code, and it is quite common to find arguments that go like this: “40 to 60% of code is reusable from one application to another” (Sametinger 1997, p. 11).

Nonetheless, in spite of object-oriented design, standards and component-based software, the design of flexible and reusable systems is still a challenge (Correa et al. 2000, p. 336).

2.2 Medical Practice as Knowledge Work

A growing amount of literature argues that a broader approach to the knowledge concept is necessary. This implies relating knowledge to practice or as something people do (Blackler 1995, p. 1023; Brown and Duguid 1991, p. 40; Czarniawska 1997; Knorr-Cetina 1999, p. 8). In order to underscore the complexity around the issue, Blackler (1995) categorizes knowledge as embrained, embodied, encultured, embedded, and encoded. He further underscores that the implication is that not only limited groups (see Alvesson 1995) are regarded as knowledge workers, but that all individuals and all organizations are knowledgeable (p. 1026). Being a knowledge worker thus means being involved in learning and the creation of new knowledge through becoming an *insider* in the community (Brown and Duguid 1991, p. 48), that is, they are acquiring not explicit, formal expert knowledge, but the embodied ability to behave as community members. Knorr-Cetina (1999, p. 1) extends this by arguing,

By many accounts, Western societies are becoming “knowledge societies,” and “a knowledge society is not simply a society of more experts, more technological gadgets...it is a society

permeated with knowledge cultures, the whole set of structures and mechanisms that serve knowledge and unfold with its articulation.

One such society is the medical context. As a complex organization, there are good reasons to look more closely into how and when and under which conditions knowledge is used and reused. A factor that influences the complexity of medical work is its richness and messy character (Atkinson 1995; Berg 1998; Strauss et al. 1985) and its continuous uncertainty (Atkinson 1995, p. 111; Hunter 1991, p. 28). Related to patient records, this uncertainty translates into making problems manageable within the hospital's working routines as:

Through [the physician's] activities of reading and writing...he narrows down the plethora of potential tasks and divergent data into a clear notion of "what to do next" (Berg 1996).

An important part of problem solving in hospitals is related to determining the diagnosis of patients. In simple cases, a disease will be easily recognizable when its major symptom is readily apparent, but in many other cases the diagnosis is far more complex (Hunter 1991, p. 70). A way to deal with this uncertainty is to use a narrative approach as every event in medicine, potentially at least, has both oral and written narratives (Hunter 1991, p. 69). There is no way to solve a difficult problem and have it known without telling the story because stories make sense of ambiguous situations (Orr 1990). This underscores the close relationship between written and oral accounts in the everyday organization of medical work (Atkinson 1995, p. 90; Hunter 1991, pp. 5-6). Work, based on narratives, also underscores that work is obviously communal and thereby collaborative. In this sense, the acquisition of new knowledge (learning) is inseparable from working, but also individual learning is inseparable from collective learning (Brown and Duguid 1991, p. 46).

3 METHOD

This study belongs to an interpretative approach to the development and use of information systems (Klein and Myers 1999; Walsham 1993) relying on four types of data: participative observations, interviews, informal discussions, and documents. The observations took place between January and March, 2001, in four departments at the University Hospital of Northern Norway. The hospital has 600 beds and has approximately 4,000 employees (400 physicians and 900 nurses).

In total, 42 hours were spent observing work. In addition, in February and March, 2000, I conducted 19 hours of observation in three other departments that were used for background material.

I participated in several morning meetings with physicians and nurses, and in coffee and lunch breaks. I also joined groups of physicians having discussions in corridors, in on-duty rooms, and in examination rooms. In one department, I observed several patient examinations. People did not seem bothered by being observed. This resulted in a fluctuation between a fairly passive role merely observing as unobtrusively as possible, and a more active role, when possible, posing questions for clarification and explanation. All together, I conducted 27 semi-structured interviews during the periods mentioned above. Each interview lasted from 1 to 2 hours.

4 THE CASES

4.1 Department of Ear, Nose and Throat: Overview and Stability

Ear, Nose and Throat is a surgical profession with many small operations. This makes the cases relatively predictable. In order to ensure efficiency in the production of discharge letters, the department routinely reuses documentation from the electronic patient record. The mode of work in the department is illustrated below.

The chief physician and a nurse, both wearing white clothes are present in one of the examination rooms. They prepare for the examination of six patients. The room seems very much like an ordinary examination room, light colors on the wall, glaring light, a large desk with a pile of documents, notebooks, short lists, and one computer.

