Decision making is at the core of our everyday lives, as well as of this thesis. Specifically, the focus of the thesis is the complex and dynamic decision making process taking place at an emergency department. The research idea stemmed from previous work where a mismatch between literature on decision making and reality was found, and resulted in the first research question: how does a complex and dynamic decision making process at an emergency department work?

In order to capture as much as possible of the decision making process, a systems view was chosen. This led to the second research question: what are the possible advantages of taking a systems perspective on such a process?
The results are described through event chain models, patient scenarios and an information node network. Describing the decision making process in these three different ways went beyond what other methods offer in terms of detail, holism, and having multiple perspectives.

In regard to the first research question: five observations concerning practical work stood out, among these that changes of responsibility occur due to time of the day, and that numerous problems exist in connection with computerised artefacts. As for the second research question: a systems view facilitates visibility of all system components and their information exchange paths, which is important when designing artefacts, work processes and decision support systems.

Kajsa Nalin
Department of Applied Information Technology
Division of Cognition and Communication

Kajsa Nalin

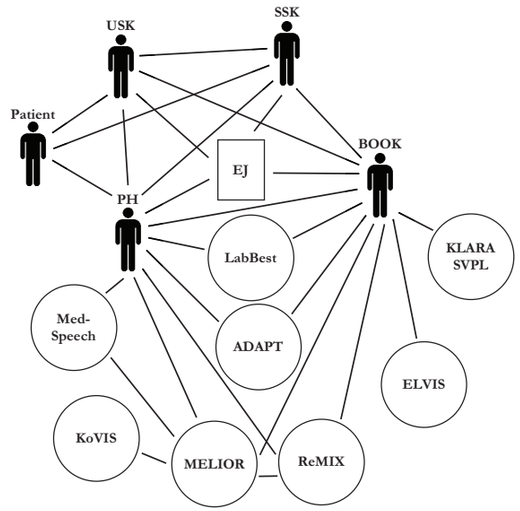
A distributed decision making process from a systems perspective: following 33 patients at an emergency department

2017

UNIVERSITY OF GOTHENBURG

A distributed decision making process from a systems perspective: following 33 patients at an emergency department

Kajsa Nalin



Licentiate thesis

Department of Applied Information Technology
University of Gothenburg, Sweden 2017

IT Faculty

A distributed decision making process from a systems perspective: following 33 patients at an emergency department

THESIS FOR THE DEGREE OF LICENTIATE OF PHILOSOPHY

A distributed decision making process from a systems perspective: following 33 patients at an emergency department

UNIVERSITY OF
GOTHENBURG

Department of Applied Information Technology

Chalmers University of Technology & University of Gothenburg

SE-412 96 Gothenburg, 2017

Print: Chalmers Repro, Göteborg, 2017

Abstract

Decision making is at the core of our everyday lives, as well as of this thesis. Specifically, the focus of the thesis is the complex and dynamic decision making process taking place at an emergency department. The research idea stemmed from previous work where a mismatch between literature on decision making and reality was found, and resulted in the first research question: how does a complex and dynamic decision making process at an emergency department work?

In order to capture as much as possible of the decision making process, a systems view was chosen, using distributed cognition as the theoretical foundation. This led to the second research question: what are the possible advantages of taking a systems perspective on such a process?

33 patients were followed through their visit at the emergency department. All communication was audio recorded and selected clips were transcribed. The results are described through event chain models, patient scenarios and an information node network. Describing the decision making process in these three different ways went beyond what other methods offer in terms of detail, holism, and having multiple perspectives. This method allowed for different process aspects to be highlighted, and the distributed nature of decision making could be visualised with the information node network model.

In regard to the first research question: five observations concerning practical work stood out, among these that changes of responsibility occur due to time of the day, and that numerous problems exist in connection with computerised artefacts. As for the second research question: a systems view facilitates visibility of all system components and their information exchange paths, which is important when designing artefacts, work processes and decision support systems.

Svensk sammanfattning

Beslutsfattande är en del av vardagen för oss alla och sker i såväl privat- som arbetslivet, men vad vet vi egentligen om hur det går till? Dels beror svaret på vilken typ av beslutsfattande det gäller (medvetet/omedvetet, själv/i grupp, rörande sig själv/någon annan) och dels på i vilken situation det är som beslut fattas. Även om forskningen kring beslutsfattande är omfattande och spänner över många discipliner så visar resultat från en tidigare studie (Nalin, 2006) att det åtminstone gällande beslutsfattande på en akutmottagning finns ett gap mellan vetenskaplig litteratur och verklighet.

I den här avhandlingen ligger fokus på hur en beslutsprocess går till, mer specifikt på en beslutsprocess som omfattar många olika individer och artefakter, samt är föränderlig till sin natur. Den teoretiska utgångspunkten för studien är en teori om kognition som distribuerad, vilket medför ett systemperspektiv. De två forskningsfrågorna lyder:

- Hur går en komplex och dynamisk beslutsprocess på en akutmottagning till?
- Vilka är de eventuella fördelarna med att ha ett systemperspektiv på en sådan process?

Studien utfördes på en kirurgisk akutmottagning och innebar deltagarobservation och ljudinspelning. 33 patienter följdes genom deras vistelse på akutmottagningen. Kommunikation med och om patienten spelades in och dessutom genomfördes ett antal intervjuer. Samtliga data analyserades och resultaten presenteras på tre olika sätt: 1/ modeller av händelsekedjor (dag och natt), 2/ fyra patientscenarier, och 3/ ett nätverk av informationsnoder.

Svaret på den första forskningsfrågan är komplext men några iakttagelser stod ut från mängden, exempelvis att en viss typ av ansvar skiftar beroende på tid på dygnet och att ett flertal problem kan kopplas till datoriserade artefakter och deras (bristande) förmåga att kommunicera. Den andra forskningsfrågans svar handlar om att ett systemperspektiv förenklar synliggörandet av systemkomponenter och vägar för informationsutbyte, vilket är viktigt när det gäller design av bland annat artefakter, arbetsprocesser och beslutsstödssystem.

We cannot direct the wind but we can adjust the sails.

The writing of this thesis has been a lengthy process, and gusts of wind have forced me not only to adjust the sails but to take them down completely for periods. During this process, my supervisors Helge Malmgren and Dick Stenmark have been reliable and rich sources of wisdom, pep talks and dry wit. For this, I am immensely grateful! Towards the end of my thesis work, Gordana Dodig-Crncovic and Pär Meiling have provided important feedback and advice.

I also wish to express my gratitude to my associate supervisor Lars-Erik Hansson, for his invaluable initial insights and contacts within the clinical world. In addition, many thanks for the exciting work done together with Martin Rydmark, Richard Dybowski, Malin Björnsdotter Åberg and Daniel Ruhe.

My place in the academic world has primarily been at the Department of Applied IT, and my colleagues have played an important role in my everyday work life. I would therefore like to thank my departmental colleagues for providing the work settings that allowed me to carry out my research work, especially those closest to me. At the Division of Cognition and Communication, I hold the many and long conversations with Gülüzar Tuna, Åsa Fyrberg Fridlizius, Alexander Almér, and Gustaf Lindblad close to heart. To all my fellow members of the impostor syndrome club, the PhD students that is, thank you and keep up the good work!

Outside the department, SweCog graduate school meant the world to me in my early days – and I am still grateful for the experiences gained from my participation.

Gesa Praetorius and Johanna Lönngren – your knowledge, encouragement and friendship have pushed me through work as well as personal life when needed. Thank you for being friends as well as colleagues.

Then, what would life be without the network of friends and family? The friends always spiritually present: Karin Jarlgård, Linda Johansson, Kine Meijer, Jan Staats, Maja Lindberg, and Susanne Andersson. Family is an inclusive term to me and members of "my" family carry many different last names: Axelsson, Öborn, Sakars, Sakars Toresson, Lövdal, Lyseng, and, last but not least, my own precious whirlwind: Tess Burns. I love you.

Abbreviations

AAP	Acute abdominal pain
DAY	Day shift
DC/Dcog	Distributed cognition
DM	Decision making
DMP	Decision making process
DSS	Decision support system
ED	Emergency department
ED_Main	Emergency department, main section
ED_Triage	Emergency department, triage section
EJ	Emergency journal
ESS algorithm	Emergency, Symptoms and Signs algorithm
EUT	Expected utility theory
EVE	Evening shift
GPS	General Problem Solver
HFE	Human factors and ergonomics
IT	Information Technology
KLARA SVPL	KLARA samordnad vård- och omsorgsplanering (coordinated planning of care and welfare)
KoVIS	Kofile Visual Information System
LabBest	LaboratorieBeställningar (Laboratory Orders)
LT	Logic Theorist
METTS	Medical Emergency Triage and Treatment System
NDM	Naturalistic decision making
NGT	Night shift
PH/PHYS	Physician
PT	Prospect theory
RETTS	Rapid Emergency Triage and Treatment (earlier METTS)
SEUT	Subjective expected utility theory
SSK	Nurse
TTP	Time to physician
USK	Assistant nurse

Contents

1 Introduction

Decision making is at the core of our everyday lives, almost anything we humans do includes decision making at one point or another.

> *Making decisions is like speaking prose – people do it all the time, knowingly or unknowingly. (Kahneman & Tversky, 2000, p. 1)*

Research on decision making is ample and has a long history. Kauder (1953) writes that already Aristotle touched on concepts that are still, many centuries later, used within decision theory, and work by the ancient Greeks is also a starting point for the logic of rational preference (Peterson, 2009). Similarly, the roots of logic can be traced back to ancient philosophy, and logic has heavily influenced research on reasoning and problem solving (Bobzien, 2016). Traditional decision making theories commonly refer to decision making (including the decision making process) as something taking place within the brain of an individual. Research studies are often performed in controlled settings where research subjects are presented with choice scenarios. Confining the decision making process (DMP) to the brain of an individual, excluding all things exterior in research, seems to overlook things that might be critical to understanding the decision making process.

Except for decisions made regarding ourselves, most of us find ourselves making decisions in a work or organisational setting, or in other forms of collaboration with others. Research on this type of decision making, group and organisational decision making, is not as historically rooted as that performed on individual decision making, but has gained substantial volume since the mid-20th century. March (1997, pp. 9-10) writes that students of organisational decisions "…focus on decision-making processes, trying simultaneously to identify the ways in which decisions unfold within them and to understand the processes as forms of social drama and locales for creating stories.". It is this process, the decision making process, which is at focus in this licentiate thesis. Still, the organisational theories encountered mostly deal with strategic or tactical decisions, whereas the focus for this thesis is decisions that are more operational in character. Researchers within group decision making research often compare different group strategies, again not compatible with the aim of this thesis.

The naturalistic decision making (NDM) approach sprung from critique against the research performed within traditional decision making research (Zsambok, 1997). It emphasizes context, with research studies usually performed in natural settings. However, even though decision making is not necessarily thought to be performed individually, my understanding is that the NDM approach still places decision making within the brain of individuals, making decisions alone or within a group of several individuals. Instead, the theoretical foundation for this thesis is distributed cognition, which also means adopting a systems view (Cole & Engeström, 1993; Hutchins, 1995a, 2006b, 2014; Nardi, 1996; Osbeck & Nersessian, 2014).

The idea of the thesis study, as well as the desire for a systems view, stem from previous work within the decision support systems domain. The project goal was to develop a decision support system, based on an artificial neural network, which could support physicians when diagnosing patients seeking care for abdominal pain (Bjornsdotter, Nalin, Hansson, & Malmgren, 2010; Dybowski & Gant, 2001; Laurell, 2006; Malmgren, Borga, & Niklasson, 2000). During literature readings for this project, it was found that decision making research performed within the health care domain is frequently carried out as controlled experiments, with study participants asked to act on a typical, imaginary or real case – thus taking an individual as the point of departure (Abraham & Kannampallil, 2014; Franklin et al., 2011; Hausmann, Zulian, Battegay, & Zimmerli, 2016).

Research studies designed for real world settings often narrow their focus to one task, something happening during a short period. Further reading showed that literature at medical programs for future physicians tend to describe the decision making process (leading up to a diagnosis and/or treatment) as being confined to the physician (Hansson, 2002, 2013; Lindgren & Aspegren, 2004). However, a pilot study at an emergency department showed that the decision making process was not at all like that (Nalin, 2006). Instead, the physician comes into the decision making process at a relatively late stage where a large amount of patient information has already been gathered, and processed, by different professional categories of nurses, and sometimes other physicians as well. Thus, the decision making process involves other medical professionals, and several types of artefacts – all combined into a complex and dynamic system.

So, if the decision making process does not always correspond to how it is described in some of the literature – how does it work? Following up on the pilot study performed in 2006 (Nalin), the study in this thesis was also carried out at an emergency department (ED).

This thesis has two parallel goals. First, to understand and describe a decision making process, in this case one taking place at an emergency department. Second, to identify the possible advantages that follow from adding a systems perspective.

1.1 Aim and research questions

Following the goals of understanding the decision making process, and doing so by using a systems view on cognition, the following aim and research questions were posed:

The main purpose of this licentiate thesis is to gain a better understanding of a complex and dynamic decision making process, such as one that aims to treat and/or diagnose a patient.

The underlying research questions are:

- How does a complex and dynamic decision making process at an emergency department work?
- What are the possible advantages of taking a systems perspective on such a process?

The thesis aims to contribute both practically and theoretically. Answering the first research question seeks to add knowledge about a certain complex and dynamic decision making process, which can be useful both practically (for people within the health care domain) and theoretically (for further research on decision making, decision support systems, interaction design et cetera). The second research question mainly concerns theoretical matters, in that it relates the systems view and the extended temporal aspect with other theoretical frameworks and research designs.

1.2 Thesis overview

CHAPTER 1: An introduction to the thesis with a presentation of the aim and research questions.

CHAPTER 2: The chronological development of research on human cognition is sketched and discussed, followed by an introduction to distributed cognition.

CHAPTER 3: The choice of distributed cognition as a theoretical starting point for this thesis is contrasted to using a theory based on the classical individual perspective.

CHAPTER 4: A methodological overview, including basic information about the setting for the study, which is an emergency department at a university hospital. Information about the required ethical approval, inclusion and exclusion criteria, as well as more practical information about how the study was carried out.

CHAPTER 5: This chapter aims to give some details about the concrete research setting chosen for this thesis study. Different sections of the emergency department, professional categories, artefacts used, and basic work organisation are introduced.

CHAPTER 6: The results from the study are presented using different methods. First, through four patient scenarios, then by highlighting certain events taking place during the studied instances of the decision making process. The end of the chapter emphasizes the need for further focus on the process interactions when studying and talking about the decision making process.

CHAPTER 7: A discussion of the results presented in the previous chapter, including thoughts on how the different ways of presenting the results affect the way the decision making process is conceived. This chapter also introduces the notion of an information node network as a way of talking about, and understanding, the decision making process.

CHAPTER 8: The conclusions and contributions from the thesis study and work are presented.

1.3 Publications and presentations

Nalin, K., Malmgren, H., Gunnarsson, U., Laurell, H., Åberg, M. C., & Hansson, L. E. (2008, October). *Automatic computer-based diagnosis in acute abdominal pain.* Poster presented at Biomedical Engineering Day (Medicinteknikdagarna), Gothenburg.

Björnsdotter, M., Nalin, K., Hansson, L. E., & Malmgren, H. (2009). Support Vector Machine Diagnosis of Acute Abdominal Pain. In *International Joint Conference on Biomedical Engineering Systems and Technologies* (pp. 347-355). Springer Berlin Heidelberg.

Nalin, K. (2009, January). *Towards an automated diagnosis system for acute abdominal pain.* Paper presented at International conference on Health Informatics, Porto.

Nalin, K. (2010, May). *Klinisk beslutsprocess i kirurgisk akutsjukvård.* Presentation at biennial SweCog Conference, Umeå.

Nalin, K., Malmgren, H., & Hansson, L. E. (2011, September). *The need for a patient focus in studies of the clinical decision-making process at an emergency ward.* Poster presented at International Symposium for Health Information Management Research, Zürich.

Nalin, K. (2012, April). *Beslutsstödsystem i ljuset av den faktiska beslutsprocessen – beslutsprocessen på en kirurgisk akutmottagning.* Presentation at annual Vitalis conference, Göteborg.

Nalin, K. (2016, October). *The decision making process at an emergency department.* Poster presented at biennial SweCog Conference, Göteborg. *In: Almér A., Lowe, R., Billing E., Proceedings of the SWECOG 2016 conference, Gothenburg Oct. 6-7 2016. p. 20 http://www.swecog.se/conference/2016/Swecog-2016-Proceedings.pdf*

2 Theoretical background

So, where do we stand? With the overarching goal of exploring how a complex and dynamic decision making process work, and what the possible advantages of a systems perspective are, some fundamental choices have been made during the design and performance phases of the study, as well as during the analysis. As the aim of the study was to capture the whole decision making process (DMP), as compared to a specific work role, action or person, the search for a theory that fitted the study turned out to be more extensive than originally planned.

At the heart of this thesis lies the concept of decision making, in itself a research term approached by researchers from several theoretical directions and traditions, amongst them economics, statistics, philosophy, psychology, artificial intelligence (AI) and cognitive science. What follows is a, deliberately superficial, sketch of how research on cognition has developed chronologically, with a focus on decision making.

2.1 Cognitive science and decision making

> *Making decisions is like speaking prose – people do it all the time, knowingly or unknowingly. It is hardly surprising, then, that the topic of decision making is shared by many disciplines, from mathematics and statistics, through economics and political science, to sociology and psychology.* (Kahneman & Tversky, 2000, p. 1)

During the history of decision making research, the distinction between the research fields mentioned above has at times only been found at a schematic and abstract level. As we shall see, researchers have not been confined to specific domains but have been working interdisciplinary. However, as this thesis uses theories and concepts primarily found within psychology, AI, and cognitive science, the following chronological sketch of evolvements in decision making research will first and foremost serve as to bring relations between these traditions into sight.

Decision making research has deep historical roots in economics through the concepts of utility and value, which can be traced all the way back to Aristotle,

who connected value to individual utility, scarcity and costs (Kauder, 1953). These concepts are in turn connected to what is sometimes termed decision theory[1], the study of rational decision making (Peterson, 2009). Even though no decision theories evolved from the ancient Greece, there is evidence that a seed was sown for the logic of rational preference (Peterson, 2009). What followed were, painted with a very large brush, the birth of probability theory (Blaise Pascal and Pierre de Fermat) as well as a formulation of the principle of maximising expected value (Antoine Arnauld and Pierre Nicole) in the 17th century. Worth mentioning is that the works of Pascal also had bearing on later theories of formal logics and reasoning, research traditions that has had high impact on research within AI and cognitive science. In the 18th century, Daniel Bernoulli introduced what researchers today call utility (Bernoulli called it moral value), a term that seems to have echoed through the centuries when it comes to discussions on decision making.

Just like the notions of value and utility can be traced back to Aristotle, so can logic, a cornerstone in much of historical as well as contemporary research on reasoning and problem solving (Bobzien, 2016). Clark (2001, p. 9) describes how the work of Boole, Frege, Russell, Whitehead, in the late 19th century and early 20th century, contributed to finding and describing *laws of reason*, first clearly expressed and used within formal logics. Clark writes that:

> *Formal logics are systems comprising sets of symbols, ways of joining the symbols so as to express complex propositions, and rules specifying how to legally derive new symbol complexes from old ones. The beauty of formal logics is that the steadfast application of the rules guarantees that you will never legally infer a false conclusion from true premises, even if you have no idea what, if anything, the strings of symbols actually mean. Just follow the rules and truth will be preserved. (2001, p. 9)*

Following the line of reasoning and problem solving, the next seminal work was the Turing machine (Clark, 2001; Turing, 1936) – a theoretical model of a device that can compute any recursive mathematical function. And, in 1945, John von Neumann wrote and distributed a first manuscript in which he wrote about a

[1] When the term decision theory is used within this text, it is done so because the researcher referred to has used that term.

"very high speed automatic digital computing system" (Original written and distributed on June 30, 1945 - Von Neumann, 1993, p. 2) – and all these three pieces (formal logics, the Turing machine and the von Neumann report) helped making it natural to compare the brain, including the mind!, to a computing machine. The argued analogy was not one of absolute similarity but rather on a level where the brain was assumed to be functionally equivalent to a computer – both thought to be performing computation in a formal, logical way. Mindware – whatever that is – was said to be the operation of a formal, computational system implemented in the meatware[2] of the brain (Clark, 2001). The *Logic Theorist (LT)*, a reasoning program by Newell and Simon (1956), was presented at what is called the birth of AI[3]; a two-month workshop at Dartmouth college during the summer of 1956 (Russell & Norvig, 1995, p. 17). Another important contribution to this domain was published in 1959, when Newell, Shaw and Simon presented the *General Problem Solver I (GPS)*, a computer program that could solve problems which could be formalized (Newell, Shaw, & Simon, 1959). The GPS was not only a contribution to the field of AI, with its similarities to human problem solving, but it also came to play a role in the domain of cognitive science. With their seminal book *Human problem solving* (1976), Newell and Simon fortified their position as explorers of a diversity of research areas: human reasoning, statistics, computer science, and mathematics –with backgrounds in economics and administration too.

However, cognitive science as a research field did not yet exist. George A. Miller, perhaps most known for his famous article "The Magical Number Seven, Plus or Minus Two" (1956) – has repeatedly stated (G. A. Miller, 1979, 2003) that a reasonable birth date for the field of Cognitive Science is 11 September 1956 – just a few months after the birth of AI. The reason for this being that this 2nd day of the MIT Symposium on Information Theory gathered speakers whose papers were to become central to the new era of interdisciplinary research. Miller (2003, pp. 142-143) gives a fairly detailed account of these seminal events, as does Gardner (1987, pp. 28-31). Still, the name cognitive science did not come about until 1977 when the first issue of the journal *Cognitive Science* was published (Gardner, 1987, p. 36; G. A. Miller, 1979, p. 4). During the decades following the

[2] More commonly denominated wetware.
[3] Gardner devotes a full chapter to the birth and early years of AI (Gardner, 1987, chapter six).

birth of cognitive science in 1956, scientists from different disciplines (neuroscience, psychology, linguistics, AI, philosophy and anthropology) gathered together and collaborated over discipline borders in an effort to shed new light on how to think of, and study, cognition. In the first chapters of *The mind's new science : a history of the cognitive revolution* (1987), Gardner describes the years leading up to the first issue of the journal *Cognitive Science* in 1977 and the Cognitive Science Foundation in 1979. On pages 6-7 he lists a few features that, at the time of writing the book in 1985, he found central to cognitive science research. These were:

- the talk of mental representations
- the belief that the electronic computer is central for understanding the human mind
- that "complicating features", such as affective factors (emotions), history and culture as well as context, were downplayed
- the emphasis on interdisciplinary research
- that contemporary cognitive science (of the late 1980's) embraced epistemological issues and concerns derived from an ancient philosophical tradition

Thus at the time, cognition was thought to be equal to computation and the manipulation of symbols (Clark, 2001; Gardner, 1987; Newell, 1980; Pylyshyn, 1998), a perspective on cognition that has later been termed the classic theory of cognition. A physical-symbol system, PSS, as defined by Newell and Simon (1976) shares many features of formal logics (see p. 7) – it consists of *symbols*, *expressions* (ways of joining the symbols) and a set of *processes* that can operate on the items (in formal logic: rules specifying how to legally derive new symbol complexes from old ones). The PSS hypothesis claims that a PSS has the necessary and sufficient means for general intelligent action. Haugeland (1985, p. 106) wrote some words that have since become famous and pretty well captures the formalists' thought of the time: "If you take care of the syntax, the semantics will take care of itself." The idea of cognition as computation generated other theories, among them Putnam's (1975) machine functionalism where he argues that mental states are functional states (as opposed to brain states), and Fodor's language of thought hypothesis (1975, 1987). Another line of thought was found within

Human Information Processing theory (Schneider & Shiffrin, 1977) where two systems were proposed. One system was described as controlled, requiring the attention of the individual, whereas the other was described as automated. From my readings, this bears similarities to recent ideas proposed by Daniel Kahneman (2011), who discusses two "thought" systems; one being fast and intuitive/affective, and the other slower and more deliberate (that which is usually defined as "thought").