The patients have been at the department for a short stay and will leave today. The patients are admitted to the room in turn and asked to sit in the examination chair. Every one of them moves normally as well as looks healthy indicating that their current illness is marginal in relationship to their total health condition. As an example, one of them, a young student, was hospitalized due to complications from tonsil surgery but, as the discharge letters states, "beyond that, the patient is in good health." The chief physician very quickly examines the throat and the nose of the other patients.

The conversation between the health personnel and the patients is easy-going and the chief physician often adds jokes to the conversation

with the patients. The atmosphere appears stable, relaxed and well-organized. The actual computer is not used during the work, indicating that the chief physician has a clear sense of the patient's condition (he does to a minor degree need to look up x-ray reports, laboratory results, etc.).

Between patients, the chief physician dictates the discharge letter associated with the previous examination. To be more correct, he only dictates the last part of it, the conclusion, which is carried out within 45 seconds and amounts to five lines of text. This work also includes specifying diagnosis and procedure codes drawn from a short list of regularly used diagnosis codes.

The rest of the discharge letter is reused from documentation already produced during the stay, indicating a certain stability of the knowledge. He checks off on a paper form, to instruct the secretary, which previous documentation from the electronic patient record to include in the discharge letter.

4.2 Department of Cardiac and Thoracic Surgery: Hectic and Highly Specialized

The Department of Cardiac and Thoracic Surgery is responsible for cardiac surgery for adults in the Northern Health Region of Norway. Most of the patients admitted to the department have received in advance a full examination by another department or (local) hospital. The patients normally stay for six days. After their surgery they are transferred to another department within the hospital or to a local hospital. In this situation, it is imperative to include the discharge letters in order to inform others of the patient's condition, medications, and further follow-up. The following vignette illustrates the work in the department:

About 10 people are present at the morning meeting, one head physician and three assistant physicians, the rest are nurses who enter and leave the room depending on whether *their* patients are involved. The discussions circle around the patients' heart surgery. The atmosphere appears hectic and effective. Any disagreements about changes in prescribed medications, further treatment strategies, or whether patients are capable of leaving today are quickly settled.

One of the assistant physicians, Pasi, breaks from the morning meeting in order to produce a discharge letter on a patient who is leaving today. He goes to the on-duty room bringing with him the paper-based patient record which he places on a desk. First of all, he picks out the admittance report and the surgery report from the previous day. He

also picks out and reads the discharge letter from a stay at the Department of Medicine one month earlier where the patient had a full examination prior to his surgery.

The on-duty room is busy and crowded. Physicians and nurses pass through all the time contributing to a hum of questions, advice, and discussions. The phone is constantly ringing. This is the place where Pasi usually dictates the discharge letters. While ignoring the noise around him, he starts to dictate the social status for a patient that has had heart surgery: “72 year-old fisherman that lives together with his wife...” The dictation is very short. As one of the head physicians puts it, “It has to be short in order to quickly point to what this is all about.” In his dictation, Pasi did not reuse the summary from the admittance report (as some do). He says, “I use it if it is good, but not always. Anyhow, most of the time goes to obtaining an overview of the case and then I have to read in the patient record. It might be that documentation produced some time ago is important. Surgical and medical texts are also very different, which means that sometimes I have to turn to old documentation to get the whole picture.” He also tells that as a very inexperienced assistant physician at this department, he often had to read for 2 hours to get an overview of a case.

He continues to dictate. It is rather staccato since he tries to make sense of information from several sources, both from the pile of papers as well as from the electronic patient record. He realizes then that he needs the patient chart. He stops dictating, walks to one of the examination rooms, finds the chart, and continues to dictate. He also reads and picks information from the nurse report. Once more, he stops dictating and goes to the patient in order to measure her talus arm index. One moment later he is back and comments “no pulse in the foot, there is better circulation in the minor arteries, but not in the large ones.” As the last point, he has to check whether the patient needs to be summoned to a control. He leaves the room, searching for the chief physician. He finds him in one of the patient rooms, gets the necessary information, and finishes the dictation.

4.3 Section of Nephrology, Department of Medicine: Specialized Work for Chronic Patients

The Section of Nephrology is a part of the Department of Medicine. The section has a lot of patients with chronic diseases such as kidney failure who come for periodic controls. In addition, as a part of the Department of Medicine, the section has to relate to a lot of emergency patients with unclear problems. Presented below is work from an experienced physician.