As for modern decision theory, two crucial events took place, according to Peterson (2009), during the 1930s and 1940s. One of them was Ramsey's work on probability (published 1931), and the other one was the second edition of von Neumann and Morgenstern's book on game theory (1947). Both these works presented axioms on how decision makers ought to choose in order to maximise expected utility, however under different circumstances; with uncertain respectively certain probabilities. The works of Neumann and Morgenstern is what is referred to as expected utility theory (EUT). In 1954, Savage published his axiomatic analysis on the principle of maximising expected utility, referred to as subjective expected utility theory (SEUT), and research on decision making carried out during the 1950s has made an enormous imprint on this field of research. Kahneman and Tversky (2000) writes that "expected utility theory has dominated the analysis of decision making under risk." (p. 17) Well, that says something about research on decision making under risk – but what about other sorts of decision making? As strange as it may sound today, not many other aspects of (individual) decision making was studied during this period of time. Rather, decision making problems were typically created as choices between alternatives, often gambles, and were studied under closely controlled settings. The notion of man as rational, termed *economic man*, seen as an individual choosing between alternatives on the basis of expected utility, has had an enormous impact – far beyond the field of decision theory. Edwards (1954, p. 381) writes that the economic man is completely informed, infinitely sensitive, and rational. However, critique towards this stance was finding its way; Allais (1953), for example, provided a paradox showing that a central axiom in Neumann and Morgenstern's work was violated by many people. This critique was followed by numerous others, showing that the axiomatic way that had been proposed was not as descriptive as thought, and thus not as predictive as hoped for. What followed

was a wave of research with a focus on describing how humans violate the axioms and principles of the economic man as well as raising ideas on how to revise or replace the view of decision making as rational. Amongst many others we find Herbert Simon's article on bounded rationality (Simon, 1955), and Ellsberg's critique against the axioms published by Savage (Ellsberg, 1961). Then, after extensive and systematic research, Tversky and Kahneman published substantial empirical evidence showing that humans were susceptible to systematic violation of the axioms of decision theory, and thus that the axioms were unrealistic as descriptions of human choice (Tversky & Kahneman, 1974). They described three sorts of heuristics, and thirteen types of biases that they had found during their experiments. Although the 1974 paper is cited over 30 000 times, and their main findings has been replicated numerous times, the thought of human as a rational being is tenacious.

> *For many years the predominant view in the social sciences had been that the rationality assumption is an adequate approximation for modeling and predicting human behavior. […] Many studies from the past three decades, however, have documented numerous ways in which judgments and decisions do not cohere, do not follow basic principles of logic and probability, and depend systematically on just such irrelevant factors. People use intuitive strategies and simple heuristics that are reasonably effective some of the time but that also produce biases and lead to systematic error. (Shafir & LeBoeuf, 2002, p. 493)*

In AI, just as in decision theory, problems with the contemporary and rather passionate promises of computers as thinking machines became the new wave after the promising early years of AI. As a result, research funding became scarce in comparison to previous years and AI had a long period of dormancy (Russell & Norvig, 1995). For example, the intelligence said to be an intrinsic feature of computers were failing – Weizenbaum's program ELIZA (Weizenbaum, 1966), which could apparently engage in serious conversation on any topic, actually just borrowed and manipulated the sentences typed into it by a human. Also, both the optimistic view that all that was needed to solve larger problems was faster hardware and larger memories and the view that the scaling up from individual to group decision making was a straight forward matter turned out to be problematic. A third difficulty was the limitation of representations. The

successfulness of the perceptron, able to learn anything it could represent, showed to be disappointing – they simply could not represent that much (Russell & Norvig, 1995). The idea of computers as intelligent, thinking machines was dismantled, or at least not as jubilant as in the early years. However, research on computerised decision support systems (DSS) continued within several domains, including business management as well as the medical/clinical setting. A couple of examples from the latter field are the knowledge-based systems DENDRAL (Buchanan, Sutherland, & Feigenbaum, 1969) and MYCIN (Shortliffe & Buchanan, 1975), where the rules (representing the knowledge) and the reasoning component (the "thinking") were separated from one another. A different way of using data was practiced in the works of diagnosing acute abdominal pain (AAP), where the aim of the computer program was to aid the clinician with "(a) the provision of diagnostic probabilities for a subset of diseases, and (b) the recommendation of acquisition of additional information" through "the statistical analysis of large volumes of data" (Horrocks, McCann, Staniland, Leaper, & de Dombal, 1972, p. 8+9). These, and other types of DSS, were examples used in a new field emerging within AI and computer science; medical informatics (also called health informatics). My reading of the historical literature is that clinical work seemed to accommodate problems that were well suited to contend with for systems like these, and that this is one reason for the rapid expansion of medical informatics.

If not before, it should now be fairly evident that the fields of psychology, AI and cognitive science are, if not fused, then overlapping substantially. However, let us return to the purely human side of reasoning, problem solving, and decision making. We left off with the advent of critique against the rationality hypothesis, the notion of economic man. Following their work on heuristics (1974), Kahneman and Tversky moved on to introduce prospect theory (PT) in 1979 (Kahneman & Tversky, 1979) – developed from a critique of SEUT. Even though there are several discerning features between the theoretical accounts of SEUT and PT, they share some fundamental features too, and the value function is one of them – even though the theories differ on how the value function works. Nevertheless, the mere use of a value function implies some kind of a numerical approach, which in turn indicates that at least some part of the process is seen as formal; in PT it is the second and last phase of the process (the evaluation

phase).The first phase of PT, the editing phase, incorporates the use of the heuristics written about in Kahneman and Tversky's earlier works, and opened up a more behaviouristic account than was ever SEUT.

As time went on, so did the search for a new, or at least complementary, way of performing research on decision making. During the 1980s, researchers who were struggling to find answers through the traditional decision making research paradigm gathered to summarise their thoughts, and at a conference in 1989, the term Naturalistic decision making (NDM) was coined. Zsambok (1997) writes that much of the definitional work carried out at the conference sprung from disagreement with the traditional research, and the key contextual factors identified all had opposing equivalents therein. In the following definition of NDM, many of the contextual factors are expressed in a more positive way, not using the traditional paradigm as a springboard any longer. Zsambok writes that "[t]he study of NDM asks how experienced people, working as individuals or groups in dynamic, uncertain, and often fast-paced environments, identify and assess their situation, make decisions and take actions whose consequences are meaningful to them and to the larger organisation in which they operate." (1997, p. 5).

As is evident from the definition above, within an NDM perspective decision making is not strictly confined to individuals. Context and situation awareness is regarded as playing an important role, and the use of the word Naturalistic supposedly aims to highlight the emphasis on real world situations as opposed to controlled laboratory settings.

Besides research on individual decision making, research on organisational decision making, as well as group decision making, existed (and exists) in parallel. The study of what is now termed an organisation was previously also labelled bureaucracy (Parsons, 1956, pp. 63-64) and organisation/bureaucracy was studied in the domains of administration as well as in economics (Simon, 1952, p. 40). Simon has contributed to many studies on organisations (selected papers/books: Cyert, Simon, & Trow, 1956; March & Simon, 1958; Simon, 1944, 1952), in addition to numerous other research areas. March (1997, p. 20) writes that (organisational) decision making is intimately linked to sense making, and that

"(a)s a result, students of decision making are preeminently students of the ways in which individuals and organizations make sense of their pasts, their natures, and their futures". By linking decision making to sense making, March has moved the traditional boundaries of decision making from seeing it as choosing between options to making sense of the world and acting accordingly. March further writes that an alternative to seeing life as a sequence of choices is to think of life as being "…more concerned with forming interpretations than with making choices" (1997, pp. 23-24).

2.2 The need for a systems view

What follows is an attempt to explain why the hitherto described theories (probably) would not suffice for the purpose of this study.

As for the traditional, already mentioned, approaches to decision making, my understanding is that many of them usually focus on an individual…:

- …with a context, but not taking context into account more than as potential input to the individual,
- …with a well-defined problem,
- …having full information,
- …choosing between two alternatives,
- …where decision making usually does not include implementation of the decision.

Narrowing the scope to medical decision making and medical informatics, numerous researchers claim that research within these areas has been guided by a classical, individual-centred, model of cognition (Franklin et al., 2011; Hazlehurst, Gorman, & McMullen, 2008; Patel, Kaufman, & Arocha, 2002). Patel et al. (2002, pp. 54-55) list seven scenarios that serve to highlight the inseparability of decision making from the systemic properties of the system in which it takes place. The patient, nomenclature, technology, team work, and uncertainty are, or can be, examples of intrinsic features of the decision making system, thus are important to account for when performing research. Hazlehurst et al. (2008, p. 231) write that the individual-centred approach has had a number of negative consequences, and that mistaking cognitive functionality performed within a system of

individuals and artefacts for cognition happening within an individual potentially carries with it:

- …redesign that puts novel or increased cognitive demand on system actors, and possibly also demount already existing ways of achieving situational awareness.
- …blaming of individuals in cases of malfunctioning, when it is rather the system that malfunctions.
- …redeployment of information within a computer system or new process without taking consideration of the contextual semantics that are the result of local practice.

NDM theories may seem to have a closer fit with the aim of this thesis, having a wider perspective than solely the individual. However, NDM still appears to locate the decision making within an individual, or within several individuals that jointly use their individual input in order to come to a decision. Franklin et al. (2011, p. 470) discuss the use of NDM theories in medicine and write that the common focus on a single task – as opposed to studying many tasks or having a process emphasis - makes it less probable that process aspects affecting decision making are acknowledged.

Within the organisational perspective the focus is commonly on larger decisions, strategic or tactical rather than operational, and as such fall outside the scope of the purpose of this thesis. Group decision making research usually assign agents to solve the same problem, side-by-side, in contrast to the team where each person participates in a specified role.

2.3 Distributed cognition

In 1995, Hutchins wrote his transformative book *Cognition in the wild* (Hutchins) where he presented an alternative way of thinking about cognition, seeing cognition as a distributed process rather than (always) happening inside the brain of an individual. In the book he argued that the classical theory of human cognition, using the image of a computer as a model of it, was a result of a misinterpretation of cognition as computation taking place within the boundaries of the skull and skin of an individual. According to Hutchins, this misconception led to the impossibility of integrating anything but the human brain in the model

of cognition. In the introduction to *Cognition in the Wild*, Hutchins portrays how the development of his notion of distributed cognition took place, starting with an experience of team work on a navigation bridge. In 1984, Hutchins began a study on what he then chose to call naturally situated cognition, the analysis of human cognition in real-life settings. Up until the end of the first study period he was thinking of cognition as cognition of individuals, but after realising "the importance of the fact that cognition was socially distributed" (Hutchins, 1995a, p. xii) he changed to a systems perspective and this was possibly the birth of DC as known since then.

The view on cognition (and/or mind) as distributed did not start with the distributed cognition (DC) perspective[4] as presented by Hutchins, but after the publication of his book in 1995 the notion of cognition as distributed certainly became entrenched in many discussions related to cognition and how to study it. From 1995 and onwards, DC has been used in several scientific disciplines, such as for example in human-computer interaction/interaction design, healthcare research, and organisational studies. The researchers performing these studies have developed somewhat different versions of DC and/or how DC is used. One of the dividing lines between researchers using DC concerns what DC essentially is and/or is used for. DC has been presented as a:

A. theory (Hazlehurst et al., 2008, p. 226; Hollan, Hutchins, & Kirsh, 2000, p. 175; Hutchins & Klausen, 1996, p. 3)
B. theoretical framework (Garbis, 2002, p. 42)
C. scientific discipline (Zhang & Patel, 2006, p. 334)
D. subfield of cognitive science (Hutchins, 2006a, p. 376)
E. research field (Sutton, 2006, p. 235)
F. theoretical framework and analytical tool (Nilsson, Laere, Susi, & Ziemke, 2012, p. 65)
G. hypothesis + theoretical approach and method (Michaelian & Sutton, 2013, p. 1 + 5)

[4] For an ample historical narrative, read Cole & Engeström's chapter "A cultural-historical approach to distributed cognition" (1993). For a synopsis of historical precedents in dissolving the boundary between cognitive and social processes, see Osbeck & Nersessian (2014, p. 84), and for more information about non-individual thoughts on cognition, see Nardi (1996, p. 35).

In an article by Hutchins (2014), he argues that DC is not a theory since it cannot be used to generate any testable hypotheses, and goes on to write that DC makes no empirical claims. This is in contrast to his earlier writings from 1996 and 2000 (A. in the list above). Further on in the article from 2014, (p. 36) Hutchins writes that "distributed cognition is not a kind of cognition; it is a perspective on all of cognition".

Besides the obvious confusion regarding what DC is from an epistemological perspective, there seems to be numerous ways in which researchers use a DC approach in relation to cognition. The section below is an excerpt from study material set together by Hutchins, text copied 2014-10-03 study material set together by Hutchins, p. 5 (my italics). Note that Hutchins here refers to DC by "Dcog".

A *hypothesis* about human cognition:

- High-level human cognition depends on interactions with culturally organized material and social structures.
- *Weak Dcog*: Cognition is affected by or shaped by interactions with the material and social world.
    - Action reveals underlying cognitive processes
- *Strong Dcog*: Some forms of human cognition are constituted in interactions of brain and body with material and social world.
    - Action is a form of cognition

Michaelian (2013, pp. 3-4) writes that the various views that consider cognition to be extended or distributed range from weak to strong in their claims about whether cognition is simply dependent upon external resources or if cognition is literally distributed across different parts of the world. Hutchins (with DC) as well as Clark (extended cognition, see for example his book *Supersizing the mind* (2008)), count as proponents of a strong view. Weaker DC-views include Rupert's "embedded cognition", Sterelny's "scaffolded cognition", and "situated cognition" written about by Robbins and Aydede as well as Roth and Jornet, to mention a few (cited in Michaelian, 2013, p. 4). A difference between strong and weak DC is the locus of interest. Whereas weak DC-views put the (human) individual in focus, and the external resources are considered 'affectors', strong DC-views focus on the interactions taking place in a system, thus being the real

unit of analysis. Using an example from the thesis study: suppose a nurse is filling out a form with a limited writing space, forcing her to sift information before writing. A weak Dcog view would put the nurse in focus and would see the form as an affector on her cognitive act, making her sift information and write the chosen information down. With a strong Dcog view, the whole of the nurse and the form (and other objects or individuals present) would be seen as a cognitive system that produces the result. With the systems perspective taken within this thesis, it follows that all mentions of DC in this thesis refers to a strong view of DC, if not otherwise stated.

2.3.1 Spoken out claims within DC

Whilst reading Hutchins' most famous chapter from the 1995 book (chapter 9, 1995a, pp. 353-374), it seems obvious that Hutchins is eager to soften, and sometimes expand, the boundaries of the unit of analysis when studying cognition, making the distinction between internal and external less important. By doing this, there are no longer any question marks whether those features earlier being regarded as non-cognitional are part of the process of cognition or not. Culture, one of the downplayed features that were earlier excluded from cognition, is frequently mentioned in the early works on DC of Hutchins and we find quotes like this:

> *Culture is not any collection of things, whether tangible or abstract. Rather, it is a process. It is a human cognitive process that takes place both inside and outside the minds of people. It is the process in which our everyday cultural practices are enacted. I am proposing an integrated view of human cognition in which a major component of culture is a cognitive process (it is also an energy process, but I'm not dealing with that) and cognition is a cultural process. (Hutchins, 1995a, p. 354)*

Furthermore, in a text from 2006, (Hutchins, p. 377) the author writes that DC "sees real-world cognition as a process that involves the interaction of the consequences of past experience (for individual, group, and material world) with the affordances of the present. In this sense, culture is built into the distributed cognition perspective as at least a context for cognition". Rather than including culture, emotions, history and context in DC systems, one understanding of Hutchins' texts is that he claims that *a cognitive process is part of a larger cultural process.*

From this follows that emotions, history and context in different ways are, or at least can be, intrinsic parts of a DC system, in a similar way to how a large unit of analysis in DC can subsume other possible units of analysis.

In contrast to many other perspectives on cognition, DC does not put the individual at the focus of interest, but rather sees cognition as *emergent from processes distributed within a (cognitive) system*. From this follows, argues Hutchins, (2014) that the interesting questions within DC concern the elements of this system, the relations among the elements, and how cognitive processes arise from interactions among those elements. The claim is, accordingly, that *cognition is to be seen as information handling distributed across elements of a system*, and depending on which spatial scale is of interest, this distribution can range from being applied to a (single) human brain up to collective intelligence of, for example, societies. Indeed, DC searches for principles that apply at multiple scales and across vastly different kinds of cognitive systems.

Zhang and Patel (2006) write that the DC approach is holistic in that it claims that the properties of the system can be different from the sum of the properties of the various components. They refer to Hutchins' paper "How a cockpit remembers its speed" (Hutchins, 1995b) after writing: "*[…] a distributed system can have cognitive properties that differ radically from the cognitive properties of the components*, and these properties cannot be inferred from the properties of the components alone, no matter how much we know about the details of the properties of the components" (Zhang & Patel, 2006, p. 334 - my italics).

2.4 Decision making/decision making process

An essential term in this thesis is decision making, but what does this mean? Not very surprising, different researchers would answer differently, but quite a few would say that it refers to the cognitive act of choosing between options – something done at a certain point in time and with (in this case as in most cases) an appointed individual as responsible for the decision. A majority of those answering in such a manner would place the decision making process within the brain of an individual. Another way of describing decision making is to refer to it as a process, a DMP, that leads up to – and includes – the final decision. Thus, whereas decision making is traditionally thought of as what goes on within (the

head of) an individual, it is here seen as the whole information propagation process within a system made up of individuals and artefacts. During this type of DMP, a number of judgments, minor decisions and many actions occur along the way, but they lead up to one formal decision point - with one person (or rather work role) in charge of it.

Other concepts often used in the thesis are presented in the table below, with explanations.

Table 1: Definitions of concepts frequently used in this thesis

Concept	Definitions
Complex	Consisting of many different and connected parts[5].
Dynamic	Something characterized by constant change, activity, or progress[5].
Network	A group or system of interconnected people or artefacts[5].
DSS	System (usually computerised) aiming to support decision maker(s).

[5] Definitions retrieved January 11 from Oxford Online Dictionary (2017)

3 Epistemological stance

This chapter aims to highlight the significance of choosing a fitting theoretical perspective, relating different theoretical accounts and discussing how their different perspectives might affect the results of the study.

If each theoretical account was given the same research task, namely to explore how a complex and dynamic decision making process at an ED work, what differences would there be in the design, carrying out, and outcome of these studies?

Before delving into reflections on how the different accounts would deal with this research task, there is a more fundamental issue to address; namely how these accounts relate to descriptive research in general? Studies with the classic perspective as the theoretical foundation have traditionally been more of the explanatory kind, hypotheses-testing rather than descriptive, whereas DC proponents generally have descriptive research as their first choice. This imbalance makes the comparison between approaches somewhat artificial, but nonetheless important as their views on cognition deviate profoundly from each other in several other respects.

3.1 Classical theory and the individual perspective

Decision making is, with the classic theory of cognition as a point of departure, seen to be taking place solely within the brain of a human. Therefore, my reading is that the subject of research would be an individual and, more specifically, whatever goes on in that person's brain.

Following this view on cognition, the unit of analysis of a DMP would probably be the individual in charge of the decision. With the, once fundamental, underlying assumption that the electronic computer is central for understanding the mind, there would arguably be theoretical limitations on what methods to choose; the methods available according to this theoretical assumption might plausibly be constrained to studies with a simulated task or other forms of individual-based studies, all most likely being performed under controlled settings. However, the classical approach could probably also encompass various ways of taking context into account, presumably considering the context to affect

or constrain the "decision-maker" in his or her decision making process. The context would hence be seen as some kind of input to the decision-maker, input that the decision-maker in some way then manipulates – together with the already existing information within his or her brain. The output would be the decision, output that would subsequently be communicated and used in action. In the study of this interaction between the decision-maker and the context several other methods than computational modelling might well be used. These include interviews, think-aloud protocols, brain imaging and even more or less unprejudiced observation, hunting for causal interactions that were not foreseen when the study was designed.

In any case, with the goal of exploring how a complex and dynamic decision making process at an ED work, the classical approach would primarily take the viewpoint of the decision-maker, a viewpoint that might differ from those of other individuals being, more or less, involved in the process leading up to the decision. The results would thus reflect solely the decision-maker's world view and this individual's process of decision making. If it is argued that the limitation to one person's viewpoint is troubling, then it would, at least in theory, be possible to perform the same research procedure for each and every one who is somehow involved in the larger DMP, where judgments and smaller decisions are included. The interesting question is what result such an approach would give – would an overall perspective be graspable through putting the pieces together as were they a giant puzzle? One possible danger with doing this could be lack of information about the interfaces between the individuals within the larger DMP, ending up with islands of information and hence limiting the possibility of seeing the bigger picture. Given that observational methods were included in the study design, the chance of acknowledging the adhesive that, presumably, holds the individual pieces together within the process increases but the question remains, would the bigger picture become visible with this approach?

3.2 Distributed cognition and the systems perspective

Decision making is, according to the position of DC, seen as distributed across elements and emergent from interactions of these same elements.

Hutchins advocates a stepwise, or circular, studying of cognition, where a descriptive and ethnographic method is the first step, in order to see what actually goes on in the "real world". Hollan, Hutchins and Kirsh (2000, pp. 180-183) propose and describe an "integrated framework for research", and they also promote conducting well-motivated experiments that can improve the DC theory. The paper by Hollan, Hutchins and Kirsh targeted research within the human-computer interaction domain, however there seems to be no obvious reason for not using the same methods in other fields of cognition research. Hazlehurst et al talk about the use of distributed cognition as a way of thinking about cognition in medical informatics (2008). Garbis (2002, pp. 46-47) writes that the expansion of the unit of analysis, from individual to a socio-technical system[6], makes it possible for the researcher to step inside the system and make observations. Zhang & Patel (2006) writes that "for the purpose of studying the behaviour of a distributed cognitive system it is usually sufficient to understand how information and knowledge are distributed and propagated across the various components of the distributed system". DiCot, an abbreviation for distributed cognition for teamwork, (Blandford & Furniss, 2006), is one example of a method that applies DC to the analysis of socio-technical systems. Blandford & Furniss also mention similar work done by others and the interpretation from various readings of the methodological efforts made is that a strong focus is placed on information handling and how this takes place. DiCot also emphases physical location and the design and use of artefacts, where the former is reminiscent of what Kirsh wrote about in his paper "The intelligent use of space" (Kirsh, 1995), that the use of space can be a support for cognition and cognitive processes.