In an office in the Department of Medicine, a physician is making himself ready to produce discharge letters. The patients involved were discharged from the hospital a couple of days ago. On the desk in front of the physician is a pile of patient records and one computer. On the front cover of several of the paper records, written in large letters, is RETURN DIALYSE. It means that these paper records are stored in the Peritoneal Dialysis section in a special archive. Patients having these records come regularly as they are special patients. As a result, only the secretaries in the Peritoneal Dialysis section write these letters in order to ensure that everything is done right.

Laboring through his workload, it becomes clear that several of the cases are quite complex: unscheduled emergency cases, several examinations in other departments, contacts with psychiatric sections, or relying on results from several laboratories. He keeps pausing to check information from several sources: blood results from the laboratory system, running notes from the electronic patient record, results from referrals, and patient charts from paper records. Together they constitute pieces in a puzzle that need to be assembled, evaluated, and assessed closely with the patient's current condition.

He reads extensively. Reading and dictating are interleaved. The physician also needs to consult a couple of his colleagues by phone.

For some of the patients he accesses the electronic x-ray system. He studies the x-ray pictures and examines the x-ray reports before making a summary of it on the fly while dictating. He also includes his own assessments. Retrospectively explaining, he states that, "Sometimes I can cut and paste from parts of the x-ray report. It depends on how much of it is important."

One of the discharge letters is based on an emergency admission. This time he dictates partly the same information that is in the admittance report (located in the electronic patient record). He explains that the reason he did not instruct the secretary to reuse the first sections was because the information in the admittance report was incorrect. He had to correct this information based on conversations with the patient and his wife. He also studies the nurse reports and says, "You have to do that often to check whether it says something important, well... nothing important this time." For the next patient, however, the physician instructs the secretary to copy from named sections of the admittance report. Now the secretary will reuse this text. The physician explains afterward that he knew what the documentation contained because he had dictated this admittance report himself.

The final patient is a chronic Peritoneal Dialysis patient. In addition to the dictation, he retrieves the patient's completed Peritoneal Dialysis form (see the figure below) from the computer. He copies it and pastes it into the discharge letter. It contains a lot of important measurements related to the patient's condition. And, as he says, "This is a patient that regularly returns to the section and he needs clear cut rules for who is responsible for what."

Date	10.01.01
Estimated dry weight	87-88 kg
weight	87-88 kg
Quantity of urine	2000 ml
Quantity of dialyse solution	13740 ml
Ultra filtrate	1000 – 1400 ml
Blood pressure	172/106
KT/V –own	1,16
–total	3,09
Kreatin-clearance	74,61/week
PET	Not performed at this stay
Prealbumin/albumin	35
HB	12,6
iron	17
TIBC	62
ferritin	295
Ca/ion. Calcium	2,36/1,22
Phosphate	1,92
PTH	20,4
Bag strength	CAPD bag strength Locolys 2,3 % 4 x 2

Figure 1. The Peritoneal Dialysis Form

4.4 The Department of Oncology Collective Sense-Making

The Department of Oncology is the only one in Northern Norway and has the major responsibility for cancer treatment in the region. Most of the patients are examined at a local hospital before they are admitted to this department. Due to the nature of the disease, some of the patients are hospitalized for a relatively long time. Others, depending on the treatment protocols, receive periodic treatment such as radiation or chemotherapy. This makes most of the daily operations planned. However, personnel experience a very hectic work environment during the day as a result of the large percentage of patients with extremely complicated conditions. We follow an assistant physician with four months experience.

We are in the assistant physician's office outside the ward. It is six o'clock in the afternoon. It is quiet. The room is semi-lit. The computer screen beams brightly at the desk. The daytime workload makes discharge letter production prohibitive. They end up as evening activities and are dictated in her office. The physician is relaxed, neither the beeper nor the phone interrupts the work and at regular intervals she allows time to explain what she is doing.

The discharge letters from this department are extensive. There is little given structure to the text; they come close to free-text descriptions. The first patient is a newcomer, requiring extra time to study. She spends some time going through the paper record as well as retrieving information from the electronic patient record. She dictates extensively, describing the current situation for the patient. She logs onto the electronic x-ray system and reads the CT description, makes a summary of it, and continues to dictate. Part of her dictation shows that, during the stay, the physicians have discussed possible treatment alternatives. The patient has also been involved in these discussions and has insisted on trying a special treatment that the patient has become aware of that may have an effect on his diagnosis D1. The patient is now discharged from the department without any documented effect of the current treatment.