Garbis also writes (2002, p. 44) that "[a] distributed cognition analysis often begins by locating and describing the goal of the entire cognitive system", and even though a systems perspective is always advocated, no strict implications for how big or small the unit of analysis should be follows from this. However, with the aim of exploring how a complex and dynamic decision making process works, there are several reasons to believe that the whole setting (i.e. all collaborative

[6] The term socio-technical is sometimes interchanged with socio-cultural. My reading is that the term socio-technical refers to systems including non-individual components, or even with a majority of non-individual components.

elements within the setting) should be included in the unit of analysis. Obviously, depending on the research setting, this can be a difficult delimitation to do – where are the boundaries of such a system, or rather, where should the boundaries be drawn? No clear guidance is to be found in the literature, except for the somewhat pragmatic statement that "[f]or distributed cognition, the existence of boundaries and centers are empirical questions. Centers and boundaries are features that are determined by the relative density of information flow across a system. Some systems have a clear center while other systems have multiple centers or no center at all." (Hutchins, 2014, p. 37). In practice, this means that there are no clear theoretical regulations as to what is to be seen as within or outside the system, nor is there any set idea of what or where a centre is to be found within the system.

Nevertheless, one of several reasons for an inclusive perspective: the judgments and the final decision usually depend on *information coming from several sources* and, furthermore, decision making often takes place in a *collaborative* manner, the formal decision-maker together with other members of staff. Secondly, at any point in the DMP the formal decision-maker, as well as other staff members, works under *regulations, rules and settings* that place constraints on the DMP. Thirdly, the decision-maker, as well as other staff members, works with different kinds of *artefacts*, relatively often including decision-support systems. Following the inclusive approach, the interesting aspects to include in a study quickly increase in number. However interesting, and however important, the large number of elements could become a disadvantage, since identifying, monitoring and describing the interactions between them probably will be a significant challenge for the researcher. If the challenge is accepted, what differences will there be using such an inclusive systems viewpoint compared to using an individual viewpoint?

For one, the systems approach takes no individual's viewpoint but is focused on describing the interactions between the elements of the system. Thus, the system activity, and how information propagates in order for it to work, is what is studied. In this sense, the systems approach is quite the contrary of taking the viewpoint of an individual, and it would accordingly be fairly strange if this had no bearing on the research results. If the concern of having the individual in focus was that interface information would either be fully missing or compromised by the lack

of whatever glues the pieces of information together – then the concern with the systems perspective would possibly be the opposite, namely that one might recognise and describe "the glue" but instead miss out on information about the elements of the system. This does not necessarily have to be a problem, though it would most probably make a significant difference with respect to the results.

Moving on to methodological choices, the relatively rich choice of methods available when having the classic theory of cognition as a starting point narrows down significantly when taking on the DC perspective. "[C]ognitive ethnography" (Hutchins, 1995a, p. 371) is the only plausible manner to perform a distributed cognition analysis of what Hutchins refers to as "cognition in the wild" (1995a, pp. 370-374). Important, though, is that Hutchins does not disparage other research methods than observational ones. On the contrary, he writes that "there are many things that can be learned only in closely controlled experiments" (1995a, p. 371). The criticism is rather that it is difficult to know how plausible conclusions drawn from research in laboratory settings are when it comes to cognition in everyday life.

The coupling between theory and method is thus tighter with this position as a theoretical starting point than with the classical account. One occasion when an alternative method can be considered, when performing research on "cognition in the wild", is when the system to be studied is part of an individual (brain regions, neuronal groups etc.). In a case like that, observational methods are hardly sufficient on their own, or impossible to realise, thus the substitution or addition of other – neuroscientific – techniques would be necessary.

3.3 DC as a theoretical and methodological starting point

Many concerns and voices of criticism have been raised regarding DC, however a major problem with DC is, as with several other research views, the lack of definitions – they seem conspicuous by their absence. There seems to be as many definitions of some terms as there are researchers using the terms, something that undermines the possible strength of certain ideas launched within the DC research subfield. Amongst numerous examples, I regard 'cognition' to be the term most important to define in a proper manner. If not in any other way, at least a stipulative definition should be possible. 'Process' is another term loosely

used, as is 'cognitive process' and how that is to be distinguished from 'cognition'. In 2014, Hutchins published a paper (Hutchins, 2014) in which he discusses cultural practices and how these practices and cognition work, in interdependence of one another. "Cognition as a cultural process" (see page 20) is thus a problematic expression since neither cognition nor culture is well defined but rather pointing to each other in a circular line of reasoning.

One well debated issue has been the expansion of the unit of analysis, and what implications follow from this. If a loss of focus on the individual is what seems problematic, there could be reason to re-think. The expansion of analysis unit in DC is merely a logical consequence of seeing cognition as emergent from interactions taking place in a system – whether the system is a brain region of an individual or a society of ants is simply a matter of scale. The obvious follow-up question would probably be; why choose a systems view? One answer is that cognition seems to be complex and in some way(s) collaborative (between nerve cells, brain regions, people, people and artefacts for example), and as such; a systems perspective is a beneficial way to look at cognition – at any level or scale.

The view of DC as holistic seems, strangely enough, only to apply to what the authors Zhang & Patel (2006) call the interactionist view of DC – as opposed to the reductionist view. A proponent of the former view "[…] considers that the interactions among the individuals can produce emergent group properties that cannot be reduced to the properties of the individuals" whereas advocates of the latter view holds that "[…] the cognitive properties of a group can be entirely determined by the properties of the individuals". This is confusing, to say the least, and the term holistic is not defined any further, though exemplified by mentioning research on properties such as group affect, collective efficacy and transactive memory systems (Zhang & Patel, 2006, pp. 335-336).

Hutchins claims no such thing as a holistic view, but he talks about "supraindividual cognitive effects" when arguing that cognitive properties of social groups can be distinct from the cognitive properties of the individuals who compose the group. (Hutchins, 2006a, p. 377). This ties in well with what Zhang and Patel refer to as the process gain of the 'effectiveness problem', namely that a group can perform better due to the use of the collective amount of (cognitive)

resources within the group. A group can also perform worse than an individual alone, depending on how knowledge is distributed across the individuals of the group. I adhere to a holistic view in the sense that the component interactions within the unit of analysis sometimes augment and/or enhance the cognitive processes that emerge from the group. That is, the interaction between system components may result in an emerging, or enhanced, cognitive process – one that would not have been possible to achieve if the interaction did not take place. The possibility that this enhancement might, in principle, be reducible to processes on a lower level does not alleviate the need for using the systems perspective.

A recurring criticism towards DC is that the possibility to generalise from research findings is limited. If the research settings are uncontrolled and the systems studied comprise interacting elements that differ from one setting to another – is generalisation possible at all? The answer given by Hutchins is that "[t]he theory claims that we should attend to the resources available to participants for use in organizing their behavior. That means that while different settings may consist of different sets of resources, they do not differ from each other in theoretically interesting ways." (1996, p. 66). He returns to this in his article from 2014 (Hutchins) but, again, gives no further description of the similarities of these resources nor of why it is that the differences between them are not theoretically significant and/or interesting. One way of looking at this is to argue that the ways in which cognition emerges, and the ways information propagates through the system, do not depend on *all* the peculiarities of the elements of the system but follow general patterns that can be identified through research performed with this systems approach to cognition. Remember that even in controlled experiments some circumstances may vary between situations, but in a way that does not block generalisations. Hutchins himself writes that "Distributed cognition searches for principles that apply at multiple scales and across vastly different kinds of cognitive systems" (2014, p. 37). Now, what does that mean? The question of representativeness is something that every ethnographic study has to pay a lot of attention to in order to counteract overgeneralisation. But I also believe that general principles are likely to be found across different settings (and possibly also at multiple scales) and therefore that studies in the wild are important complements to research carried out in more controlled settings. Or, rephrasing the last sentence after some thought digestion, maybe it should be seen

the other way round, at least timewise. That is, once research carried out in the wild has brought light on what Hutchins refers to as "the cultural nature of cognition" (1996, p. 67), some aspects can be studied further in more controlled settings. Important to remember, however, is that any research setting, whether in the wild or in a laboratory, is cultural – the difference being that the degree of control over how the context (read: the cultural aspects) affects the subject of study is probably higher in settings where the experiment or study is taken out of their natural context.

And, last but not least; if DC is not a theory, then what is it? According to Hutchins it is a perspective, a way of looking at the world (of cognition) – a perspective that can encompass theories which, in turn, generate testable hypotheses. In what way does this differ from a theory and what implications follow from this? For a start, this claim gives, or presumably intends to do so at least, Hutchins some degree of freedom. If DC is not a theory with claims that can be tested as being true or false, neither can it be discarded by reference to empirical data. However, I argue that certain statements within DC (see p. 19), carry theoretical assumptions regarding the world and have implications for how the world can be studied – and this differs in no relevant way from how (other) theories of cognition work. My understanding is that DC, in all relevant aspects, is a theory.

4 Methods

From the theoretical choices made, that is from the theoretical stance based on DC, a systems perspective follows naturally. The use of a systems view when talking about health care, and, more precisely, when talking about the ED is not new (Laxmisan et al., 2007). A systems view has also been used in research on decision making in navigation at sea and in the air (Hutchins, 1995b) and other examples can be found in research on memory (Michaelian & Sutton, 2013), on information fusion (Nilsson et al., 2012) and on discourse in adults with brain injuries (Duff, Mutlu, Byom, & Turkstra, 2012).

4.1 The logical basis for a systems perspective

The connection between the study and the theory chosen, or rather the systems perspective, might need some clarification. Following up the results from the pilot study (Nalin, 2006), the thesis idea was to deepen the understanding of, and describing, how a DMP at an ED works. The literature read beforehand tended to look either at a certain point in the process or taking an individual as the locus of interest, or both. Study designs like these seemed, however important and/or justified in their own cause, to lack the possibility to encompass the complexity and dynamics that takes place in a DMP at an ED – and here the systems perspective finds it place. Instead of studying one professional work category, the focus is on the information propagation as well as the interaction between the individuals, and the artefacts, included in the decision making process – thus seeing the DMP as a system.

With a systems perspective chosen as the preferable way to look at the DMP, the next choice is how to perform such a study. Garbis (2002, p. 44) writes that "[a] distributed cognition analysis often begins by locating and describing the goal of the entire cognitive system", and the goal of the DMP in the study is to treat and/or diagnose patients seeking care at the ED. Garbis also writes (p. 47) that the expansion of the unit of analysis, from an individual (brain) to a (socio-technical) system, enables the researcher to "[…] literally step into the socio-technical system and observe what representations are used, what they are used for, and how they are transformed and propagated throughout the system and turned from input into output". The goal, combined with a systems perspective, makes it less interesting to observe and follow any specific category of staff, and

more interesting to capture the whole process in some way. To step inside the system calls for an observational study and the primary question at hand is then how to design the study in order to follow the process rather than any component of the process. Rejecting the idea of following any professional work category of staff, the patient suddenly stands out as a plausible alternative to anchor the observational study to. This does not mean that there is any intention whatsoever to take the *perspective* of the patient throughout the study, the goal was simply to follow the patient when it came to collecting information – and there are several reasons for doing so. First, information about the patient is a crucial part of the DMP from beginning to end, and as such is a central part of the system. In addition, the patient is the recipient of the DMP output (treatment and/or diagnosing the patient). Also, following patient information allows for following several trails of the DMP with partially different system components (not the same staff included in all patient cases) – thus facilitating the possibility of finding general features and actions of the entire DMP. Finally, this choice makes it possible to get an overview of the whole DMP and its information propagation that leads up to the final decision. Before getting into the details of chosen methods for data gathering and analysis, the study setting will be presented.

4.2 Research setting

The ED observed in the study is part of a university hospital in a Swedish city, with patients seeking care for injuries or diseases that they felt could not wait, or could not be handled by out-patient care such as the local primary care unit. The ED is specialized for accepting patients seeking care for medical or surgical conditions, however only the surgical part of the ED was included in the study and only patients seeking care for acute AAP at this surgical unit were followed. A more detailed description of the ED will be presented in the chapters following this. In all ensuing text of this thesis, when referring to the ED it is the surgical section of the ED that is meant.

There were three different work shifts per day at the ED. In the study these are labelled Day (DAY), Evening (EVE) and Night (NGT), more information about this in next chapter. The actual work shifts included in the study were primarily chosen as to give a good overall view of the work process in terms of number of medical personnel on duty, variations in medical professional competence and

expected patient flow. However, the difficulties of following multiple patients in parallel during DAY and EVE work shifts led to an overrepresentation of NGT work shifts.

If several physicians worked in parallel with each other and more than one patient with AAP was admitted to the ED during this parallel work, there would be no other way to capture all communication as stated above unless only the first of these patients was followed through to discharge. It also proved to be difficult to record all communication regarding a single patient since several communication routes existed simultaneously, especially during D and E shifts when staff numbers were high. Certain members of staff tended to pay regard to the study through alerting the researcher when communication or some other event regarding a patient that was included in the study was about to take place, however most part of the time no such alerts were given. The fact of 1) some communication and/or events in the patient/work process not being included in the study and, 2) staff obviously being affected in their work by the study surely had some impact on the study and the transferability of its results. Hopefully, the numerous hours (more than 80 hours) of observation and recorded communication compensates somewhat for the distortion of the process. The study occasions were spread across six months and altogether 8 periods, with a length of 8 to 15 hours, were spent at the ED. They included, in whole or in part, eleven work shifts and 33 patients were followed, generating 273 audio clips. The distribution of patients followed, and the relation between work shifts and study periods, is summarized in the table below:

Table 2: Work shift(s) and patients at each study occasion

Observation occasion	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Work shift	NGT	NGT	DAY, EVE	DAY, EVE, NGT	EVE	NGT	NGT	NGT
Patient	1-3	4-8	9-12	13-19	20	21-23	24-29	30-33
Number of clips	16	46	34	58	18	37	38	26

4.3 Ethical considerations

For research within the health care system, and where patients and/or staff are included as research participants, an application for ethical review has to be registered and approved by the regional ethical review board. The application form includes the following headlines to answer[7]:

1. Information concerning the body principally responsible for the research etc.
2. Information concerning the project
3. Information about the research participants
4. Information and consent
5. Considerations in the light of research ethics
6. Presenting the results
7. Reporting the financial circumstances and dependencies

Application 480-10 for the study performed in this thesis was reviewed and approved, by the regional board of Göteborg, 7 February 2011.

In accordance with ethical guidelines, as well as practical considerations, the inclusion criteria were as follows.

The *inclusion* criteria for patients were:

- 18 years of age or over
- seeking care for AAP
- providing written consent for study participation (see below)

The *exclusion* criteria, assessed in agreement with the receiving nurse at the time of patient arrival, for asking patients for their participation were:

- severe pain
- unconsciousness
- traumatic injury

Another exclusion criterion was if the patient, at the end of the researcher work shift, would not be possible to follow all the way through the ED.

[7] Headlines somewhat changed since the time of the study. Link to updated form: http://www.epn.se/media/1207/application_form__translated_.pdf

Inclusion criteria for medical personnel were simpler, simply all staff present and involved in the DMP of any patient included in the study was asked for participation.

Patients identified as seeking care for AAP by the receiving nurse, meeting the inclusion criteria and not excluded by the above criteria, were asked for study participation immediately upon arrival. All patients were informed orally as well as given written information before asked to sign the consent form. The consent form stated that participation was voluntary and that the consent to participate was possible to withdraw at any time by notification to the researcher. Each included patient was given a number, from 1 to N, and only that number was subsequently used in the registering and handling of the data.

All medical personnel on duty at each work shift were asked to participate and, with one exception, all employees accepted participation, giving written participation consent on the same conditions as the patients included in the study. Staff was, after giving consent to participating in the study, given a code consisting of staff category abbreviation + a number (1 to N), and only that number was subsequently used in the registering and handling of the data.

Following the systems perspective, which in itself follows from the theoretical perspective of DC, certain methodological choices were made and the remainder of this chapter is a narrative of how and why those choices were made. Terminology and definitions are borrowed from Patton (2002), Silverman (2010) and Miles & Huberman (1994). The way these authors, Patton in particular, generally describe qualitative research, it can be read as a method only aimed towards understanding individuals (and their experiences), not including the understanding of information propagation, activities or other system features. Trying to understand how a DMP actually works involves the study of complex interactions rather than the study of individuals' experiences but, despite the change of study focus, the terms in the mentioned works and their general definitions still seem plausible. So wherever not stated otherwise, the writings of the aforementioned authors are used and accepted as they are originally written.

The unit of analysis for the current study is the different elements that take part in the DMP for the patients included in the study. These elements include (at

least) the patient, the staff involved in the handling of the patient, as well as different artefacts used in the DMP. Due to the descriptive nature of the study, the design called for a qualitative, or more specifically an *ethnographic*, approach. Patton (p. 81) writes that "[…] the notion of culture is central to ethnography", which reconnects to Hutchins' and his emphasis on the cultural aspect of cognition (see p. 19).

As for *sampling* selections, a mixture of criterion-based and maximum variation was the original strategy (Miles & Huberman, pp. 27-28), and the sample size was set to a minimum of 30 patients. Patton writes that "[t]here are no rules for sample size in qualitative inquiry. Sample size depends on what you want to know, the purpose of the inquiry, what's at stake, what will be useful, what will have credibility, and what can be done with available resources." (2002, p. 244). The purpose was to develop an understanding of the DMP by studying it in situ, and the sample size of at least 30 patients was chosen so that a variety of medical problems, patient age, professional categories, work shifts, and staff members would be represented in the data material. However, and as mentioned earlier, practical circumstances made it impossible to include all patients arriving to the ED and meeting the inclusion criteria. During certain work hours it was simply unmanageable to follow several patients simultaneously and, besides fulfilment of criteria, inclusion of patients was therefore due to whether they arrived whilst the researcher was already following one patient (not included) or not (included). No set number of observation periods was defined prior to the start of the study, and it was natural to add observation periods instead of adjusting the sample size.

4.4 Data collection

Seeing the DMP as a process where a lot of information is handled, there was an urge to capture as much of the information and information management as possible. One way of doing this was to do field work as a participant observer, taking notes. Another way was to record communication (audio) and a third way to perform unstructured interviews.

The purpose of participant observation was to be able to perform audio recording, but indeed also to complement the recordings with observations of actions and non-verbal communication of importance from an information

management perspective. Patton discusses (pp. 265, 266) the continuum that stretches from being completely immersed as a participant observer to being an onlooker or spectator. On this spectrum, the observation performed in the study, with the researcher being passive rather than active, placed the researcher much closer to the spectrum end of being an onlooker than to that of a fully immersed participant. Exceptions to the passive stance were when being asked to intervene (handing something over for example) or being engaged in communication by study participants. Another question in regard to doing observational studies is whether the observations are carried out overtly or covertly, an issue mainly raised in association with questions of reliability of observations (Patton, pp. 269-273). The study was carried out in full disclosure, and the purpose of the study was explicit in the written information given to all participants prior to their participation. As Silverman writes (2010, pp. 29, 30), there are also important reflections to be made when carrying out fieldwork as a participant observer regarding preconceptions when entering the setting of the study. With an educational background in informatics and cognitive science, the researcher previously knew the ED setting as seen through the lens of a citizen and individual user, as well as through an observational pilot study (Nalin, 2006) that gave a brief overview on the work at the ED. Preconceptions of how the ED works were formed by that study, reading of literature, societal discussions and relatively scarce personal experiences, and consisted mostly of thoughts about long waiting hours for patients and perceived difficulties in information management. The study design of recording the whole DMP and all communication regarding each included patient was a way to try to balance these preconceptions, forcing the researcher to step inside the DMP at a very concrete level and minimising personal emotional involvement.

Notes, as well as recording clips and interviews, from different shifts were kept separate from each other and were subcategorized as either belonging to a specific patient, to another system element (staff, artefacts etc.), or as merely an overall observation and/or experience in order to function as a reminder later on. Certain documents were also included as data in the study, for example a template of the paper journal (later termed the EJ) that was used during each patient´s visit at the ED and a guidance document for performing certain procedures.

The judgment to include things in the study or not was based on whether they presumably added understanding of the way the DMP worked or not.

The choice of recording all communication with and about each patient included in the study meant recording communication between patients (and their friends and relatives, and/or interpreters, if present) and clinical staff as well as between staff communicating regarding each patient, from the moment of patient arrival to the ED until their discharge. A Zoom Handy Recorder H1 was used and each recorded clip was numbered from 1 to N, for each observation occasion (coded with YYMMDD+D/E/N) when saved on the computer. In correspondence to each clip, written information was registered using a template, one for each observation occasion, as shown below in Table 3.

Table 3: Example of a register over clips from an observation occasion

Study occasion YYMMDD + shift(s)					
Patient	Clip	Start time	Activity	Participants	Room
1	1	13:15	Triage	1, 1R, SSK1, USK1	2
1	2	14:00	Triage, continued	1, 1R, SSK1, USK1	2
2	3	14:14	Triage	2, SSK2, USK1	4
1	4	14:30	Change of room	1, 1R, USK1	2 → 5

After each observation occasion, the recorded clips were transferred to a folder on a password protected hard drive and the corresponding observation notes were archived in a locked filing cabinet pending data analysis. After all data collection, information about the 273 clips were compiled into one single file, adding a unique number to each clip.

With the intention of understanding the structures that constrain and/or enable the DMP at the ED the study also encompassed a few unstructured interviews. The vast majority were follow-up interviews where there was apparent need for clarification of some kind. One example is when staff filled out forms in order to send blood samples to the laboratory, another when they were using computer applications to organise work, and a third when physicians were asked to explain their train of thoughts – that is, when the only way of understanding certain

procedures called for description or explanation by the actor. A few interviews were held with open questions, mainly regarding work or organisational settings, clarification of work hours and work roles during each shift, for example. Both these types of interviews were held with working clinical staff during their shifts, at times when work tasks were temporarily fewer or easier, thus when there was no risk of disturbing staff in their work and when discretion, if talking about certain patients for example, was possible. No pre-determined questions existed for these occasions but they were posed spontaneously based on the given situation.

One interview was held with local management in order to understand the more formal aspects of the department as well as how the ED work was influenced by regional and/or national demands from politicians. This interview was the only one containing pre-determined questions, but the questions were open and additional and clarifying questions were added during the interview.

All interviews were recorded and noted using the same template as in Table 3 but instead of patient number they were marked with an x.

4.5 Data analysis

The purpose of following >30 patients through the handling at the ED was to collect data that would help revealing general patterns and increase the understanding of the DMP. At first, all observation notes were transcribed and so were all notes from the audio recordings templates (Table 3). The software used was Microsoft Office Word and all transcribed files were, once completed, printed and then kept in binders.

Moving on to the audio recordings; there were over 70 hours of recordings from 33 patients (a total of 273 audio clips) – no lack of data existed but rather the opposite. The original plan was to transcribe all clips, however this turned out to be impossible due to time limits. An unfortunate and, time wise, extremely expensive formulation in the ethical review application made it impossible for anyone else than the recorder to listen to the audio files. This had several consequences; one being that there was no possibility of quality check-up of the transcriptions to be made. Another consequence was that some sort of selection

was needed on which clips to transcribe, due to a time limit. As for the quality aspect, not much could be done other than to 1/ make sure that this mistake is not repeated, and 2/ to be as transparent as possible with regards to how the selection and transcription process has been performed. Nevertheless, even though only a selection of audio clips were transcribed, 42 out of 273, all clips have been listened to at least once and their essential content is thus included in the analysis work at a general level. This means that the understanding of the DMP builds on all the collected data, not only the transcribed clips. However, the scenarios presented in the Results section are based on the selected clips that were transcribed.

A first selection principle in order to decrease the number of clips to transcribe was to exclude any patient where the line of clips was broken, i.e. it was evident that some meeting between, primarily, patient and staff had taken place without observation and recording. This reduced the number of clips by almost 10%. Subsequently, the selection was primarily made based on representativeness, trying to choose audio clips from all types of shifts and from all observation occasions, as well as ensuring that there was no obvious bias regarding patient problems and/or events during the patient's visit at the ED. With still several patients (and corresponding clips) to choose from, the next selection level concerned that the clips included should have a variability of staff, primarily with regard to experience level.

Transcription was made at a content level, meaning that basic grammar was corrected and that stuttering and other types of "content free" utterances were excluded, at least to a certain level. Patients' pain expressions, as well as all expressions of hesitancy and periods of silence, were marked. The initial decision to include such expressions was based on an inkling of their potential importance for the information propagation, but they proved to be of little importance in the analysis work. When participants were overlapping each other verbally, the utterances were printed chronologically, one after another. An example transcript is shown in appendix 1.

Already at the start of listening, selecting and transcribing recordings of observations, interviews and patient clips, the analysis phase was initiated.

Following each patient through their visit at the ED influenced the understanding of the DMP in that it was initially seen as consisting of a number of temporally extended event chains. These event chains were in turn composed of a number of events, linked in certain orders, the events being common (or potentially common) to all patients visiting the ED. When considering how to present the results, the primary idea was to present models of the event chains and to deepen the description of each action by elaborating about them in text. Implementation of this idea turned out to be difficult, the text would not conform to the results from the data. It was challenging to pinpoint what caused the mismatch, but the event chains captured the organisational and practical part of the work processes (for short, its "structure") rather than the information propagation at the ED. An idea of writing patient scenarios seemed an adequate and possible solution in order to portray both the work process and the information propagation. The scenarios are intended to be narratives of the DMP for a few patients, using the events from the event chain models as anchors for each scenario, highlighting aspects of interest through using quotes from the patient transcripts. Semi-authentic case scenarios were construed in order to show typical cases through using snippets from observation and patient transcripts and piecing them together. Typicality does not here refer to being either the most common or the most representative patient scenario, but rather a scenario that holds a number of different aspects of the information propagation at the ED, without losing authenticity. One such aspect of information propagation concerns how information from the patient is dealt with throughout the DMP, that is, registering or updating information in applications and handing over information between staff members. Another aspect concerns how different individuals and applications handle information exchange, for example when information about a patient is coming from a source external to the ED.

Whilst trying to portray scenarios anchored to the events from the event chain models, it became clear that the event chains had little to add to the scenarios. So, to display the information propagation aspects more fully, the event chains were left out of the scenarios, but were kept as models since they show the structure of the work processes. The models are typical and representative of the work processes at the ED in the sense that the event chains are, or can be, common denominators for all patients visiting the ED.

During the writing of the discussion chapter, a sense of something important gone missing still lingered. The results appeared to not quite depict the complexity of the DMP at the ED. There were event chain models in the results, showing the structure of typical work processes for patients visiting the ED. In addition to this, there were the scenarios, each of them portraying the information propagation for a patient at the ED. However, there was nothing showing the complex interactions during the DMP, and the information node network grew from this insight, adding a systems view to the temporally extended singular views of the event chains and the scenarios.

5 The ED

All descriptions of the ED are made in present tense, but refer to the ED as it was during the time of the study, that is 2011 and 2012. The different sections will be frequently mentioned throughout the thesis and a description of how the terms to denote them are used is therefore given below.

5.1 ED sections

The ED consists of two different sections: 1/ the ED_Triage (emergency department – triage section), deals solely with triage and medical judgments subsequent to the triage, and 2/ the ED_Main (emergency department – main section), works as the emergency ward itself.

Colours used in model			
Explanation of colours	Areas belonging to ED_Triage section	Areas belonging to ED_Main section	Areas belonging to the Medicine ED

Figure 1: Explanation of colours used in figure 2

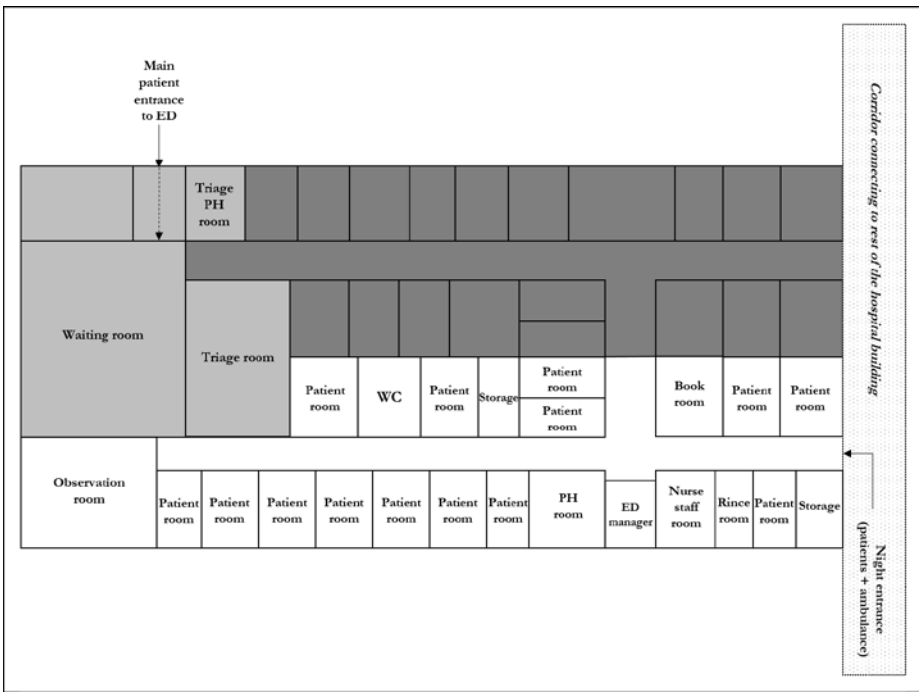


Figure 2: Map showing ED sections and rooms

The corridor that constitutes the ED_Main section holds twenty-three rooms. The majority, fourteen, of these rooms are for patients but there are also rooms for disposing and cleaning hospital material, as well as rooms for the staff. The latter include a staff break room, the "book room", the "physician room", and the ED manager's office. The book room lies almost in the centre of the corridor and is where the coordinating nurse, usually called the book nurse, sits. It is also where all nurses, as well as physicians, generally share information with each other regarding patients, and where other work is done that needs to be carried out. The physician room lies close-by, and is where the physicians check patients' journal (in MELIOR), to dictate (using MedSpeech) and to carry out other patient related administrative work.

At one end of the corridor the door to the patient waiting room is found, and adjacent to this room lies the triage room. These rooms, plus the triage physician room in the medicine ward corridor, constitute the ED_Triage section. The entrance to the ED is found on the other side of the waiting room. Thus, patients normally enter the waiting room, take a queue number and await their turn. The "triage room" is an elongated room holding four hospital beds, separated by ankle-length curtains, plus a desktop space where the coordinating nurse, again called the book nurse, sits. Nurses in the triage room deal with patients within the field of medicine as well as surgery, and the triage room has two entrances; one from the ward corridor taking care of patients with medical conditions and one from the ED_Main corridor, taking care of patients classified as having surgical conditions. There is also a window in the middle of the triage room, facing towards the waiting room where all patients, regardless of main cause being within medicine or surgery, sit down to await their turn. Patients arriving by ambulance daytime, whether seeking surgical or medical care, arrive through the medicine corridor. The staff entrance is found at the other end of the ED_Main corridor, and this is also where patients arriving at night time enter the ED.

5.2 Supporting artefacts at the ED

There are many artefacts used at the ED, ranging from the basics of pen and paper to highly advanced medical equipment and computerised applications. However, only the ones that hold, use or communicate information will be included and mentioned herefrom.

The artefacts most commonly used during the DMP are mentioned below, and will be further described in the Results section.

- ELVIS
- MELIOR
- LabBest
- ReMix
- WebADAPT
- KLARA SVPL
- MedSpeech
- KoVIS

The artefacts above are computerised applications.

The first of the two artefacts below is a work routine and a paper based system, whilst the second is a coordinating system for part of the work process.

- METTS/RETTS triage system and emergency journal (EJ)
- The prioritising system

5.3 Professional categories at the ED

There are several different professional categories working at the ED. The categories that are somehow included in the study will be listed here, along with a short description of the features that distinguish them from one another.

In this thesis the term *physician* is used for anyone having a degree from an academic medical education with a license as a physician at any level. The term includes several different competence levels, however all categories, except for junior doctor (underläkare), requires that the Swedish academic medical program of 5,5 years is completed with approved results – or that the individual has an equivalent education and a licence from Socialstyrelsen (Socialstyrelsen, 2014). To substitute as a junior doctor (underläkare), nine completed and approved terms on the medical program is required. The physicians included in this study have the same tasks at the ED, regardless of competence level.

Unlike for physicians, different professional **nurse categories** have different work descriptions and follow different routines, as well as having different work hours and shift start and endings. Nurses rotate over ED sections as well as over types of wards at the ED (i.e. medicine/surgery).

Assistant nurse (undersköterska (USK)) is not a regulated professional title in Sweden, and to work as one there is no need for an academic degree but is enough with an education from an appropriate upper secondary school program (gymnasieutbildning). *Nurse* (sjuksköterska (SSK)) denotes those with a degree from a 3 year academic education to become a nurse. A *nurse practitioner* (specialistsjuksköterska) has added another year, or more, to the academic education of becoming a nurse/SSK. However, no work distinction of importance for this study is made between SSK and nurse practitioner/specialistsjuksköterska, only between USK and the other two groups together. Therefore, differentiation is only made between the professional categories USK and SSK in the thesis.

5.4 Work shifts

There are three different **work shifts** per day at the ED; day (DAY), Evening (EVE) and Night (NGT). Table 4 below shows the respectively working hours of the staff included in the study, categorised for each shift.

Table 4: Start and end of each staff category per shift

Shift	Work category	Start	End
DAY	USK	06.45	15.00
	SSK	06.45	15.00
	PH	07.45	16.30
EVE	USK	13.00	21.30
	SSK	13.00	22.00
	PH	12.00	21.00
NGT	USK	21.00	07.00
	SSK	21.00	07.00
	PH	21.00	08.00

6 Results

As written earlier, the empirical data of this study consists of 273 audio clips, including a few semi-structured interviews, from following 33 patients through their visit at the ED, and of observations made during the eight study occasions. All in all, the amount of data is fairly big and some sort of selection on what to present as results had to be made, without losing authenticity or detail, and still managing to capture the bigger picture.

Illustrating typical and relevant patient scenarios was chosen as the basic means to present the results. Out of the transcribed part of the data set, four semi-authentic patient scenarios were pieced together to depict the DMP at the ED.

6.1 Scenarios

The following four scenarios portray the information handling in the decision making process that ensues when a patient seeks care at the ED. Each patient scenario follows the patient from their arrival to the ED through to their discharge or referral from the ED. The scenarios are authentic at a detail level, but are composed of details from different patient scenarios. This way, however similar, no scenario is fully identical with any one patient scenario captured during the study.

Three different text genres will be interlaced in the following scenarios, the different formatting styles being as presented below;

The patient scenarios.

All text formatted as shown above – in italic, with dotted outside paragraph borders, and 0,5 cm indentation on both sides – represent parts of the patient scenarios. This text is supposed to be the guiding theme of the results chapter.

"Explanations or comments by staff", observations by the researcher or other information propagation related information or communication.

Text presented as above – with a dashed border on left and right side and 0,25 cm indentation on both sides – is using *quotes* or observations to highlight aspects of the information propagation process.

General information about the ED, procedures, or artefacts.

No formatting is used for text that concerns general research settings, information about staff, computerised systems, routines or standard procedures.

6.1.1 John

It is night time, midweek, and the ED_Triage section is closed since 10 pm. The ED_Main section houses several patients and 5 in the staff; three SSK nurses, one USK nurse and one physician (termed PH1). The USK nurse is termed USK1 while the SSK nurses will be termed SSK1book, SSK2 and SSK3. This team of five is since 10 pm responsible for running the ED through the night shift, which ends somewhere between 7 and 8 am, depending on staff category and individual differences in scheduled working hours.

A new patient, John, has found his way through the ambulance entrance, the only entrance open at night, and as he comes into the ED_Main corridor, looking for somewhere to register, SSK2 sees him and goes to greet him. John is asked why he has sought the ED and he tells her, in broken Swedish, about the severe pain that he experiences in his lower back area. SSK2 asks for his ID card and advises him to provide a urine sample, then to sit down somewhere in the corridor and wait for further assistance. SSK2 goes to the book room and hands over the ID card to SSK1book, the SSK nurse currently responsible for the administration of patients at the section, as well as for the coordination of physicians seeing patients. SSK1book now proceeds to use two computerised systems to register John; ELVIS and MELIOR.

ELVIS is an administrative care planning system used to help coordinate all patients currently attending any section of the ED, but has other functions too; it is used to administrate economical and statistical information within the region[8]. The other system, MELIOR, is where patients' medical journals are kept. Within each MELIOR patient journal, all medical information regarding a patient, collected at any visit to any of the health facilitators within the region, is stored.

Ten minutes later, SSK1book has registered John into ELVIS, has opened and checked his MELIOR, which was clean, meaning that no previous visits within the region are registered. SSK1book has also instructed SSK3 to perform the triage assessment.

If possible, the USK working is also asked to attend the triage but since there is only one USK and two SSK's at night, the USK might be occupied with another triage, which is the case now, or with other duties.

[8] the geographical region of Västra Götaland: http://www.vgregion.se/en/Vastra-Gotalandsregionen/Home/

SSK3 therefore grabs a pen and a RETTS emergency journal (EJ), as well as an ID bracelet. The ID bracelet is automatically printed as SSK1book registers John into ELVIS. The EJ is a paper based journal that will follow John's way through the DMP of the ED. IT will give SSK3 guidance in the triage assessment of John, and will also provide a common documentation for all ED staff that will meet John later on.

SSK3 goes to look for John, who is sitting on a chair in the corridor. With no bed in the room that John is about to be shown into, SSK3 goes to find one and returns shortly. SSK3 and John enters the room and John is asked to lie down on the bed. John cries out loud of pain as he does so. SSK3 starts the triage routine by asking John why he has sought the ED, normally the first question to be asked unless the answer is undoubtedly obvious and/or if the patient is unable to answer. John answers, as he did when asked by SSK2, that he suffers from lower back pain, adding that it has been painful since a couple of hours. SSK3 asks if John has provided a urine sample and then if he has previously suffered from kidney stones. John answers affirmative on both questions. John also says that he has been feeling feverish and in a lot of pain, for which he took over-the-counter analgesics an hour and a half ago or so. SSK3 asks for his closest relative and that persons phone number, but John's pain makes her skip the routine of acquiring the number and instead she says "you say that you have kidney stones since before, you are sure about this" which he confirms. On the open fields of the EJ, SSK3 registers a brief synopsis of John's story and carries on with the examination of John's vital signs.

"Vital signs" is the first parameter of two in the guidance that the EJ provides in the triage assessment process. The vital signs are:

A. Airways – only noted if airways are not free
B. Breathing; respiratory rate and pulse oximetry
C. Circulation; pulse and blood pressure
D. Disability; RLS (Reaction Level Scale) or GCS (Glasgow Coma Scale)
E. Environment or Exposure; body temperature

John's vital signs are measured and the results are, one after another, plotted on predefined intervals of each letter, A-E. The vital sign showing the highest priority colour will give John his preliminary priority level. Whilst some of the vital signs are still being checked, SSK3 asks John questions 1-5 + 8 from the routine questions below, i.e. whether he:

1. is essentially healthy prior to this
2. has any illnesses for which he takes any medicine
3. is allergic to anything
4. has any blood infection

5. has been hospitalised outside of Sweden
6. has been in contact with anyone with a stomach flu in the last couple of days
7. can give name of, and number to, his closest relative
8. wants the visit to the ED to be handled confidentially

These are routine questions that should be asked to all patients and the answers are noted in the EJ. Other routine questions, although not necessarily noted in the EJ, concerns

- the pain (for how long it has been there, how it started, place of pain for example)
- how the patient manages the toilet routines (are they painful, more/less frequent
- or in other ways deviating from normal)
- last intake of food or drink

SSK3 registers John's answers on the EJ as the procedure is progressing.

The second triage parameter is the patient's contact reason, also called ESS for Emergency, Symptoms and Signs. RETTS has 42 classified ESS algorithms, with subgroups following ICD-10[9] codes. Each ESS algorithm gives guidance for choosing a triage priority colour. If the priority level from the contact reason/ESS is higher than from the vital sign check, the patient is prioritised according to the higher level.

Which tests to take is indicated by the ESS algorithm, as is the scheduled TTP (time to physician) and how the patient is to be monitored (if monitoring is necessary).

After registering all answers to the routine questions, SSK3 double checks John's personal ID-number, before putting on the ID bracelet. John is informed that SSK3 will go fetch a syringe with analgesic, whereupon John says that he already has taken two tablets. SSK3 answers that "we start with this type of analgesic because I can administrate that without ordination from the attending physician and that is how one normally starts, with a syringe". John continues, saying that "but I have taken two tablets, that is why I'm telling you" and SSK3 answers that "yes, I will talk to the physician to make sure it is ok but I am almost certain that I can give you one of those".

[9] http://www.who.int/classifications/icd/en/

Then she asks John to change into a hospital shirt and goes to ask the physician if she can administrate a syringe of analgesic. The meeting between John and SSK3 lasted a little less than five minutes.

Straight after leaving John, SSK3 goes to consult PH1; "Got a man here, presumably with a kidney stone attack". "Yes", answers PH1. SSK3 continues: "According to himself, he's got no MELIOR here with us". PH1 asks SSK3 about possible differential diagnoses and then suggests that he can go see John quickly with SSK3, and together they go to talk with John. PH1 introduces himself and asks about the location of John's pain and for how long it has been occurring. He listens to John's bowel with a stethoscope and less than two minutes after meeting John he agrees to SSK3 giving the analgesic syringe, explaining to John that his working hypothesis is kidney stones. He continues by asking if the diagnosis of kidney stones is common in his family history. John says "no" and some confusion arises, however PH1 stands with the decision to give John the syringe and adds to SSK3 that "a urine sample is needed". He says "goodbye" and "see you again" to John and leaves SSK3 to continue the triage. Temperature and other controls are taken before SSK3 reels John's bed to another room, leaving him in promise to return with an analgesic syringe in short.

While SSK3 prepares the injection syringe, SSK2 describes how a NGT shift SSK has the possibility to give analgesics by clearing it with the book nurse, whilst an SSK at a DAY or EVE shift has to consult a physician before any analgesics is given. The SSK continues: "We're saving time doing like this" (giving analgesics to certain patients in severe pain). Giving analgesics like this is done after the triage assessment, and after the customary samples are taken, but before the patient is seen by the physician. "When there is a suspicion of, for example, kidney stones we always take a urine sample. If there is blood in the urine the probability of kidney stones is highly increased and, if giving analgesics eases the pain, the attending physician can examine other patients before this patient. When seeing this patient the physician can, in addition to having the results from other samples, see the possible effect of the analgesics which will help him identifying the correct diagnosis and/or treatment."

A couple of minutes later, SSK3 returns to John's room with what is needed to give John the syringe of analgesics. John is told to lie down on the side, instead of on his back, since the shot is to be given intramuscularly on the back side of his hip. John moans as he rolls over and it takes a while before he understands how SSK3 wants him to lie. When done, his trousers are slightly pulled down. SSK3 prepares the syringe, the skin on the injection

site is disinfected, and the injection is given. SSK3 takes note of the analgesic and time in the EJ, leaves John with a wish of lessened pain and with a reassurance of PH1 returning as soon as possible.

As mentioned earlier, ELVIS is a tool to help the book nurse coordinate the attending patients. All patients registered in ELVIS are displayed as a list on the screen and the prioritizing is mainly based upon the triage priority levels of the attending patients, which is shown in one column of this list. However, if several patients are categorised with the same priority level it is up to the book nurse which patient is in most urgent need of seeing a physician. This judgment is based on vital signs, pain level and general condition of the patient. As new patients arrive, the queuing order can be altered due to the medical needs of the newly arrived. The prioritizing order is supposed to reflect the urgency of the medical needs of the patients, however there are some exceptions to this need based prioritizing system; one example is if there are more patients than rooms and beds available, or if one or more patients can be quickly treated or referred – or a combination of these. Then the book nurse can make the physician(s) see one or a few of these patients in order to free up rooms and/or beds at the ED, and as a bonus the waiting for the patients seen to is drastically shortened whilst the waiting for the remaining patients is not that much delayed.

There is a specific routine for showing the physician(s) which patient is next to be seen. It is presented through three soft plastic card holders that are attached to plastic magazine files, containing patient EJs and corresponding to different spatial locations at the ED_Main. In addition to the patient rooms at the ED_Main, there are plastic magazine files for 1/ the corridor, 2/patients sent to x-ray, 3/ patients waiting for test results and 4/ patients placed in a room called the observation room. When a book nurse has made the prioritising, he or she attaches the three soft plastic card holders with the respective 1, 2 and 3 queue number to the appropriate magazine files. Once a physician goes to see the patient that is number 1 in queue, the book nurse shifts the places of the card holders in order to update the queue positions amongst the patients. The queue system itself is not noted in ELVIS, but information about which patient the physician has seen is, as is information about nurses seeing to a patient waiting for a physician.

SSK3 goes to hand over the EJ to SSK1book, and to verbally inform SSK1book about John's medical condition as well as what actions are taken. SSK1book places John's EJ in the magazine file corresponding to his location. SSK1book goes on to prioritise, namely

to decide which patient currently attending the ED_Main section is next to be seen by a physician.