After the stay, the physicians have continued to evaluate the case and have agreed to invite the patient to an ongoing research study outside the given protocol. This implies that the patient will receive treatment T1. A complication is that the patient may also suffer from diagnosis D2. If so, normally treatment T2 would have been given, but the physicians have never previously combined treatment T1 and T2. One

of the involved head physicians recommends that they order treatment T1 (and not treatment T2) even if the patient also suffers from D2.

The assistant physician works over half an hour with this discharge letter, producing two pages of closely spaced text. Afterward she explains that they treat many different types of cancer, some of which are rare for general practitioners. It is therefore difficult to know what to be aware of, for instance possible side effects of certain treatments. These are rather specialized things that should be included in the discharge letters.

5 ANALYSES

5.1 The Complexity of Contexts

Producing discharge letters implies reading textual documents such as previous running notes, admittance reports, etc. A basic point with reading such texts and thereafter reusing them is to understand their content. The chief physician in the Department of Ear, Nose and Throat underscores that “the conditions for systematic reuse are existing documents that are brief, concrete and simple.”

Such documents are shaped by the context in which they are produced. As the context in Department of Ear, Nose and Throat illustrates, when the context is relatively self-contained, a narrow set of diseases and with patient cases that are relatively clear cut, the potential for reuse of knowledge increases. In fact the knowledge in this department reflects a certain stability and then the knowledge, as the chief physician argues, “becomes first-hand facts as it is very much in accordance with what really happened during the stay rather than producing a story out of it afterwards.”

In this way, a high degree of reuse is associated with a known context. Knorr-Cetina (1999, p. 97) use the notion of *acting body* as a way to increase understanding and illustrates this as “a person insisting on meeting a phenomenon face-to-face in order to understand its properties and procedural implications.” Another example is when the physician in the Section of Nephrology decides to reuse existing information because he knows the context in which the information was created. He knows the patient and has dictated the admittance report himself.

However, as the number of contexts increases (expressed as a myriad of information sources or different departments), *body-experience* becomes difficult to achieve. Texts that are to be used across contexts are objectified; meaning is detached from local contexts of interpretation (Lam 1995, p. 989;

Naur 1985, p. 254; Smith 1990, p. 211). Thus, reading means to relate and translate—and understand—a text to a new context. This makes it imperative to participate in what Boland and Tenkasi (1995, p. 351) denote a *perspective-taking* process, the ability or capability to take the knowledge of other communities of knowing into account. Consider for instance Pasi (Department of Cardiac and Thoracic Surgery) when he dictates the discharge letter, how he strategically picks out the 1-month old discharge letter from the Department of Medicine and underscores that information produced a while ago might be important. As Pasi says about getting an overview of a case: “The discharge letters from the Department of Medicine are very thorough. Reading them is a good way to obtain overview of a case.”

As the Department of Medicine gives the patients a full examination prior to their surgery at Department of Cardiac and Thoracic Surgery, this is hardly surprising. However it illustrates that Pasi takes another perspective when reading. He not only produces the facts related to the current surgery in his discharge letter, he also obtains the conditions for the surgery in the first place. Yet another example of perspective taking is when the physician in the Section of Nephrology uses the x-ray report. He sums up what he considers important and adds his own assessments, thus translating the knowledge to the current context.

Different degrees of tacit knowledge between communities might also hamper knowledge sharing. Some knowledge may not be migratory because it is highly embedded in complex social interactions and team relationships within organizations (Lam 1997, pp. 974-975) as is illustrated from the receiving end of the discharge letters (among the general practitioners):

Sometimes we receive discharge letters from highly specialized departments where it is difficult to know what the conclusion is; whether the patient has as disease or not. A specialist can read more between the lines...but to a general practitioner, it is not clear what the assessment is and how close the patient is in the process towards a diagnosis or the current status of the treatment.

This underscores that understanding can be reconciled with explanation in text (Czarniawska 1997, p. 141) and that understanding is related to the knowledge creator’s abilities to explain and justify the knowledge (Naur 1985, p. 256). It also underscores that it is necessary for the producers of knowledge to have another perspective in mind when they dictate. Sometimes this becomes expressed explicitly, as is the case when the assistant physician in the Department of Oncology dictates discharge letters. She underscores that her own half

year of experience as a general practitioner, as a part of her training, has made her aware of what kind of knowledge the general practitioners need:

The head physicians possess a lot more routine than us, but maybe we [assistant physicians] are more concerned about how general practitioners think and pay more attention to its content....[And as a former receiver of discharge letters] I try to imagine what kind of information I would have appreciated.