The patient information SSK1book registers in ELVIS about John is, at this point, the given triage colour, that John has been seen to by a nurse, and information about the syringe given. SSK1book then looks at the list of attending patients, makes a decision about John's priority in comparison with the other patients and decides that he is to be seen as number two, and therefore she places the card holder with number two on the plastic magazine file holding his EJ.

Almost thirty minutes after SSK1book's priority decision, PH1, the attending physician, is ready to see a new patient. PH1 goes to see SSK1book, looks at the magazine files, and picks up John's EJ from the magazine file with the card holder now saying 1 on. SSK1book briefly informs PH1 on noteworthy findings from the triage routine, and that the analgesic syringe is given by SSK3, as agreed upon. SSK1book notes in ELVIS that PH1 is about to see John. PH1 goes to an office room to look through the EJ, and possible other information in the project view folder, and also checks MELIOR to see John's previous medical history. John has no previous history in MELIOR, which PH1 explains as usually only happening when the patient is very young, very healthy, or has recently moved to the region (thus might having previous records in another region's system, not accessible here). PH1 then goes in to the room where John is waiting. John has now waited approximately forty minutes after the analgesic syringe was given.

PH1 asks John about his pain level and general feeling. John says he "feels the same", and PH1 double checks: "just as much pain"? John answers that he got "stomach pains after the syringe", that he "felt the urge to use the toilet" and tried, but with no success. PH1 says that "the syringe still can have some more effect", and continues by asking John to sit up, or even to stand up if possible. John grimaces and moans but manages to get up. PH1 asks him to "bend sideways" to check his back so that something like ordinary back pain is not mistaken for acute abdominal pain. After lying down again, PH1 continues the physical examination. John is thereafter asked about how the pain began and what he was doing when it started, and John and PH1 goes through the development of symptoms, fever and pain, until John's arrival at the ED. PH1 then decides that an alternative type of analgesic is to be given to see how John responds to that, and informs John that a nurse will come to give him another syringe, and that PH1 will come see him later again.

After leaving John, PH1 briefly describes the mental flow chart he uses when physically examining a new patient, once the EJ and MELIOR have been checked. Regardless of any suspected diagnosis, this flow chart almost always guides PH1 through the examination, and PH1 says that one reason for this is "*not being as responsive to different types of biases*", as well as "*not as easily missing out on any differential diagnosis due to selective focus*".

Another physician's strategy was described as checking the EJ and MELIOR, then seeing the patient for a physical examination – the examination more being focused on confirming or rejecting a hypothetical diagnosis previously formed. This physician then used to leave the patient with the excuse of checking blood samples, or something similar, in order to get a chance of collecting thoughts, before returning with a strategy for further examination or treatment.

The way of handling patient meetings is something that differs substantially between the physicians encountered during the study.

PH1 leaves John and goes to update SSK1book about the ordination of another type of analgesic, and to hand over the EJ again. PH1 adds, in an explanatory way, that the analgesic syringe is given for diagnostic as well as analgesic purposes. If a patient gets pain relief, this further suggests that he is suffering from a kidney stone attack.

SSK1book updates ELVIS, and writes a note about getting SSK3 to administer the analgesic syringe. When SSK3 has been informed to give John the analgesic, preparations for the injection are made and SSK3 goes to see John again. This time John is to lie on his back, the injection is given subcutaneously in the stomach. All proceeds according to plan and SSK3 once more leaves John with a wish of lessened pain.

In all patient rooms at the ED, there is a button to press if in need of staff. When a patient, or relative, presses such a button an alarm goes off, and a sign mounted in the ceiling of the ED corridor flashes the number corresponding to the room where the button was pressed.

SSK1book can see that John has just pressed his button. All nurses are currently occupied seeing to other patients, but when SSK2 returns to the book room she is asked by SSK1book to check on him. SSK2 goes to see John, and she enters the room whilst she says, in a questioning manner, "you rang the bell?". John says that it was five minutes ago, and SSK2 answers that there are other patients to see to as well. SSK2 suspects

from John's way of talking that he might be suffering from side effects from the analgesic, and asks if he is feeling dizzy. John confirms that this is so and SSK2 explains that this is a common side effect. John asks when the physician will come back. SSK2 says that it is hard to say and then asks John about his pain, if he feels any better. John says he feels a little better, then that he is feeling very cold and asks for a blanket. SSK2 fetches one and lays it over him, saying that he "best lie down and stay still". John asks for the lights to be turned off, and SSK2 turns them off as she leaves. When back at the book room, SSK2 updates SSK1book about John's condition. SSK1book updates ELVIS with information on that John has been seen to by a nurse, and that he has had an adverse reaction from the second analgesic syringe. The responsibility for John is now back to SSK1book.

A conversation about working NIGHT versus DAY and EVE shifts arises between nurses having a brief pause while sitting in the book room. One of the nurses says that *"I generally feel a greater sense of responsibility when working at night than during daytime",* and further explains this by saying that *"if you postpone doing something at night it will end up affecting a colleague"*. The other nurses agree with this description.

Another nurse says *"the ED_Triage book nurse has less responsibility than the ED_Main book nurse"* and that *"work seems slower during daytime"*. This also seemed to be relatively generally agreed upon.

Yet another nurse says that *"there can be total confusion occurring night time due to fewer in staff"* – adding that *"this is highly dependent on who works as the book nurse"*. Variations of these differences between shifts were highlighted in conversations with different individuals of staff at several different study occasions, thus indicating this being recognized by a number of staff. And, one particular night during the study, one of the two SSKs working next to the book nurse goes as far as to make parts of the book nurse's job too, registering an incoming patient and adding the triage colour in Elvis. The explanation given upon the researchers question about this is that: *"the book nurse on duty is not that stress tolerant and is rather stressed out right now"*.

SSK1book knows that John has had two analgesic injections and that he is waiting to see the physician again. Numerous other patients are waiting too, and SSK1book has to constantly prioritize between these so that PH1 sees the patient that is in biggest need of it. As mentioned earlier, there are exceptions to this, but the normal procedure is to follow the medical needs. A little over two hours after meeting PH1 the first time, it has become John's turn to be seen again. SSK1book once again places the card holder with number 1 on at the plastic magazine file holding John's EJ.

PH1 enters the book room to see which patient is in turn. Picking up the EJ from the plastic magazine file with the number 1 card holder, PH1 turns to SSK1book for an update. SSK1book informs PH1 about John's perceived dizziness after the second analgesic injection and that it has gone roughly an hour and a half after the injection was given. PH1 goes to see John again, asking how he is feeling right now. John complains about pain and swelling after the syringe, and PH1 can confirm the swelling and also notes that there is some redness after the injection. PH1 goes on to explain to John that "if the analgesia has lessened the pain, it sounds as if though you have had a stone in your kidney which is now on its way down and will come out. What we will do now is that you will be discharged, I will write an electronic prescription, and you will be given some analgesic suppositories to bring as you go. Then a control x-ray will be carried out in approximately three weeks, you will receive a letter about this.". Some more explanation is given, there are some misunderstandings due to language barriers, and then PH1 concludes by saying that "a nurse will come to take care of the details before you can go home". PH1 suddenly thinks of John mentioning driving, and tells John that it is not a good idea to drive for a few hours. John is offered a bed in an observation room, to rest for a few hours before getting behind the wheel.
PH1 leaves John for the book room, where he updates SSK1book that John is to be discharged, that John needs suppositories, and that John also might need somewhere to stay for a couple of hours before being able to drive his car safely.

It is now almost three o'clock in the morning and PH1 says *"Well, really I should do some dictating but do I dare to start that now?"* SSK1book answers *"it is very, eh…",* and PH1 fills in *"it is still gluey?",* to which SSK1book confirms: *"drop downy"*. What PH1 and SSK1book refers to is the general malfunction of the computer environment around three o'clock each night.

PH1 thereafter goes back to the physician room to check if it is possible to dictate, and it is. PH1 does John's dictation, using MedSpeech, but MELIOR cannot be updated until John is discharged from ELVIS. After this, PH1 goes to ask SSK1book for the next patient.

Whilst walking off to see the patient PH1 turns to add that *"Normally, I should have looked in MELIOR first, but it is supposedly a little slow right now",* stating that the normal routine of checking MELIOR before seeing a new patient will be disregarded due to computers not working properly at the moment. This happened each night that the researcher visited the ED, and was confirmed to be a regular thing around 3-4 each night/morning.

Whilst PH1 did the dictation, SSK1book asked SSK3 to inform John about the possibility to stay in the observation room for some hours of sleep. When SSK3 comes to John's room, he is about to leave. SSK3 becomes apparently confused and after some dialogue SSK3 says she will go to check with PH1. She comes back after a few minutes and says that PH1 recommended him to stay for some hours before driving. John is worried about getting a parking ticket but SSK3 assures him that this will be cancelled if he gives the parking company a note from the secretary that proves that he's been admitted to the ED. John agrees to stay, SSK3 asks him to take his belongings and off they go to the observation room where SSK3 leaves him with a bed. SSK3 returns some thirty minutes later with the suppositories. John is on the phone but pauses that conversation to talk to SSK3, who gives him the suppositories and repeats the information about them given by PH1, then leaves him again. Just about when SSK3 reaches the book room, John turns up and says that he has spoken to one of the other nurses about his friend coming to pick him and his car up. When SSK3 enters the book room, she double checks the information with SSK1book, who already has this information and can confirm that John intends to leave.

Next time PH1 enters the book room, SSK1book hands over the EJ and says that John has left. By this time the computers are back to normal functionality and SSK1book has discharged John from ELVIS. PH1 goes to the physician room to update MELIOR.

PH1 updates the EJ with the suspected diagnosis, and with further actions to be taken. When the EJ update is completed, PH1 comments on the procedure of scanning the EJ into the computer: "*Well, yeah, it ought to be done straight away but the new thing is that the EJ should be faxed to health administrators at a ward and then get scanned by them. I think it should be me who scans the EJ right away… Well, it ends up as an external program in MELIOR, found under e-journal and e-archive system KoVIS.*". All EJs are thus faxed to health administrators at another ward, where the health administrators scan them as pdf files in KoVIS.

All in all, John stayed at the ED for approximately four hours and met four out of the five in the working team during that time. Information about John was registered and/or updated in ELVIS, MELIOR, the EJ, MedSpeech, KoVIS, in conversations and several notepads. The RETTS triage system as well as the prioritising system were also used.

6.1.2 Mark

It is late evening in the middle of the week, and the ED_Triage section is about to close. The night shift has taken over and one physician (PH1), three SSK nurses (SSK1book, SSK2, SSK3) and one USK nurse (USK1) will form the ED_Main team for the night.

The book room, being a central place in the ED process, also lies in the centre of the ED_Main corridor. Next to the ED book room, only a doorframe separating them, lies the acute medicine ward book room (see figure 2). The acute medicine ward works much like the ED does and occasionally they help each other out, just as the ED_Triage and ED_Main sections help each other out when needed. All nurses rotate over wards, working at the medicine ward some shifts and at the surgery ward other shifts. SSK nurses also rotate over work roles – sometimes working as book nurse, at other times as section leader and sometimes "just as" a SSK nurse.

This night, the medicine team approaches the surgery team. They have received a patient with severe chest pain but neither tests nor examination show any signs of heart problems. Now they are wondering whether the patient's pain could be regarded as acute abdominal pain. PH1 discusses with one of the responsible physicians at the medicine ward and agrees that the patient's symptoms might be caused by abdominal problems. The patient is referred to the surgery ward, i.e. the ED_Main. The patient's name is Mark and his bed is rolled from the medicine ward into a room at the ED_Main by SSK1. Based on Mark's symptoms, SSK1book and PH1 decide that Mark should be seen straight away, and just a couple of minutes after his arrival to the ED_Main, PH1 goes to the physician room to read up further on Mark on the EJ and in MELIOR, whilst SSK1book registers him in ELVIS. Thus, the previously made prioritization of the patients already registered at the ED_Main is stalled. The numbered plastic holders are left as they were, since the prioritization after Mark is still the same.

In a conversation about different ways to end up at the ED - through referral from a local health centre, ambulance, helicopter, on your own etc. – in association with information entered in ELVIS and MELIOR, one nurse said: *"We have another system (KLARA SVPL) for patients arriving from health centres or home health care. Eh, it is followed up, supposed to be followed up, daily. Really, it is where we check to see if we have any incoming messages*, *laughs*, *which we had there. It is the "home health care" service that sends a message saying that "we have sent a patient normally belonging to home health care to you" and some information about what help this patient*

might need, why they have sent the patient to us and earlier diseases and so on. Once read, we acknowledge the message in KLARA which gives the home health care a signal saying that we have received the patient information." Information in KLARA is followed up at the ward (researcher's note: the ED_Main) too.

PH1 enters Mark's room and Mark and Mark's relative, as well as PH1, introduce themselves. PH1 double checks Mark's identity by asking him to repeat his last name. The medical questions during the following physical examination are interspersed with PH1 making conversation about other things, such as what Mark does for a living. PH1 uses information from the EJ and MELIOR too, for example which city Mark comes from and if they are only in town for a visit. Mark is in apparent pain, and PH1 poses questions to his relative too, using her knowledge about his normal condition. After seven minutes, PH1 concludes in silence that Mark should be referred to a (non-acute) surgical ward for further examination and treatment, with a suspicion of pancreatitis. PH1 explains to Mark that additional analyses of the blood samples taken at the acute medicine ward has been ordered, and that the answers should come in an hour and a half or so. PH1 continues by saying that Mark will be referred to a surgical ward, and that a physician there will assume responsibility for his medical condition and have the results of the blood samples – then says "goodbye and good luck" and leaves.

PH1 updates the responsible physician at the acute medicine ward that the ED (acute surgery ward) will take over responsibility for Mark, then goes to the physician room to dictate. Once there, a question pops up and PH1 goes to Mark's room again and asks him, for the record, if he had been drinking any alcohol before the pain started. Mark answers negatively and PH1 goes back to the physician room. The ward to which PH1 wants to refer Mark needs to be informed and to agree with Mark coming. PH1 calls the on-call physician to assure that referral is ok, then starts the dictation.

The dictation is made using application MedSpeech and includes information that the handling physician sees as noteworthy. This includes a summary of the patient's narrative of his or her medical history, which tests and blood samples are taken, and possible findings during the physical examination. Dictations can be tagged with high, medium or low priority, and once completed and tagged they become visible for health administrators to transcribe. High priority is used for patients that are to be seen in the near future by another health care provider, medium priority is given for patients that are referred directly to another ward or to an examination, and low priority for patients that are not likely to return for

some time. When the transcription is done, the corresponding MELIOR journal is supposed to be signed by the patient's handling physician.

> One physician said that *"When signing the MELIOR journal, one can scroll down to see what has happened since discharge or referral of the patient."*. To do like this is the only (standard) possibility for the formerly responsible ED physician to receive feedback on his or her treatment and/or diagnosis. Once the journal is signed, no other staff than the ones currently working with that specific patient is allowed to enter that journal.

If a patient is sent home and no further information is to be found within the MELIOR journal, other (non-standard) ways of feedback to the physician come through:

- meeting the patient again, the patient seeking care for the same symptoms at the ED yet again, which suggests that the treatment, and/or diagnosis, was inadequate the first time
- being called to a meeting about the patient's visit, indicating that something was not satisfactorily handled somewhere in the process
- not meeting the patient again, which – amongst other things – can indicate that the treatment, and/or diagnosis, was correct

> Whilst updating MELIOR, PH1 describes how using keyboard short cuts simplifies the many steps required to navigate from the standard patient window in MELIOR and reach, for example, lab results, which require "*six steps of mouse clicking on menus*".

> *PH1 then goes to the book room to check if SSK1book can complete the referral, but more documentation is needed. After PH1 and SSK1book have agreed on further documentation to be included, SSK1book gets an update on Mark; he needs to be given a drip and he needs to be blood typed. SSK2 hears this, picks up on the drip and blood type, and goes to prepare for this. Once Mark is updated for referral in ELVIS, PH1 leaves for the physician room whilst SSK2 goes to see Mark. SSK2 introduces herself to Mark and tells him that he's about to get a drip, and that he is to be referred to a ward. Before continuing the procedure, SSK2 asks Mark to say his ID number, and he says his birth of date, pauses and then continues with the last four digits. SSK2 says "thank you" and moves on to continue preparation for blood typing and the drip. Mark asks if he is to have yet another needle, but SSK2 assures him that blood can be drawn from*

the already existing needle. SSK2 finishes the tasks and leaves Mark, prompting him to call if needed.

Half an hour passes before SSK1book calls the ward for referral, other tasks are prioritised. Information being passed on to the ward include Mark's ID-number, name, cause of hospitalization, suspected diagnosis, and that there is an MRSA suspicion (since Mark has previously been treated at a hospital abroad). Additionally, that there is a dictation and a completed drug curve, that there is a peripheral vein catheter, and that blood typing is sent to the lab.

During SSK1book's call, PH1 has updated the information needed and, when SSK1book hangs up, informs SSK1book on this. Just after, Mark pushes the button indicating that he wants to be seen, and SSK2 goes to see him. Mark seems worried and points to the drip bag. SSK2 says that Oh, the drip is finished, let's turn it off. Mark says that he thinks blood is coming, and SSK2 reassures him that this is normal when a drip is empty, and that she will return shortly to disconnect the drip. Fifteen minutes later, SSK2 sees Mark and disconnects the drip. Somewhat later, SSK1book calls for a janitor to take Mark to the ward, and when this takes place the journey at the ED is over for Mark.

All in all, Mark was at the ED for an hour and a half, meeting two persons from staff. Information about Mark was registered and/or updated in ELVIS, MELIOR, LabBest, the EJ, MedSpeech, KoVIS, in conversations and several notepads. The RETTS triage system as well as the prioritising system were used too. However, previous to his visit at the ED Mark arrived with ambulance to the medicine acute ward, and this is not included in the ED time or staff counting.

6.1.3 Sam

It is Friday and just past normal lunch hour. The triage room is starting to become rather crowded due to overlapping staff shifts. The team of nurses that started work early morning (SSK1book, SSK2-3, and USK1) are about to leave for their lunch, while the team that has just began their shift (SSK4book, SSK5-6, and USK2) is settling in and is about to take over. A total of seven SSK nurses and one USK nurse have been sharing information with one another in the triage room. PH1 is the attending physician at ED_Triage.

Several patients sit in the waiting room, each one of them with a queue number ticket in their hand. One of them is Sam, who is waiting for his queuing number to come up on

the screen placed in middle of the waiting room. His number comes up next time the bell rings, and he approaches a little window to talk to a nurse, USK1 in Sam's case. USK1 asks for Sam's name and ID-card, then asks him why he has sought the ED. Sam gives a brief account of his major symptom – general abdominal pain. USK1 lets Sam in to the ED_Triage and he is shown to one of the beds. USK1 hands over Sam's ID-card to SSK1book, the SSK nurse currently responsible for the administration of patients at the triage section, as well as for the coordination of physicians seeing patients. Just like all patients seeking care at the ED, Sam now has to be registered as a patient at the ED. The process of registration is almost identical to the description in previous scenarios, but as the ED_Triage section is open, registration is made to their ELVIS instead of straight into the ED_Main ELVIS.

The function of SSK1book at the ED_Triage is similar to that of the book nurses in the former scenarios, but some differences in responsibility are discussed by nurses in the triage room. One of them says that "The most common task performed by the ED_Triage book nurse is to register patients in ELVIS." and the other one comments that "Well, it is a little bit like that, you are like an office man.". The first continues: "Right, and you might be consulted as to what you think (by other nurses) – what triage priority level should be chosen.", and the second nurse adds "And you decide which patient the triage physician should see next.".

Whilst SSK1book registers Sam in ELVIS and opens up the MELIOR journal, USK1 picks up an empty EJ and enters the bay where Sam sits down waiting. Sam is asked to take his coat off and lay down on the bed. SSK2 comes in to relieve USK1, it is a busy day and USK1 is needed somewhere else. SSK2 brings Sam's ID bracelet, printed as SSK1book has completed registration of Sam into ELVIS. As USK1 exits the bay she closes the curtains around the bed in order to generate some degree of privacy for Sam. SSK2 starts the triage routine by, once again, asking Sam why he has come to the ED. Sam gives a detailed account of several months of bowel problems, describing visits to a local health centre as well as seeing a private physician. The health centre gave him a referral to the hospital for a colonoscopy, due the following Thursday, and the private physician prescribed two weeks of medication as treatment, but the pain has returned after the end of the prescribed medication. On the open field of the EJ, SSK2 writes down a summary of Sam's medical history, and goes on to check Sam's vital signs. Whilst some of the vital signs are being checked, SSK2 asks Sam the routine questions (see John's scenario for details).

After answering the routine questions, Sam is given the ID bracelet by SSK2, who then proceeds by gently palpating (feeling) Sam's abdomen. Sam is told that he is to see a physician and that they will await instructions from the physician on what tests are to be taken. Sam's two levels, from vital signs and ESS, are in agreement and result in that no tests are to be taken prior to seeing an ED_Triage physician, with the exception of a urine sample. SSK2 goes to see if there are any available rooms, then returns to Sam, gives him a plastic glass and instructions on how and where to administrate the urine sample he has been asked to provide. Lastly, Sam is told to sit down in the waiting room again until an empty room is found. All in all, this meeting between SSK2 and Sam has taken a little more than fifteen minutes.

SSK2 hands the EJ to SSK1book and updates her verbally on Sam's triage priority.

At certain times, the book nurse assists the nurse that has performed the triage routine in assessing the correct triage priority level, but in Sam's case the guidance from the EJ was sufficient to confidently indicate a level.

SSK1book registers Sam's triage priority level in ELVIS, and places his EJ in a letter tray.

At the ED_Triage section, there are fewer magazine files (compared to the ED_Main section); one each for a couple of rooms in the ED_Main corridor, and a plastic letter tray for those patients that have been triage assessed but are shown to the waiting room until a room is available.

SSK1book goes back to prioritize between the attending patients, finding that Sam ought to be seen first, and thus needs a room. SSK1book instructs one of the nurses to show Sam into a room, then files Sam's EJ in the corresponding magazine file and places the plastic card holder saying 1 on it.

Whilst Sam is waiting for a room, a new patient meeting the study inclusion criteria arrives. The researcher is invited to observe this patient too, and the researcher has to make a decision on how to handle this type of conflict. With the intent of following each patient through the entire ED process, there is no possibility of simultaneously following more than one patient at a DAY or EVE shift. At NGT shifts, a limited number of staff is present, making it possible to keep track of several patients at the same time. With numerous nurses and physicians, this proved to be an impossible task. Thus, the

researcher chooses to keep following Sam to the end, and to exclude all patients arriving to the ED before Sam's referral or discharge from the study.

PH1, the next physician ready to see a new patient, goes to SSK1book, looks at the magazine files, and picks up Sam's EJ since his magazine file now has the card holder saying 1 on. PH1 also gets an update from SSK1book that briefly informs PH1 on noteworthy findings from the triage routine, such as that the dipstick urine sample has been processed and no deviations from normal values were found. SSK1book notes in ELVIS that PH1 is about to see Sam.

PH1 goes to an office room to look through the EJ, and possible other information in the project view folder. MELIOR is also opened to show Sam's previous medical history, and PH1 notes that Sam has sought care for similar problems before. Then PH1 goes into the room where Sam is waiting, and after introducing one another, PH1 starts by asking why Sam decided to seek care at the ED. Sam answers that he suffers from abdominal pain and bowel irritation, for which he already has an appointment booked with the hospital, in ten days. As the problems increased he tried to book an appointment with his local health care centre but when there were no available times he was advised to seek emergency care, rather than to wait for an appointment after the weekend. PH1 asks about a previous medical investigation noted in Sam's MELIOR journal and they talk about this, as well as about Sam's visits to primary care and what has followed from those meetings. After a few minutes PH1 starts asking about toilet routines, and after this he wants to palpate Sam's abdomen and asks Sam to lie down. During the palpation he asks about Sam's occupation, then about the current pain status and whether Sam has seen any blood in his faeces. He continues to palpate and finishes the physical examination with a rectal examination, which shows normal findings. PH1 concludes that the forthcoming colonoscopy is timely since it is the type of investigation needed to determine the cause for Sam's problems. PH1 informs Sam that blood samples are to be taken in order to make sure that Sam's pain does not require urgent action. If no urgent actions are needed, Sam will be sent home to wait for the colonoscopy, and the waiting time for the blood sample results are approximately two hours. PH1 also updates the EJ regarding which samples are to be taken. The meeting between Sam and PH1 has taken almost ten minutes.

PH1 goes to SSK1book to hand over the EJ and to verbally inform about the samples to be taken. This implicitly means that Sam will be referred to the ED_Main section. Some confusion arises about the urine dipstick PH1 was informed about earlier, whether it belonged to Sam or another patient, but as a precaution another urine sample will be

asked for. PH1 is satisfied with this and leaves the triage room, whilst SSK1book ensues by updating ELVIS regarding the blood samples to be taken. Tags for the vacutainers, the tubes that blood will be collected into, are printed through the computer application LabBest (or are hand written) and, finally, the attending ED_Triage book nurse either assigns the task to another nurse or proceeds to take the samples. Which scenario plays out depends on current workload of the group, and the present book nurse makes the decision.

SSK1book goes to take blood samples from Sam about fifteen minutes after PH1 left him. SSK1book introduces herself to Sam and explains her errand. The blood samples are taken and Sam is asked to provide his personal ID-number. This is to make sure that the personal data printed on the tags attached to the vacutainers is correct. SSK1book informs Sam that the waiting time for the results is a good hour and Sam asks where he is supposed to wait. SSK1book asks if he can sit down in the waiting room again, explaining that he is to see another physician when the results have come. Taking the blood samples took less than five minutes and Sam's overall time at the ED has been approximately fifty minutes.

Sam sits down in the waiting room whilst the blood samples are sent off to the hospital central laboratory for analysis. SSK1book updates information about Sam in ELVIS, then refers Sam from the ED_Triage section to the ward, to the ED_Main section. The referral from ED_Triage is thus made through discharging Sam from the ED_Triage in ELVIS plus talking to the book nurse at the ED_Main section, SSK7book, as well as handing over Sam's EJ. The DAY nurse team is already in place at ED_Main, consisting of nurses SSK7book, SSK8-9 and USK3.

Regarding handover of patients, an ED_Triage nurse does the following reflection: *"Well, you can feel that it gets a bit tedious for the patients because first they meet a nurse at the triage* (ED_Triage section) *that probably gets to hear a long story. Then you have to report this over to someone* (book nurse, another nurse or to another section) *that hasn't heard exactly what the patient has said – it is really important to have a good hand over communication. It is a bit unlucky the way that information gets lost between all the steps. Sometimes it's not even the nurse who has seen the patient that hands information over which makes the selection of what is written on the EJ even more important* (the field on the EJ for writing freely is limited to a couple of very short sentences).

SSK7book places the EJ in the magazine file for the waiting room, and then registers Sam in the ED_Main section of ELVIS.

Writing in ELVIS, a book nurse commented: "*it could have been designed differently, one cannot write that much"*. In order to overcome the space shortage in ELVIS and to facilitate the use of the commentary field in ELVIS, nurses at the ED have developed an abbreviation system. Next to the main computer in the book room, as in the triage room, lies a paper with all hitherto invented abbreviations.

When a book nurse was registering information in ELVIS, an observation and a comment was made by the researcher regarding the computers and how they seem to not work properly at the moment. The book nurse says: *"Yes, the biggest problem [with administration] is that our computers don't work as they're supposed to. They stop working sometimes – the programs we use, the three. MELIOR is pretty stable but ELVIS and LabBest… Eh, and this ADAPT* (WebADAPT) *too, it has stopped working now, no radiology results come through any longer. And even when working, no notification about arrival of new results appears in the normal ELVIS view."*

The researcher then asks about the situation regarding results coming from the lab. At an earlier study occasion no link between ELVIS and the lab results application (*LabBest*) existed, staff had worked round this by asking the lab staff to fax in order to alert ED staff about new available results being there to be searched for. The book nurse confirms the situation still being unsolved, *"the lab is still sending fax to alert the book nurse that new results are available, then one has to look for them in LabBest, so that's a miss too"*. Another nurse interjected *"…many steps are required to navigate within ELVIS and its surrounding systems",* as well as saying: *"there are so many codes needed to access the systems too"*.

SS7book goes through a similar prioritizing process as did SSK1book previously; checking how Sam's priority position stands in relation to the other patients currently at the ED_Main section. When a room at the ED_Main section has become available, SSK7book asks US3 to see Sam into it. US3 goes to the waiting room to find Sam and to show him into the available room. Sam is also asked to leave a urine sample which causes Sam to ask if he has to do it again. US3 is surprised to find that he has already done this and looks for the result in the project view folder but cannot find it. Sam is left in the room and US3 goes to find out if the result is somewhere else to be

found. After talking to SSK1book at the ED_Triage, things become clear and US3 returns to ask Sam to please provide another urine sample.

Some time later, a fax from the lab comes through to the book room, indicating that the results from the blood samples taken from Sam earlier are updated in LabBest. SSK7book navigates from the custom view, being ELVIS, to another application, LabBest, to see the results. The results are printed and filed in Sam's EJ folder, and any results seen as deviations from normal are noted in ELVIS.

Further a little later, PH2, one of the attending physicians at ED_Main, goes to the book room to find out which patient is next to be seen. By looking at the plastic magazine files, finding the one with a 1 on, PH2 finds that Sam is next patient to be seen by a physician. SSK7book gives PH2 a brief account of the information regarding Sam that is collected so far.

PH2 goes to the physician room to check MELIOR as well as look through the EJ picked up from the magazine file. About an hour and a half after the triage, PH2 is ready to see Sam. PH2 asks about Sam's pain level and general well-being. Sam answers that he is not in that much pain at the moment. PH2 continues by telling Sam that all tests taken show values within the normal range. With no urgent need to examine Sam further at the moment, PH2 concludes that Sam will be discharged.

PH2 goes to tell SSK7book that Sam is to be discharged, then goes to the physician room to dictate. SSK7book discharges Sam from ELVIS and closes any other application windows open for him.

Altogether, Sam's total time at the ED has been just over two hours, and he has met six persons from the staff. Information about John was registered and/or updated in ELVIS, MELIOR, the EJ, LabBest, MedSpeech, KoVIS, in conversations and several notepads. The RETTS triage system as well as the prioritising system were also used.

6.1.4 Joanne

It is mid-day Friday, overlapping staff shifts today as well. The morning team (SSK1book, SSK2-3, and USK1) is gone for lunch and the day team (SSK4book, and SSK5-7) has taken over.

SSK4book has received information on all patients from SSK1book but wants the new team to have first-hand information on the attending patients. This is done by asking

SSK5-7 to check on the four patients lying in the ED_Triage room. A similar process is carried out at ED_Main, also shifting teams over lunch hour. PH1 is the attending physician at ED_Triage.

Joanne is one of the patients that arrived to ED_Triage before the EVE team started their shift. Joanne was greeted by USK1, who also started a triage assessment that SSK4book now tells SSK7 to finalise. SSK7 picks up Joanne's EJ and finds her lying on one of the beds in the ED_Triage room, behind drawn curtains. First of all, Joanne is asked to say her ID number, then SSK7 proceeds with the triage assessment. SSK7 chats to Joanne during the assessment, asking her why she has come to the ED. It turns out that Joanne sought the ED during the past night too. The place of the pain, being close to the heart, frightened Joanne who previously suffered from a heart attack. During the previous night visit, her heart status was checked through tests and an ECG. Since all seemed normal, Joanne was discharged, with the advice to search again if the problems persisted for a long time or if they increased. Now, approximately 12 hours later, the pain is still there, causing Joanne to search the ED again.

SSK7 checks Joanne's vital signs while Joanne gives a brief recap of how the pain started and has developed. After checking vital signs and ESS, SSK7 returns to update SSK4book; Joanne's triage level should be yellow, which SSK4book notes in ELVIS. SSK7 goes back to Joanne, taking blood samples according to yellow triage level yellow whilst inquiring about Joanne's medical history. This takes less than two minutes, after which SSK7 tells Joanne to sit out in the waiting room again.

Before Joanne is shown back to the waiting room, SSK7 asks her for a urine sample. Joanne agrees and, for her part, asks about estimated waiting time. SSK7 responds that Joanne most probably will have to wait for a good couple of hours before being seen by a physician. After leaving Joanne, SSK7 asks SSK4book at the ED_Triage to update ELVIS so that ED_Main can take over Joanne as attending patient. Thereafter, SSK7 goes to see the SSK11book at ED_Main, handing over information and the EJ. The handover comprises the physical handover of the EJ as well as a verbal summary from SSK5 on what is known about Joanne's medical problems and examinations up to now.

At ED_Main, the shift of staff has also just taken place. SSK8book, USK2 and SSK9-10 has left for lunch and SSK11book, USK3 and SSK12-13 has taken over. PH2 and PH3 are the physicians at ED_Main.

After several hours of waiting, Joanne manages to provide a urine sample and wants to know where to leave it. She talks to SSK5 at ED_Triage, and after leaving the urine sample she asks about estimated remaining waiting time. SSK5 starts to walk Joanne up through the corridor to see SSK11book at ED_Main. During the few seconds leading up to the book room, Joanne tells SSK5 that she is hungry but only managed to drink a cup of cold tea earlier. SSK5 shows great surprise and says in a questioning manner "but you know that you are not supposed to eat or drink anything?" to which Joanne responds that "no, no one has said anything about that". SSK5 answers that Joanne should stay clear of eating and drinking from now on and Joanne says that "sure, I just had a bottle of orange juice before too – it would have been great if I had known that from start".

They reach the book room and SSK5 catches the attention of SSK11book, then says: "here is a patient, Joanne, who has some questions". SSK5 leaves and Joanne says: "Hello, how long time do I have to wait, I have been sitting her for four hours". Joanne continues, "My stomach hurts so badly. I was here all night.". "Is it Joanne?", wonders SSK11book. "Yes. I was here 4-5 hours last night.", Joanne says. SSK11book responds: "Yes. The way it looks now you are number four." "Hm", Joanne thinks out loudly, "then it is at least another hour…" After discussing the alternatives available for Joanne; to wait or Joanne discharging herself, SSK11book offers Joanne a bed instead of sitting up in the waiting room. Joanne accepts and SSK13 comes with a bed after a couple of minutes. There are still no available rooms, so the bed is to be placed somewhere in the ED_Main corridor. SSK13 is trying to find as quiet a place as possible but just when they found a spot they realise that the bed is broken. SSK12 passes with another bed and Joanne changes to this new bed, hoping to be able to sleep. SSK11book updates Joanne's location in ELVIS, from Waiting room to Corridor, and files the EJ in the plastic magazine file for patients lying in the corridor.

Almost two hours later, SSK12 fetches Joanne and the bed and rolls the equipage into a room. Joanne is now next in turn to be seen by a physician, thus, the patients who were prioritised as in more urgent need to see the physician have already been seen.

PH2 picks up Joanne's EJ in the book room, and gets an update from SSK11book. PH2 goes to the physician room to check the information written at the EJ, as well as looking in MELIOR. A few noteworthy things to follow up on are found, but PH2 says that they indicate no specific diagnostic suspicion. Once in Joanne's room, and after greeting, PH2 asks Joanne to retell how her pain and problems started. Joanne does so and PH2 follows up with a lot of questions, as well as a physical examination. After

about 15 minutes of examination, PH2 decides on taking an ECG and to give Joanne what is called a gastric cocktail. This so called cocktail consists of an anaesthetic fluid and two effervescent tablets, both aimed to give pain relief. Custom action time is at least 20-30 minutes. If pain after this time is relieved, it suggests that the patient is suffering from gastric catarrh. If not, gastritis problems can be excluded and further investigations will be needed. PH2 makes notes about "ECG", "asking the laboratory for an extra test" (from the blood samples sent to them earlier), and "gastric cocktail" on the EJ. Then PH2 says goodbye for now to Joanne and heads to the book room.

SSK11book is busy elsewhere, consequently PH2 writes a note about ECG, extra test and gastric cocktail. The note, and the EJ, are left at SSK11book's desk before PH2 leaves for the physician room. When SSK11book comes back, and has read the note, information about the ECG, test, and gastric cocktail is registered in ELVIS. SSK11book talks to SSK13 to carry out what is asked for. SSK13 starts by calling the central laboratory to see if they can take an extra test from the blood samples sent to them earlier. The laboratory personnel double checks Joanne's ID number, as well as which tests are already taken, and then confirms that a complementary test is possible to take. SSK13 marks this down on the EJ, tells SSK11book that this was ok, and proceeds to see Joanne to take the ECG and to give her the gastric cocktail. Joanne is thinking that she will have to take another blood sample, and is happy to learn that they were able to use the already taken samples for this test too. The anaesthetic fluid that Joanne is given is of quite thick consistency, and Joanne struggles a bit with getting it down. After this, SSK13 gives her the next cocktail beverage, the effervescent tablets that right now are about to dissolve in water. While Joanne drinks, SSK13 prepares for the ECG, and when Joanne is ready they proceed with the ECG. After the ECG, SSK13 says that all seems normal, but also adds that the definitive result has to be given by a physician. SSK13 thereafter asks Joanne to be patient and wait for at least 30 minutes before the gastric cocktail can be thought to have reached maximum effect. SSK13 leaves, heading for the book room where SSK11book is informed about the ECG. The EJ is now with SSK11book again, and until SSK11book prioritises Joanne as being number one to be seen by a physician, Joanne has to wait again. Thus, PH2 and the other attending physician are seeing other patients, all according to the prioritisation by SSK11book. During this time, attending nurses see to Joanne regularly, or if at any time Joanne calls via the button by her bed. As always, when any nurse sees a patient, the attending book nurse is updated with new information, and, if thought to be necessary, the book nurse updates ELVIS.

After a couple of hours, when PH2 once again goes to SSK11book to find the next patient to be seen, PH2 is told that Joanne is next in turn. PH2 gets an update about Joanne's current status from SSK11book; Joanne has been seen by SSK13 and it seems as if the gastric cocktail has had good effect, the pain is almost gone. After the update PH2 brings the EJ and accompanying papers to the physician room to look through the test results. Not feeling totally confident about how to proceed; PH2 goes to consult the other attending physician, PH3, who is a specialty surgical physician. PH3 listens to PH2 and asks for PH2s thoughts on treatment and eventual further actions. PH3 agrees to PH2's ideas and PH2 leaves to go see Joanne again.

Once in Joanne's room, PH2 rhetorically asks Joanne "So you're feeling better now?", which Joanne confirms, saying that she "fell asleep as soon as her head hit the pillow". PH2 says that the fact that Joanne got pain relief from the gastric cocktail strengthens the suspicion of gastritis, and that any cardiac problems can be ruled out from tests and the ECG. It could still be problems with the gall bladder but nothing is shown from the tests, which it normally does, and the pain is not similar to how it typically presents itself if gallstones are present. Just to be sure, PH2 palpates Joanne's stomach once again, and finds that it is soft and non-tender. PH2 prescribes stomach acid suppressant tablets to be taken during a couple of weeks, and tells Joanne that "if problems persist as bad as now, come back to see us. If only moderate, contact your local health centre for further investigation. Hopefully you will have no problems at all." Joanne asks for a couple of tablets since all pharmacies are closed at this time of day, and PH2 promises that she will be given a couple before she leaves. PH2 leaves the room while Joanne gathers her belongings.

As usual after seeing a patient, PH2 goes to the book room to update the attending book nurse. In this case it is SSK11book, who is informed that Joanne is to be discharged and that she needs a couple of stomach acid suppressant tablets to go. SSK11book confirms that this is understood, and while PH2 goes to the physician room to dictate and then discharge Joanne, SSK11book updates ELVIS and informs SSK13 to administer a couple of tablets to Joanne.

PH2 completes the dictate and files the EJ in the plastic box for the administrators, then closes Joanne's MELIOR and proceeds to find out which is the next patient waiting to be seen.

In total, Joanne stayed at the ED for around 8 hours and met seven persons from the staff. Information about Joanne was registered and/or updated in ELVIS, MELIOR,

the EJ, LabBest, MedSpeech, KoVIS, in conversations and several notepads. RETTS triage system as well as the prioritising system were also used.

The scenarios presented above portray different ways that the DMP can present itself at the ED. That is, they follow and describe the information handling from start to end for each patient portrayed. They also show all individuals and artefacts making up the information handling system for each patient. However, other ways of referring to the work process at the ED exist too, and will be presented below.

6.2 DMP events

During the first period of the study, the DMP for each patient was seen to comprise a number of events, actions or instances of data collection, all linked together in an event chain. The events in such an event chain (all cases of events, actions or instances of data collection will hereafter be called events) are or can be common to all patients. They are linked together in a way that made them become theoretical references in conversations; between staff but also between staff and the researcher, as well as between staff and the patients. Even though the event chains does not fully describe the DMP at the ED, they give a decent description of organisational and practical part of the work processes at the ED.

6.2.1 Models of the event chain

Following the explanation of symbols and abbreviations, two models of the theoretical event chain will be depicted.

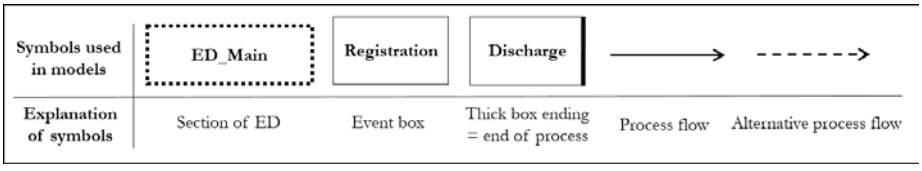


Figure 3: Explanation of symbols used in figures 4 and 5

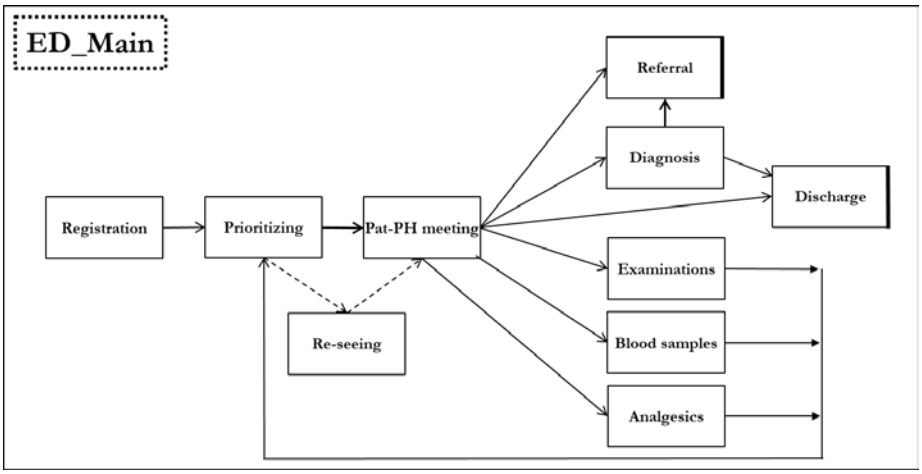


Figure 4: Model of event chain during an NGT shift

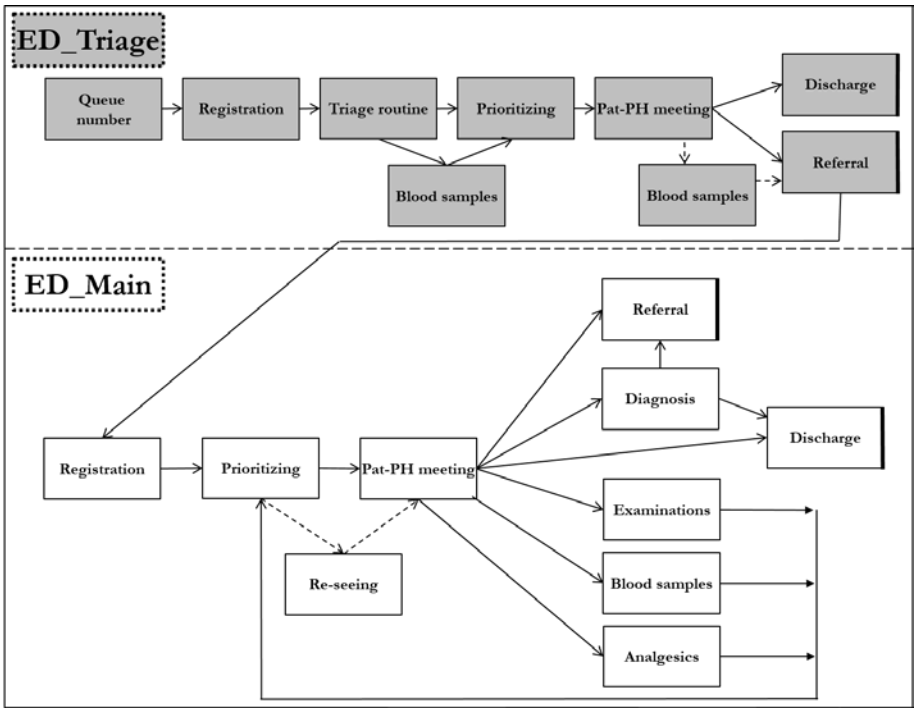


Figure 5: Model of event chain during a DAY and/or EVE shift

Night shift model

The first two study occasions were carried out during NGT shifts. As patients were followed through the different events of the ED process, observations made

regarding the work process were written down and a sketchy model was formed by the researcher (figure 4 is the final model worked out from that sketch).

In scenario John, the visit at the ED starts by the patient arriving through the ambulance entrance, being followed or directed to the ED_Main corridor by a janitor. John's scenario included several of the depicted events from the model, and in the order illustrated in it – besides PH1's visit before SSK3 giving the analgesics; Registration, Triage routine, (Physician), Analgesics, Prioritizing, Physician, Analgesics, Prioritizing, Re-seeing, Physician, Discharge. As for Mark, coming from the medicine ward and already having been through registration and triage, only a quick ad hoc prioritisation was made at the ED, no triage routine needed, thus starting straight off at the Pat-PH meeting step. Directly after seeing PH1, immediate referral to a ward, and taking blood samples, followed – in conflict with the process flow of the model. This conflict will be discussed in chapter 8.