5.2 Trust in Knowledge Sources

Collaboration in complex organizations presupposes trust (Atkinson 1995, p. 118; Davenport and Prusak 1998, pp. 34-35). Trust is related to how and when information is achieved and to personal experience. Knorr-Cetina (1999, pp. 97-98) denotes it

the acting body...[where] sensory performance and action go together....[From this viewpoint,] the body is trusted to pick up and process what the mind cannot anticipate.

Knorr-Cetina (1999, p. 131) argues that trust classifies participants in terms of what is known about them, that is, whose work can one build upon and whose results are believable—a point also made by Smith (1990, p. 217) related to trust in textual sources. The degree of trust, in information from the patient's chart or advice given, depends very much on whose observation or opinion it was (Atkinson 1995, p. 57). This draws an important distinction between experts and nonexperts (Knorr-Cetina 1999, p. 131) or the distinction between head physicians and assistant physicians:

If it is some of the regulars that have produced the summary then I might accept it at face value and use it as is. But if it is produced by an inexperienced physician, then I have to read more thoroughly to check whether it can be used.

The assistant physicians can be complete novices, just graduated from medical school, or have several years experience in other fields but are completely new to the current one. The implication, regarding the content of the admittance reports may be as follows:

Often it is the novices that receive the patients [which means] that assessments can be turned around the following day and thus resulting in worthless summaries (Physician, Section of Nephrology).

This implies that the assistant physicians' current trustworthiness has to be built and reinforced. One way of doing this is through alliances with head physicians, as is the case in the Department of Oncology where the assistant physician gains force from a head physician when further treatment of a patient has to be decided.

However, in complex collaboration forms it is not only people that must be trusted. Certain contexts and being a part of that context ensure better trustworthiness. Consider the practice at the Section of Nephrology and their use of the Peritoneal Dialysis form:

We have dialysis patients that come in regularly for treatment, and every time there are certain things that must be carried out....partly some extremely important computations which indicate if it is necessary to change modus and whether their medication is sufficient....We paste the results into the discharge letter.

For these chronic patients, it is in fact imperative to reuse the computations to ensure proper quality. It is also enabled by a reasonable level of overview of what is going to occur with the patient during the stay. In these cases, trust is not only related to physicians, but also to the particular context. This is the only place where these records are archived and only the secretaries in this section are trusted to write these letters.

In some contexts, a high share of the knowledge only exists in an oral and distributed form as is the case when Pasi at the Department of Cardiac and Thoracic gathers information for the discharge letter. The discharge letter is not only based on existing documents but also on solely verbal accounts. Pasi gathers necessary information from the morning meeting (such as current status, change in medications, and further treatment strategy) as well as halting his dictating in order to ask his colleagues about follow-up information. He also stops in order to measure the patient's talus arm index, which shows that knowledge is produced *in-the-making*.

The on-duty room in Pasi's department also serves as an illustration of how knowledge is orally produced and reproduced. Physicians and nurses regularly come and go, they ask questions, discuss cases, coordinate activities, and talk on the phone with patients. Knowledge is then created through a collective process

in a community (Brown and Duguid 1991, p. 46) and trust is ensured by being a part of this community (Van House et al. 1998, p. 339). Such a context contains discourse that transforms individual knowledge into a sort of distributed cognition or a stream of collective self-knowledge recognized by a constant humming with itself about itself (Knorr-Cetina, 1999, p. 173).

5.3 Uncertainty

Often physicians have to deal with situations characterized by high degrees of uncertainty and limited amounts of resources. Hunter (1991, p. 28) underscores this:

uncertainties of diagnosis and prognosis are fundamental to medicine, the methods physicians have devised to meet them are a fundamental part of medicine as well.

Consider, for instance, the following quote denoting an unplanned patient admittance:

If the admittance report summary produced in the emergency department is a mix of previous case history (the reason for admittance and what the physician believed was the patient's problem) and then afterwards it appears to be something completely different, then the summary of the admittance report becomes completely useless and wrong—both in professional terms and in terms of being uninteresting for the one receiving the discharge letter to know what the admitting physician believed in that situation.

However, as a patient "develops" in the department, shaped by a rising or falling temperature, pulse, blood pressure, lab-results, and x-ray diagnoses, the physicians get to know the patient. In addition, there are meetings where they discuss and assess further care and treatment. In this way, through collective sense making, uncertainty is reduced and knowledge is created.

Based on new information in the process we discuss the case with pathologists, radiologists and haematologists as well as internally in our department...the outcome is regularly documented as a note in the patient record (Assistant Physician, Department of Oncology).

In spite of distributed knowledge of a case, however, physicians may experience uncertainties of diagnosis and prognosis. Such a situation is familiar for the Department of Oncology where the diagnosis is uncertain; the treatment also is uncertain and they both are a matter of negotiation. Possible side effects are difficult to predict. The uncertainty and the whole process of negotiation is even reflected in the extensive discharge letter. The letter reflects the outcome of the negotiation process, this time between the patient, the assistant physician, and the head physician, where alternative assessment and treatment are discussed and where they try to make sense of an uncertain case. Still, the conclusion is not obvious. The content is more analogous to a narrative that is capable of embracing ambiguity (Boland and Tenkasi 1995, p. 357; Hunter 1991, p. 28; Orr 1990).

Knowledge in these contexts is thus constructed and reconstructed in an ongoing process of targeted investigations and information gathering, a process that is supported by continuous discussions of the case. As one physician puts it:

We are a kind of oral and assessing profession...it is important to have meetings, to discuss which treatment is most important or correct and whether it should change or not...[for chronic patients] we have medications that will not be effective within 3 months or 6 months time (Physician, Department of Rheumatology).

During such a process, some of the discussions and their outcomes are stored as notes in the patient record, especially abnormal results and carefully improvised treatments. The discharge letter (the collective consensus) then is the result of continuous negotiation of the meaning of the case. It also means that the possibility for reuse has increased during this process.

6 CONCLUSION

The paper shows that knowledge is fluid, shaped by processes of discussions and negotiations where knowledge and trust are interwoven. Work is needed to make information credible and trustworthy, for instance, by interpreting, assessing, and validating the information in order to make it relevant and reusable for a given purpose.

In order to consider information for reuse, it appears that predictability and overview are key conditions. However, as is shown, this is not always the case. Uncertainty in diagnosis and treatment strategies as well as fluctuating competence influences many work situations. Designing information systems

under such conditions must take this into account. This underscores the point of moving beyond just making information available.

First, as the analysis suggests, reusing information across contexts can be complicated as information in different contexts sometimes is comprehended differently (Ruhleder and Jordan 2001). Whenever there are difficulties in understanding information (for instance, in the discharge letter), the information system should offer links or references back to previous related information (if it exists) that more thoroughly elaborates the conditions for the current situation or assessment. From a general practitioner's point of view, for instance, this would mean potentially accessing hospital information systems, such as electronic patient records, radiology systems or other specialized information systems, facilitated by the proper link or reference.

Second, as the analysis has illustrated, overview and stability enhances potential for extensive reuse. In such situations, it might be possible, promoted by an information system, to structure the knowledge in predefined categories, thus making it possible, on a more detailed level, to reuse some of these knowledge elements at a later stage. At the point of production of the information, it is possible to have reuse in mind and carefully adhere to the agreed-upon knowledge categories. It seems likely that such a strategy would also imply that the process of interpreting and validating information would become more structured, regulated, and disciplined—as well as more transparent.

Third, keeping *track* of what kind of information has been reused and in what situations (e.g., checking off from a list) might demonstrate the usefulness of reusing certain information elements, for instance by counting how many times information has been reused and who has produced it.

Fourth, as a part of their training, it is the assistant physicians that normally receive the patients, which sometimes results in worthless summaries in the admittance report (see the analysis section). Therefore, It seems reasonable to demand that the electronic patient record provide a feedback loop for the assistant physicians, offering a list with reference to the corresponding discharge letters. Consequently, the assistant physician would get an evaluation of earlier assessments such as insufficient description of status, disregarded things, or incorrect planning.

7 REFERENCES

- Alvesson, M. *Management of Knowledge-Intensive Companies*. Berlin: Walter de Gruyter, 1995.
- Atkinson, P. *Medical Talk and Medical Work*. London: Sage Publications Ltd., 1995.
- Berg, M. "Medical Work and the Computer Based Patient Record: A Sociological Perspective," *Methods of Information in Medicine* (37), 1998, pp. 294-301.
- Berg, M. "Practices of Reading and Writing: The Constitutive Role of the Patient Record in Medical Work," *Sociology of Health and Illness*, (18), 1996, pp. 499-524.