Day and eve shifts model

The third shift(s) to be included in the study was a part of a DAY shift as well as a good part of the following EVE shift. Figure 5 was sketched to capture the work process during DAY and EVE shifts.

As in both Sam's and Joanne's scenarios, the event chain starts by Queue number, Registration, and Triage routine. Sam's scenario runs straight forward in the ED_Triage section - with Prioritizing, Physician, Blood samples and Referral, whereas Joanne's scenario deviates from the model after the Triage routine. In Joanne's scenario, instead of going through the following events at the ED_Triage section, as in Sam's case, there is a jump directly to Referral. Sam as well as Joanne are referred from the ED_Triage section to section ED_Main, where they both go through the first three events; Registration, Prioritizing, and Physician. Sam is discharged after seeing the physician, whilst Joanne's scenario continues for a few more events; Analgesics, Prioritizing, and Physician, before Discharge.

When the models were used as mental guidance, certain results presented themselves more noticeably than others, and were therefore expected to emerge clearly during the analysis phase. These included:

1. Work processes and roles change due to time of day
2. Fragmented system of supporting artefacts
3. Lack of structured feedback to physicians

6.2.2 Work processes and roles changes due to time of day

As an EVE shift switches over to an NGT shift, the work process changes in several ways and the following paragraphs intend to highlight how, as well as in what way the changes might affect the DMP at the ED. Obviously, the changes also take effect, in a reversed way, when the DAY shift takes over from the NGT shift. Below is a list of some things that changes as an EVE shift ends and a NGT shift starts:

- The waiting room closes, which leads to all patients waiting to be seen having to wait in the corridor.
- As the waiting room closes, so does the entrance that up to that time was a door into the waiting room. Instead, the entrance is now through the ambulance entrance.
- The triage section, ED_Triage, closes, making the ED_Main the only section open. Thus, the ED_Main section now manages everything that ED_Triage and ED_Main sections handled previously.
- Staff numbers significantly decreases, from being two teams of at least 6 (minimum of 12 in total) to one team of 5.
- ED_Main section staff numbers decrease, only one physician is at work through the NGT shift, during DAY and EVE shifts there are at least two.
- Physician work responsibility changes, from there being several physicians working in parallel to one working alone.
- SSK work roles are somewhat changed; at NGT shifts, SSK nurses are allowed to, with authorisation from the attending SSK_book nurse, to administer analgesics to patients after the triage assessment. At DAY and EVE shifts, analgesics is not given before the patient has seen the physician.

There is, formally, no increased demand on nurses working NIGHT shifts but in practice, with fewer in staff, the demands are raised. As shown in the event chain

models (figures 4 and 5), even though the events themselves do not change between DAY, EVE and NGT shifts – the event chains change substantially. At DAY and EVE, there are two sections, with somewhat parallel events, whereas at NGT, the one section open performs what the two sections do during DAY and EVE. Another aspect of these different work processes concerns the number of staff. The staff number attending the two sections together at DAY and EVE shifts varied between 12 and 24, whereas staff number at NGT was 5.

6.2.3 Problems with supporting artefacts

The system observed in the study comprised patients, staff, and the artefacts mentioned in section 5.2. The artefacts were all in the system with the aim of supporting staff, and included computer applications as well as the EJ and work routines/algorithms such as RETTS (the triage system) and the prioritising system. Other objects were used too, but focus was and will be on the objects designed and developed specifically for being supportive to the DMP in any way.

Lagging computers night time

One problem occurring frequently during the study was that the computer environment was lagging night time, as commented on in John's scenario. In Sam's scenario a nurse reported on another recurring problem, namely that several applications at times stopped working.

Lack of communication between applications

A lack of communication between applications was very often observed during the study, and was commented upon by staff too, for example in Sam's scenario.

Artefacts and limited space

Limited space for information registration was observed, and commented on in Sam's scenario, regarding the EJ and in ELVIS.

6.2.4 Lack of structured feedback to physicians

Several ED physicians commented on a perceived lack of feedback regarding preliminary diagnoses and treatments made and, as we could see in Mark's scenario, at least some of the physicians had found a way to follow the medical development regarding referred patients.

6.3 The need for a complementary perspective

Initially, the results from the study were to be presented using the event boxes from models 4 and 5 above as reference nodes for the scenarios, by anchoring the scenario narratives to the events. However, as time and work went on there seemed to be a lot of data to present (regarding the ED DMP) that did not fit within such a scheme, and this was a reminder not to lose the systems perspective. A discussion around the models and their validity for describing the work processes at the ED is found in the following chapter, but here are some examples of things that were hard to tightly associate with the events, or the event chains, of the models:

- the non-sequential structure of work at the ED – staff do not work strictly according to the event chains, they handle many such event chains simultaneously
- the interlacing of work tasks, within one patient event chain but also over several patient event chains
- the duration of one event sometimes overlapping another event, thus not being as distinguishable as described in model
- information being handed over between staff
- registering information using the EJ or various computerised applications
- checking information using the EJ or various computerised applications
- physically organising information bearing objects as a way of communication between staff
- rearranging information in order to overcome application deficiencies
- administration regarding discharged or referred patients (such as ordering services to transport patients, ordination of temporary medication, updating applications for home health care services et cetera)
- (ordering and use of interpreter services)

Whilst the event chains mainly describe the work processes for one patient at a time, using scenarios was (hopefully) a more adequate way of presenting the results. The scenarios, just like the models, mainly depict the DMP regarding one patient after another, but put a heavier focus on the information propagation. The

scenarios also describe the individuals and artefacts that together comprise the cognitive system at the ED. However, there seemed to be a gap to fill when trying to describe the complexity and dynamics of the DMP at the ED, and putting the spotlight on the interactions might just be the way to go forward. More on this in the following chapters.

7 Discussion

The scenarios used in the previous chapter anchored the narratives to the patients, aiming to guide you through typical DMPs at the ED. By doing so, the perspective was narrowed to one patient at a time, which is problematic since it does not fully portray the complexity of work at the ED. There is also some form of linearity in the scenarios, following the patients from their entrance at the ED to their exit thereof. This sense of work as being a linear process was further amplified by the use of the models. However, the scenarios and event chains are still useful for presenting and understanding the results of the study, if one at the same time keeps the real world complexity in mind. In Section 7.2, a model that hopefully captures much of this complexity will be sketched.

The results accounted for in the scenarios will now be further discussed.

7.1 DMP events

The events in models 4 and 5 share the feature of being somewhat formalised in the sense that there are, at a minimum, routines for the execution of them. Some routines are invented by staff themselves, others are developed elsewhere and then shared at a larger geographical space (hospital, region et cetera). As well as being developed from merely a work organisation perspective, routines can also be in place because of national or international legislation. In addition, the events themselves are not seldom the focus of various research in clinical settings and were therefore easy to recognize while performing the study.

7.1.1 Models of the event chain

The conflicts between reality and model 4 indicate that the model might not be a reliable way of depicting the DMP at the ED. However, the events seemed important to capture, at least as a starting point, as a common ground for the researcher, staff, and patients to communicate around the DMP. The DAY and EVE model is not totally consistent with the real events either, but even more important – and initially a little surprising to the researcher – the models seem not to say very much about the DMP itself. That is, the models account for the events taking place during the DMP, however do not portray much of the information handling that is at the core of the DMP.

The answers to questions of when, where and how the decision making process unfolds at an ED seems tightly connected to the perspective taken on decision making (as discussed in the theory chapter). With a conventional perspective – that is, an individual perspective on decision making – the events can be understood and analysed as smaller decisions leading up to the final decision. In this kind of research, the events themselves are often the focus of the studies, sometimes with an even narrower scope such as looking at one of the events from a particular perspective – for example a nurse perspective on the triage routine, or the role of decision support for the outcome of the triage routine. From a distributed cognition perspective, seeing the decision making process as information handling, the events can be seen as points in this process, and the process flow gives an idea of how the points are, or can be, interconnected. However, the events are from the distributed cognition perspective not necessarily distinct from each other, nor need they follow this exact process flow, and, more importantly, the information flow is not confined to the events nor to the process flow of the model. The events only show the main structure of the DMP for one patient, and work at the ED is not confined to the dealing with one patient at a time. Even so, these models worked as tools for discussion, and for establishing a shared understanding of the events at the ED. In much research literature (decision making, informatics, medicine), the conventional focus is on events and on individual perspectives during certain events, making events easy to resort to as focus points. A different perspective will be discussed further on in this chapter.

As written in the Results chapter, the following results were anticipated to emerge as stable patterns during the analysis phase of the study:

1. Work processes and roles change due to time of day
2. Fragmented system of supporting artefacts
3. Lack of structured feedback to physicians

Indeed, all of above proved to be visible during and after analysis, and will be discussed below.

7.1.2 Work processes and roles changes due to time of day

Even though the same events are taking place during DAY/EVE and NGT shifts, there is a significant difference in how many events there is or can be, and in the order of them, during DAY/EVE and NGT shifts (see models 4 and 5). The one section open during NGT shifts, ED_Main, is performing all that the two sections, ED_Triage plus ED_Main, do during DAY and EVE shifts – and with considerably fewer in staff. Thus, with fewer individuals performing the same events, the work processes are very likely to be changed too.

Before delving into how structural changes of work process can affect the DMP, let us discuss the reasons for the change between DAY/EVE and NGT shifts. Staff costs are heavily increased night time, whilst at the same time the number of patients seeking care is decreased. To balance costs and patient needs, staff numbers are reduced during nights. Thus, there is primarily an economic cause for this change in work process.

In addition to change of work process, certain work roles were altered in respect to responsibility. That is, SSK nurses at NGT shifts had greater autonomy, being able to ordinate analgesics without consulting the attending physician. Having only one physician attending the NGT shift, this increased responsibility for SSK nurses was probably introduced to lessen the work load on the physician, but this is only speculative on my part. The only difference recognised in connection to the respective physician categories was that, during a DAY or EVE shift, the more competent physicians were placed in the triage section. When thinking about these differences between shifts in relation to the DMP, how could they affect the DMP? First, SSK nurses quoted in John's scenario spoke about feeling a greater responsibility whilst working the NGT shift. Only speculative, but the feeling the team talked about might have a positive impact on the precision of work done, thus implying that feeling greater responsibility towards team members would increase effort and therefore sharpen your accuracy. Secondly, fewer system nodes could be argued to imply increased density, keeping information more tightly coupled within the cognitive system, and thereby affecting the DMP. However, the perfect number of system nodes is a delicate balancing act in any system, and there would be only a theoretical answer to what number is optimal; the number of nodes that can propagate information without

adverse effects on the information and what the information is used for. When staff shifts were overlapping between DAY and EVE shifts, there were up to four times as many staff attending the ED as at a NGT shift.

Another cause of the perceived sense of greater responsibility could be the changes in the work role of the book nurse. As already shown, a patient's visit at the ED begins by the book nurse registering the patient in Elvis. The use of ELVIS differs between sections, and also within the same section (ED_Main) depending on work shift. ED_Triage book nurse mainly uses ELVIS for information regarding the triage assessment of patients, whereas ED_Main book nurse deals with a lot of information that has to be visible in order to prioritise between patients. From two up to more than 10 information items have to be registered in ELVIS in order for the ED_Main book nurse to keep track of information about the patients currently registered, and to prioritise correctly between them. During NGT shifts, the book nurse handles and registers the same information that the book nurses at ED_Triage and ED_Main handle together – hence, the NGT shift book nurse has more patients to coordinate and prioritise between, and the amount of data about each of these patients is larger.

Most medical staff want to hear the patient's problem described by the patient him- or herself, one reason being that the symptoms can change over time, but this sometimes led to the patient having to repeat the same story numerous times – especially at DAY and EVE shifts, and in particular during shift overlaps. As a nurse commented during Sam's scenario, patients uttered frustration over repeating the same story, asking if the previously presented information had disappeared. Since the reason for asking again primarily had to do with staff wanting to hear the patient story first hand, the question could be seen as a misunderstanding – but in fact it has some bearing, even though disappearance of information was not the reason for asking again. Every time a patient tells his or her story, the staff listening only registers (at the EJ, at a note pad, in dictation) and hands over (to the nurse book, a physician, a nurse colleague) what he or she believes to be relevant based on the medical situation. From an information propagation perspective, this is interesting because the same information is repeatedly inserted into the system, but to different nodes. This could be thought to counteract any miscommunications, securing that relevant information reaches

relevant persons. At the same time, only the first staff member to meet the patient (possibly) hears the patient story before having any other information about the patient. That is, all staff members meeting the patient after the nurse(s) that has the first encounter have some medical information prior to meeting the patient. This prior information builds on what was registered at an earlier stage, from previous encounters between one of the staff members and the patient that the staff member has registered. Thus, only selected information of some kind is presented to the staff member that is about to see the patient, and even if the patient repeats the story given from the first encounter with medical staff - word by word - the staff member presumably is influenced by previous information given. All this possibly affecting the selection this staff member makes in turn. And so it continues through the system, or at least it is possible that it does.

7.1.3 Problems with supporting artefacts

The use of computers at work is no longer anything out of the ordinary, rather the contrary – computers are intrinsic to most work places, replacing manual routines and older technologies, such as fax machines and conventional fixed telephones. These older technologies appear less and less frequently, and for any technology that is introduced or taken away – structural changes to the work process is necessary in order for these different technologies to coexist and work towards the goal of the process. At the ED, cutting edge technology is intermingled with quite surprisingly old technology, affecting the way information is handled and propagated. All patient information judged to be relevant from a medical perspective is to be registered, and most information is registered using computer applications – the EJ excluded. Thus, the vast majority of actions performed by staff at the ED includes the use of computers, either directly by using a computer application whilst performing the action (such as registering the patient into ELVIS) or indirectly by using one or more applications as information pools. Three main issues were found concerning the use of computers, and these will be discussed below.

Lagging computers night time

Computers do play a significant role in the information propagation process, and therefore the reoccurring night time lagging reported on in John's scenario, and/or freezing of all computers, was rather surprising. This affected all

computerised applications and sometimes caused staff to postpone certain work, hence adding to the cognitive workload by having to remember yet another thing to do. At times it also made them break the normal routines of work, making them prioritise work tasks, and sometimes even prioritise patients, differently. Information that was normally registered directly in computerised applications, or dictated, were scribbled on note pads or simply memorised – that is, information was re-routed. Examinations, such as x-rays and certain blood samples, were put off because computers did not function well enough to support these actions (making referrals and printing tags for vacutainers for example). Patient information that was normally sought before seeing a patient was difficult (sometimes impossible) to access, leading to the attending physician sometimes meeting patients without the possibility of having beforehand information normally possible to have. Whether or not this affects the DMP differs between patients, however it can be argued that lacking information about things like previous operations and treatments can lead to less informed judgments and decisions, alas affecting the DMP. All problems mentioned above could also occur due to certain applications not functioning at times, see Sam's scenario – especially ELVIS, LabBest, and WebADAPT.

Lack of communication between applications

The lack of communicational interfaces between computerised applications working side by side in a process can be looked at on different levels; a general level as well as those associated with specific applications. At the general level, the lack of communication between different applications required staff to register information in several systems in order to ensure that relevant information was to be found anywhere where it could be needed. For example, a nurse ordering a blood sample through the use of LabBest system, also had to register this on the METTS/RETTS emergency journal (EJ). Another example concerns when the EJ + verbal information was handed over from a nurse or physician to the book nurse, when as in Sam's scenario, relevant information had to be manually updated in application ELVIS. Similarly, when a lab result came back to the book nurse, the result had to be manually updated in ELVIS in order to be visible without the user going to an external application. Thus, as in this example, for each action performed in connection with a patient there were almost always multiple systems to update. This is of course problematic in many ways. First, the

use of a computerised artefact should facilitate the DMP, not increase work burden, as seemed to be the case here. The DMP is thought of as being a time-critical and complex process already in its most basic form; to receive and coordinate patients seeking care for acute medical problems with the overall aim to treat and/or diagnose them correctly. Any system implemented in such a process should, on its own and in cooperation with other implemented systems, enhance or facilitate this process. When performing a basically simple task requires manual updates in several systems, there is risk of more loss than gain on an overall level. Evaluation of gain on an overall basis is hard, and many evaluations are action or computerised system focused rather than looking at the overall process (Olovsson & Arvola, 2007). That is, evaluations sometimes only evaluate the gains of a system devoted to a specific action; does this specific system enhance decisions made or facilitate information handling? The argument of this thesis is that the need for an overall systems perspective needs to be addressed in order to implement applications and specific systems successfully in the future.

At the more specific level, systems intended to enhance or facilitate a certain action or a process can, due to lack of sufficient communication, add to the work strain for the very action or process, or to the overall process. One example concerns how new information arrived to staff at the ED through computerised applications. The book nurse used the ELVIS system alongside several other systems to have an overview of the patients currently attending the ED. However, new information arriving to the other systems was not automatically updated in ELVIS, the program at front by default, nor was it alerted to the book nurse in any digital way. At least two systems were identified having this problem; a) LabBest, where results from blood samples taken at the ED were updated, and b) KLARA SVPL, through which information to the ED from outpatient care or communal services is sent. As shown in Sam's scenario, a new manual routine had to be created for LabBest in order to overcome communication shortage – namely that the lab section sent a fax to the ED in order to alert them that LabBest had new information regarding one of the patients attending the ED. For KLARA SVPL, another routine was created – to regularly check for new information, something that was forgotten at least once during the study. This, as does the LabBest example, calls for an overall systems perspective.

Artefacts and limited space

Early on during the study observations at the ED, a limitation regarding space was noted for the EJ as well as the ELVIS application. The EJ contains a small area for free text and the first nurse to meet any patient had to, heavily, condense the information given by the patient, as spoken about in Sam's scenario. This can be problematic for a number of reasons. First, the selection of what is regarded as the most important information can bias staff seeing the patient later on. If the first nurse seeing the patient suspects a certain diagnosis, it is not unlikely that this might cause the selection of facts to include in the free text. If the nurse is right, this is presumably not a problem, but if the suspected diagnosis is wrong, then vital information might have been excluded which might delay making a correct diagnosis. Secondly, patients attending the ED often meet numerous nurses and physicians during their time at the ED. Nurses told that when asked for the same information for perhaps the fifth time, patients show irritation and/or complain. It is understandable that each involved clinician wants to hear certain things first hand from the patient; onset of symptoms, current status of symptoms et cetera. However, to be asked to repeat one's medical history over and over again seems unnecessary – information regarding previous operations, referrals or other information with little association to the patient's personal experience of the symptoms could easily be part of the EJ – if there was space allowing it.

In ELVIS, information about each patient is shown as a row in the application window. A number of fields are predefined for certain information but there is also a commentary field for free text, though this is restricted to a certain number of characters. Most patient information not purely administrative is confined to this area, something that often proved to be difficult to manage, see Sam's scenario. In order to increase possible information to be registered, ED nurses had come up with an abbreviation system, and a paper showing the agreed upon abbreviations was left lying next to the computer screens at the ED. Again, this puts more strain on staff who are, often, working in time-critical and complex situations. Again, the only reason for the added work is a shortcoming in one of the systems that are there to support their work. With staff complaining on too many steps to navigate between applications, and countless codes to access systems, the need to use abbreviations in order to make room for all necessary information seems (frankly expressed) absurd and counterproductive.

All the examples above highlight the need for flexibility in design. A patient with a straight-forward medical history, or with a diagnosis that is fairly obvious and requires few exams or blood samples, can do with limited space for free text. However, it seemed during the study that a majority of patients shared so much information that nurses had to sift information and register only that which they found most important for treatment and/or diagnostics.

Synopsis regarding artefacts

Whilst reading observations and transcribed clips from the study it became increasingly apparent that many of the computerised applications used at the ED works by supporting single actions rather than the entire process at the ED. This leads to staff having to bridge difficulties in interaction between applications as well as coping with malfunction of the very same applications (and the general computer environment).

In total, not only does the computer environment, and applications created to support actions and decisions, show shortcomings with regards to functionality – they sometimes create a need for new decisions through bad interfaces, insufficient interoperability and inflexibility in design. The argument in Section 7.2 is that a perspective change, from looking at events to having a systems view, might enable a better understanding of what needs there are to relate to whilst developing artefacts – computerised or not.

All in all, computers and computerised applications are, or can be, important parts of the DMP at the ED. Almost all actions taken by staff at the ED are registered in one or more systems, and relatively often actions include the use of a system (patient registration and coordination, triage, ordering of lab tests, exams, dictation, and other fundamental parts of the DMP). Even though it might sound like a platitude to say that a holistic view of the DMP and all of its components is needed to ensure smooth information propagation, the results of the study indicate that specific actions rather than the overall DMP has been at heart when designing, developing and implementing applications.

7.1.4 Lack of structured feedback to physicians

For most patient cases, no feedback regarding the diagnosis or treatment is given to physicians. Even though there is no unanimous view on the role of feedback

for the quality of decision making (Archer, 2010; Kluger & DeNisi, 1996), it seems quite uncontroversial to argue that feedback on whether a correct medical judgment was made or not could be of interest, if not of importance. Further research in this area would be beneficial but there are a number of factors to take into account before doing so. If the quality of a decision is what one intends to measure, then it is important to establish a clear definition of what quality stands for. Is it diagnosis accuracy, correct treatment (regardless of diagnosis[10]), time spent for diagnosis and/or treatment, or a combination of these that is an adequate quality measurement? Research like this also touches on the ethics of health care: how do we prioritise? Is it always that biggest need should go first or are there reasons for prioritising differently sometimes? The same question is relevant for treatments too, how much is to be spent in order to cure, alleviate symptoms – and are all, regardless of what type of medical need and what has caused it, to be equally treated? This is nothing new, these questions are being and have been discussed – probably for as long as there has been any organised medical care. The possibly new in this is to look at how these issues influence, if at all, the daily work of health care staff.

As shown in Mark's scenario, physicians wanted to see how things turned out for some of their patients. No follow-up questions were asked on why this interest arose, so it could well be simple curiosity. Speculatively, it is quite possible that the physicians wanted to see how "they did", that is how their decisions turned out, in order to enhance their competence.

7.2 A complementary perspective

When trying to establish an understanding of the DMP at the ED, an intuitive way of doing so was to search for commonalities in the information handling regarding patients – to "follow the information". Two different types of patterns were identified throughout the study and the subsequent analysis. The first has already been presented and discussed: the event chain. The other pattern, an information node network, grew from analysis of the study results and has continuously emerged as an important perspective. Even though the theoretical point of departure in the thesis was always distributed cognition, there was a

[10] It is not always necessary to know the exact diagnosis in order to treat the symptoms.

difficulty of having the systems glasses on whilst observing the DMP in the study. In different ways, these two ways of talking about the DMP presumably stems from different views on decision making, on the decision making process, and on cognition in general. For example, Patel, Kaufman, and Kannampallil (2013) discuss different research traditions within medical decision making, contrasting research performed in real-world settings, here exemplified by NDM, with laboratory studies, and Patel and Kannampallil (2014) advocate DC as a prominent theory for addressing complex interactions, thus using a systems perspective. Davies and Michaelian (2016) also contrast different research traditions, in this case presenting a task-based DC approach as an alternative to agent-based extended cognition.