- Blackler, F. "Knowledge, Knowledge Work and Organizations: An Overview and Interpretation," *Organization Studies* (16:6), 1995, pp. 1021-1046.
- Blume, S. S. *Insight and Industry: On the Dynamics of Technological Change in Medicine*. Cambridge, MA: MIT Press, 1991.
- Boland, Jr., R. J., and Tenkasi, R. V. "Perspective Making and Perspective Taking in Communities of Knowing," *Organization Science* (6:4), 1995, pp. 350-372.
- Brown, J. S., and Duguid, P. "Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation," *Organization Science* (2:1), 1991, pp. 40-57.
- Cicourel, A. V. "The Integration of Distributed Knowledge in Collaborative Medical Diagnosis," in J. Galager, R. E. Kraut, and C. Edigo (eds.), *Intellectual Teamwork. Social and Technological Foundations of Cooperative Work*. Hillsdale, NJ: Erlbaum Associates, 1990, pp. 221-242.
- Correa, A. L., Werner, C. M. L., and Zaverucha, G. "Object Oriented Design Expertise Reuse: An Approach Based on Heuristics, Design Patterns and Anti-Patterns," in W. B. Frakes (ed.), *Software Reuse: Advances in Software Reusability, Sixth International Conference*. ICSR-6 Vienna, Austria, Proceedings. Berlin: Springer, 2000, pp. 337-352.
- Czarniawska, B. *Narrating the Organization*. Chicago: The University of Chicago Press, 1997.
- Davenport, T., and Prusak, L. *Working Knowledge: How Organizations Manage What They Know*. Boston: Harvard Business School Press, 1998.
- Hunter, K. M. *Doctors' Stories. The Narrative Structure of Medical Knowledge*. Princeton, NJ: Princeton University Press, 1991.
- Klein, H., and Myers, M. "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems," *MIS Quarterly* (23:1), 1999, pp. 67-94.
- Knorr-Cetina, K. *Epistemic Cultures: How the Sciences Make Knowledge*. Boston: Harvard University Press, 1999.
- Lam, A. "Embedded Firms, Embedded Knowledge: Problems of Collaboration and Knowledge Transfer in Global Cooperative Ventures," *Organization Studies* (18:6), 1997, pp. 973-996.
- Naur, P. "Programming as Theory Building," *Microprocessing and Microprogramming* (15), 1985, pp. 253-261.
- Nonaka, I., and Takeuchi, H. "A Theory of the Firm's Knowledge-Creating Dynamics," in A. D. Chandler Jr., P. Hagstrom, and Ø. Sølvell (eds.), *The Dynamic Firm. The Role of Technology, Strategy, Organization and Regions*. Oxford: Oxford University Press, 1998.
- Orr, J. E. "Sharing Knowledge, Celebrating Identity: War Stories and Community Memory," in D. S. Middleton and D. Edwards (eds.), *Collective Remembering: Memory in Society*. London: Sage Publications Limited, 1990, pp. 169-189.
- Ruhleder, K., and Jordan, B. "Co-Constructing Non-Mutual Realities: Delay-Generated Trouble in Distributed Interaction," *Computer Supported Cooperative Work*, (10), 2001, pp. 113-138.
- Sametinger, J. *Software Engineering with Reusable Components*. Berlin: Springer Verlag, 1997.
- Smith, D. E. *Texts, Facts, and Femininity: Exploring the Relations of Ruling*. London: Routledge, 1990.
- Strauss, A., Fagerhaugh, S., Suczek, B., and Wiener, C. *Social Organization of Medical Work*. Chicago: The University of Chicago Press, 1985.
- Van House, N. A., Butler, M. H., and Schiff, L. R. "Cooperative Knowledge Work and Practices of Trust: Sharing Environmental Planning Data Sets," *Proceedings of the Conference on Computer Supported Cooperative Work '98*, Seattle, WA, November 14-18, 1998, pp. 335-343.
- Walsham, G. *Interpreting Information Systems in Organizations*. Chichester: John Wiley, 1993.
- Zack, M. H. "Managing Codified Knowledge," *Sloan Management Review* (40:4), 1999, pp. 45-58.

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