Beginning to see the DMP at the ED as an ongoing process or even as several intertwined processes, rather than a chain of events, made the information node network perspective more and more appealing, especially since it highlights the systems perspective that is downplayed in the earlier descriptions of the DMP at the ED. A schematic model of the information node network is presented in figure 7 below. The nodes in the network model comprise different actors, that is individuals and artefacts, connected to each other in an information system.

The lines in the model show which nodes can, from an information perspective, be connected to one another. For example, the node termed Patient is an individual who is – or could be – exchanging information with other nodes, in this model the nodes PH, USK and SSK. The lines merely show that information might be going from one node to another, and do not say anything about the direction of the information propagation, or about the volume or any other feature possibly associated with the information. The model is based on a NGT shift, thus the nodes representing individuals are limited to five, which is the patient and four types of staff roles. A model based on a DAY or EVE shift would be substantially harder to sketch, due to the number of individuals involved in the DMP. Thus, the possible number of relations would be vastly increased, and as such very difficult to represent in a 2D figure. However, the model presented here could still be beneficial as a starting point for discussion since the changes in work and responsibility for SSK nurses and physicians (discussed in

7.1.2) presumably do not entail equally great changes in the kinds of relations that hold between the nodes.

The nodes can be linked to several events, and most of the nodes are frequently mentioned in each scenario. In comparison to the events and the scenarios, the nodes are rather consequent in that they have the same, or similar, roles in each DMP at the ED. The information node network is the perspective that brings the distributed nature of the DMP at the ED to light, showing the interconnectedness of individuals and artefacts that work towards a common goal, diagnosing and/or treating each patient seeking care at the ED. In essence, these nodes and their connections can be thought of as the distributed cognitive system of the ED, for each patient's DMP at the ED. However, a limitation of this model is that, once again, one patient is singled out to be represented – even though work at the ED is more complex than that. So, why could such a model still be an important step forward? Well, for one because it focuses on the information and the interrelations within the cognitive system in the DMP at the ED. Moreover, the visualisation offers an alternative view of work at the ED. Instead of talking solely about the events and how they come about, the different parts of the system and their interrelations are taken highlighted.

Abbreviations used in model	**ADAPT**	**EJ**	**USK**	**Book**	**SSK**	**PH**
Explanation of abbreviations	WebADAPT	Emergency journal	Assistant nurse	Coordinating nurse	Nurse	Physician

Figure 6: Abbreviations used in figure 7

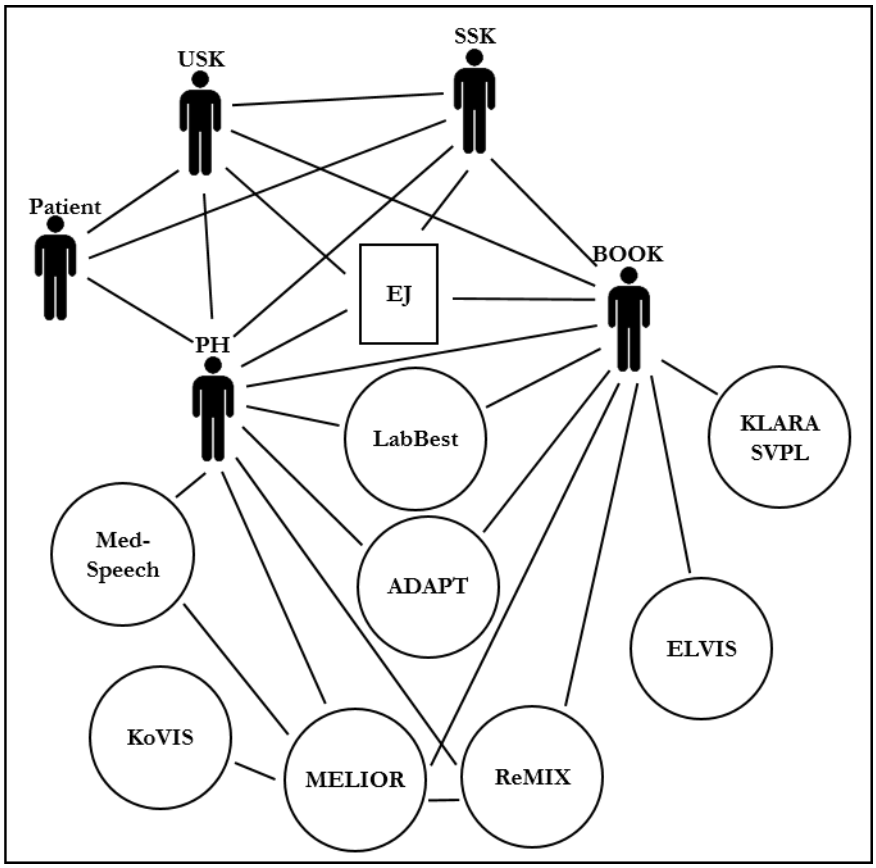


Figure 7: A model of an information node network

The nodes differ from each other in several ways. A few basic differences are reflected in the graphical representation: the stylised humans represent individuals, the round shapes the computerised applications, and the square the paper based triage journal, the EJ. Moreover, the nodes differ in how they handle information. Certain information nodes stood out as more central than others, acting like hubs and having relations to many persons and/or artefacts. Nodes with many relations include the physician, the book nurse, and the EJ. The patient, MELIOR, and to some extent the EJ, are also nodes that are vital parts of the system. That different system nodes carry differing information loads is not a new discovery. For example, Spencer, Logan, and Coiera (2002, p. 69) write that one important finding of their study "[…] was that different staff members carried

different communication burdens relating to their specific role, some of which could be reduced through targeted organizational, educational or technological changes.". The interventions proposed concern, amongst other things, improving overall communication flows, and even though their study focused specifically on communication and work interruptions, their findings are well in line with the findings from the study in this thesis.

The information nodes show other differences too, some are merely storage (and/or transition) nodes whereas other nodes can be seen as sources, storage as well as end nodes. An example of a storage node is LabBest, where information from the ED is sent to the central laboratory, and then the results are sent back. It can be argued that the results coming back from the central laboratory, being new data, can make LabBest a source node too, showing the difficulty to discern node types from each other without overlap. The patient, however, is undeniably a source node, but is also at least an end point in some way. With no real distinction to be made during the remainder of the chapter, this paragraph only served to show that an awareness of differences is present but will have no place henceforth. Now, a presentation of each node of the network.

First and foremost, the **patient**. The individual person having the problem(s) that causes her to seek care at the ED is obviously a key information node in the DMP at the ED.

The **EJ** is another example of an information hub, a new EJ being created for every new patient seeking care at the ED. The EJ is after that used to register certain medical and administrational information, but also to guide the nurse(s) performing the triage assessment. After the triage, the EJ is passed on to the book nurse, who mostly uses it indirectly; filing any eventual papers regarding respective patient in the EJ plastic file, and filing the EJ plastic file itself in the plastic magazine file corresponding to the patient's location. Whenever new medical information regarding the patient (blood sample results, changes in vital signs et cetera) is received, this is noted in the EJ or printed and filed together with the EJ. When a patient is to be seen by a physician the EJ is handed over, and the physician uses it to get an update as well as to register information about examinations (such as x-ray) and blood samples to be taken thereon. Referral

information is recorded too, as is the diagnosis if there is one. If the patient is referred from the ED_Triage to the ED_Main, the EJ is handed over from the book nurse at ED_Triage to the book nurse at ED_Main. The process is thereafter as below. If the patient is to be immediately referred to another (non-acute) ward or discharged, the EJ stays with the physician until it is faxed to the administrators to be scanned into KoVIS. If, on the other hand, the patient stays at the ED for further investigation, the EJ is handed back to the book nurse, and the process iterates until the patient is referred or discharged.

MELIOR is another information node that is used from start to end of a patient's visit at the ED, as is **ELVIS**. Whereas MELIOR is used primarily by the physician(s), ELVIS is used first and foremost by the book nurse(s). MELIOR brings together medical patient information that is collected at any time within the region, using several computerised applications in addition to the MELIOR application itself. MELIOR is, as an information point, a hub that provide a comprehensive and necessary background to the staff, especially to the physicians. ELVIS is more actively used, particularly by the book nurse(s); information collected during the current patient visit is noted there and used as a basis for coordination and prioritisation. Administrative data are collected too, and used for statistical and economical purposes by other divisions at the hospital.

BOOK NURSE(S) play a key role regarding information propagation. All other staff members report to them and they are responsible for delegating tasks according to their prioritisation of patients' needs.

PHYSICIAN(S) are, with a few exceptions, responsible for which exams, blood samples, and medical ordinations and actions that are to be taken – as well as for identifying a diagnosis. As such, they are normally the last human information point (at each section of the ED) in the decision making process. All relevant information gathered before their entrance in the decision making process should be accessible to them.

Computerised applications like **LabBest**, **MEDSPEECH**, **ReMix, KoVIS, WebADAPT**, and **KLARA SVPL** are information nodes too that respectively store information about particular features of the patient's medical condition. LabBest is used to order and receive information regarding blood samples,

MEDSPEECH is the dictation software, ReMix where x-rays are ordered, KoVIS where scanned documents are added to a patient's journal, WebADAPT is used to see x-ray results, and KLARA SVPL is an information sharing application between home health care and the ED. Numerous other information nodes exist too, including for example other staff (janitor, administration to name a few), friends and relatives to the patient, as well as other artefacts such as notepads and books, but they are not shown in Figure 7.

Nodes do not only interact with each other, information handling is usually happening within the nodes too. For example, when SSK3 in John's scenario makes a decision that John should be given an analgesic syringe, it is a conclusion based on the information that SSK3 has collected during the triage assessment. The EJ supports SSK3 in deciding on the correct triage level, but no other artefact or individual is directly involved in the decision regarding giving the analgesic syringe. Another example of within-node activity is when SSK1book prioritises between patients, also in John's scenario. Previously collected data and information about the patients currently attending the ED form the basis for SSK1book's decision on who's first to be seen by the physician, but the decision is usually made individually. Other examples include ELVIS that creates administrational, statistical and economical summaries from information that is registered into it, LabBest that creates tags for vacutainers for blood samples, as well as all other individuals involved in the DMP who make small judgments and decisions along the way of the DMP.

The information nodes are still intrinsically connected to events, or is it rather the other way around? Instead of the information nodes being associated to the events, the argument here is that events could be seen as associated to the information nodes. With this reversed or at least balanced view, the focus is placed on the relations within the system rather than on the events. Quite possibly, this changes the way that the nodes are perceived and talked about – not being secondary to the events, but being centre staged. With that comes an opportunity to keep track on the interface aspect of the artefacts, and the relational aspects of the system.

7.3 Transferability

As already mentioned in section 4.2, one limitation concerns the group of patients included in the study. Only including patients seeking care for AAP will have had some effect on the understanding of the DMP, for example in relation to what type of information is collected. However, the vital signs collected, and the routine questions posed, whilst performing the triage assessment using the EJ are the same for all patients seeking acute care. The RETTS triage system is not only used at the hospital included in the study, but at all hospitals within the region and at several other places in Sweden. Other triage systems, used in Sweden as around the world, differ slightly from RETTS, however there are usually more similarities than differences between the data collected in connection with the use of them. When it comes to the practical work, other examinations might be performed for patients seeking care for AAP than for other patient groups, and the event chains might vary slightly from the ones depicted in this thesis (figures 4 and 5). Other differences regarding the work process probably exists too, between hospitals as well as regions and countries, such as use of other work routines, computer applications, professional categories and work roles. How these differences affect the DMP at the ED will only be possible to answer with further studies.

With the above limitations taken into account, transferability of the benefits of a systems view seem uncontroversial for any complex and dynamic DMP. The same appears to be true for the idea of anchoring the observation to a constant in the process, the patient in this study.

7.4 Future research

Several research ideas have emerged during the work with this thesis, and will be briefly described here.

Based on the inconsistent research about the quality effects of feedback mentioned earlier, to follow the role of feedback would be very interesting; does feedback on the decisions taken affect future decisions? In what way? It would also be interesting to look more closely into why it is it that physicians want to follow-up on their decisions, what exactly they do look at, and what kind of actions they take based on the information collected.

Ideas closer to the work done in this thesis comprise:

- a follow-up observational study at a different ED – using a broader patient group to see how the results stand.
- a comparative study – testing how the results from this study plays out in a different setting than within the health domain.
- design and development of a DSS adapted to the real structure of the ED and aimed at the support of diagnosing patients seeking care for AAP

8 Conclusions

With the objective of answering the research questions posed, a descriptive study was carried out. More than 30 patients were followed through their ED visits, with the researcher as a participant observer. Audio recording of communication between patients and staff, and between staff when communicating regarding patients, was performed. The recordings were transcribed and, along with the observations, analysed.

The answer to the first research question – *How does a complex and dynamic decision making process at an emergency department work?* – is as complex as the DMP itself. The lengthy answer is given in chapter 6 and 7, though the following five observations regarding the practical work at the ED deserve some extra attention. 1/ Levels of responsibility, and to some extent also nature of work, change due to time of the day. Work at night places higher levels of responsibility on staff, mainly due to fewer individuals in the work team but also because of differences in work tasks and content of work roles. The number of individuals involved in the DMP, as well as level of responsibility placed on these individuals, is likely to affect handling of information, and with this the DMP. 2/ The computer environment was lagging most nights, forcing staff to deviate from normal routines, and postponing certain work tasks, while waiting for computers to function normally again. Deviating from routines presumably adds to the cognitive workload of decision-makers which in turn may well have a negative influence on the DMP. 3/ Furthermore, computerised supportive artefacts were found to have limited intercommunication, increasing cognitive and practical workload on staff in order to keep information updated where needed. Again, added workload, whether cognitive and/or physical, is likely to have a negative impact on the DMP. 4/ One artefact, ELVIS, was designed with information space so limited that staff created their own abbreviation system in order to work around this perceived problem. The paper based emergency journal was designed with a limited area for registering the patient's medical history, which certain nurses identified as problematic forcing them to condense heavily or choose what information to include. Going from the normal routine of writing down what seems to be of most importance to having to select between seemingly important pieces of information ought to affect the DMP adversely. 5/ Another issue concerned physicians and their perceived lack of structured feedback on the decisions made

regarding treatment and/or diagnosing. Even though research on the effect of feedback regarding decision making is far from unanimous, physicians sought feedback and even departed from routines in order to get it. Whether or not this affected the DMP is only speculative on my part, however, since the physicians actively sought feedback they presumably believed it could have some impact on the DMP.

The method of following the DMP from start to end enabled a holistic view of the DMP and yielded valuable insights that would otherwise not have been able to obtain. The five observations described above gave knowledge and understanding of issues having an adverse effect on the DMP. As such they constitute a practical contribution for healthcare practitioners, as well as for researchers within several domains, ranging from interaction design to decision making and informatics.

The second research question – *What are the possible advantages of taking a systems perspective on such a process?* – is less complex, even though parts of the answer came relatively late in the study. The information node network model (see figure 7) is the perspective that brings the distributed nature of the DMP at the ED to light, showing the interconnectedness of individuals and artefacts that work towards a common goal, diagnosing and/or treating each patient seeking care at the ED. Two main advantages of adding the information node network perspective can be identified. Firstly, the system nodes, whether they are individuals or artefacts, gain visibility through the systems perspective. Remembering each system node, and their interconnectedness, when discussing, changing, or designing work processes can facilitate understanding of the complexity of the decision making process. Secondly, considering the information exchange paths of the system when designing artefacts and work processes would likely counteract the connectivity problems experienced during the study.

Describing the DMP in three different ways goes beyond what other methods offer in terms of detail, holism, and having multiple perspectives. This method allowed for different process aspects to be highlighted, and the distributed nature of decision making could be visualised with the information node network model.

REFERENCES

Abraham, J., & Kannampallil, T. G. (2014). Quantifying Physician Activities in Emergency Care: An Exploratory Study. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 58, pp. 798-802). SAGE Publications.

Allais, M. (1953). Le comportement de l'homme rationnel devant le risque: critique des postulats et axiomes de l'école américaine. *Econometrica: Journal of the Econometric Society*, 503-546.

Archer, J. C. (2010). State of the science in health professional education: effective feedback. *Medical education, 44*(1), 101-108.

Bjornsdotter, M., Nalin, K., Hansson, L. E., & Malmgren, H. (2010). Support Vector Machine Diagnosis of Acute Abdominal Pain. *Biomedical Engineering Systems and Technologies, 52*, 347-355.

Blandford, A., & Furniss, D. (2006). DiCoT: a methodology for applying distributed cognition to the design of teamworking systems *Interactive systems. Design, specification, and verification* (pp. 26-38): Springer.

Bobzien, S. (2016). Ancient Logic. *The Stanford Encyclopedia of Philosophy.* Winter 2016. Retrieved from https://plato.stanford.edu/archives/win2016/entries/logic-ancient/ Accessed January 24, 2017

Buchanan, B. G., Sutherland, G. L., & Feigenbaum, E. A. (1969). Heuristic DENDRAL: A program for generating explanatory hypotheses in organic chemistry. In B. Meltzer, D. Michie, & M. Swann (Eds.), *Machine Intelligence 4* (pp. 209-254). Edinburgh, Scotland: Edinburgh University Press.

Clark, A. (2001). *Mindware : an introduction to the philosophy of cognitive science*. New York ; Oxford: Oxford University Press.

Clark, A. (2008). *Supersizing the Mind: Embodiment, Action, and Cognitive Extension: Embodiment, Action, and Cognitive Extension*: Oxford University Press.

Cole, M., & Engeström, Y. (1993). A cultural historic approach to distributed cognition. *Distributed cognitions*, 1-46.

Cyert, R. M., Simon, H. A., & Trow, D. B. (1956). Observation of a business decision. *The Journal of Business, 29*(4), 237-248.

Davies, J., & Michaelian, K. (2016). Identifying and individuating cognitive systems: a task-based distributed cognition alternative to agent-based extended cognition. *Cognitive processing, 17*(3), 307-319.

Duff, M. C., Mutlu, B., Byom, L., & Turkstra, L. S. (2012). *Beyond utterances: distributed cognition as a framework for studying discourse in adults with acquired brain injury.* Paper presented at the Seminars in speech and language.

Dybowski, R., & Gant, V. (2001). *Clinical applications of artificial neural networks*: Cambridge University Press.

Edwards, W. (1954). The theory of decision making. *Psychological Bulletin, 51*(4), 380.

Ellsberg, D. (1961). Risk, ambiguity, and the Savage axioms. *The quarterly journal of economics*, 643-669.

Fodor, J. A. (1975). *The language of thought* (Vol. 5): Harvard University Press.

Fodor, J. A. (1987). *Psychosemantics: The problem of meaning in the philosophy of mind*.

Franklin, A., Liu, Y., Li, Z., Nguyen, V., Johnson, T. R., & Robinson, D. (2011). Opportunistic decision making and complexity in emergency care. *J Biomed Inform, 44*.

Garbis, C. (2002). *The cognitive use of artifacts in cooperative process management: Rescue management and underground line control.* (Published doctoral thesis), Linköpings universitet.

Gardner, H. (1987). *The mind's new science : a history of the cognitive revolution*. New York: Basic.

Hansson, L.-E. (2002). *Akut buk*. Lund: Studentlitteratur.

Hansson, L.-E. (2013). *Akut buk: diagnostik och behandling av akut buksmärta* (Vol. 2., [rev. och uppdaterade] uppl.). Lund: Studentlitteratur.

Haugeland, J. (1985). *Artificial intelligence : the very idea*. Cambridge, Mass. ; London: MIT Press.

Hausmann, D., Zulian, C., Battegay, E., & Zimmerli, L. (2016). Tracing the decision-making process of physicians with a Decision Process Matrix. *BMC Medical Informatics and Decision Making, 16*(1), 133.

Hazlehurst, B., Gorman, P. N., & McMullen, C. K. (2008). Distributed cognition: an alternative model of cognition for medical informatics. *Int J Med Inform, 77*(4), 226-234.

Hollan, J., Hutchins, E., & Kirsh, D. (2000). Distributed cognition: toward a new foundation for human-computer interaction research. *ACM Transactions on Computer-Human Interaction (TOCHI), 7*(2), 174-196.

Horrocks, J. C., McCann, A. P., Staniland, J. R., Leaper, D. J., & de Dombal, F. T. (1972). Computer-aided Diagnosis: Description of an Adaptable System, and Operational Experience with 2,034 Cases. *British medical journal, 2*(5804), 5-9.

Hutchins, E. (1995a). *Cognition in the wild*. Cambridge, Mass.: MIT Press.

Hutchins, E. (1995b). How a Cockpit Remembers Its Speeds. *Cognitive Science, 19*(3), 265-288.

Hutchins, E. (1996). Response to reviewers. *Mind, Culture, and Activity, 3*(1), 64-68.

Hutchins, E. (2006a). The distributed cognition perspective on human interaction. *Roots of human sociality: Culture, cognition and interaction*, 375-398.

Hutchins, E. (2006b). Imagining the cognitive life of things. *workshop on 'The cognitive life of things: Recasting the boundaries of the mind', McDonald Institute for Archaeological Research, Cambridge, April*.

Hutchins, E. (2014). The cultural ecosystem of human cognition. *Philosophical Psychology, 27*(1), 34-49.

Hutchins, E., & Klausen, T. (1996). Distributed cognition in an airline cockpit. *Cognition and communication at work*, 15-34.

Kahneman, D. (2011). *Thinking, fast and slow* (1.ed. ed.). New York: Farrar.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*, 263-291.

Kahneman, D., & Tversky, A. (2000). *Choices, values, and frames*. New York: Cambridge University Press.

Kauder, E. (1953). Genesis of the marginal utility theory: from Aristotle to the end of the eighteenth century. *The Economic Journal*, 638-650.

Kirsh, D. (1995). The Intelligent Use of Space. *Artificial Intelligence, 73*(1-2), 31-68.

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: a historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin, 119*(2), 254.

Laurell, H. (2006). *Acute Abdominal Pain.* (Doctoral thesis), Uppsala Universitet.

Laxmisan, A., Hakimzada, F., Sayan, O. R., Green, R. A., Zhang, J., & Patel, V. L. (2007). The multitasking clinician: decision-making and cognitive demand during and after team handoffs in emergency care. *Int J Med Inform, 76*(11-12), 801-811.

Lindgren, S., & Aspegren, K. (2004). *Kliniska färdigheter: informationsutbytet mellan patient och läkare*: Studentlitteratur.

Malmgren, H., Borga, M., & Niklasson, L. (2000). *Artificial neural networks in medicine and biology*: Springer London.

March, J. G. (1997). Understanding how decisions happen in organizations. In Z. Shapira (Ed.), *Organizational decision making. Cambridge series on judgement and decision making* (pp. 9-32). New York: Cambridge University Press.

March, J. G., & Simon, H. A. (1958). *Organizations*. New York: Wiley.

Michaelian, K. (2013). JFGI: From distributed cognition to distributed reliabilism.

Michaelian, K., & Sutton, J. (2013). Distributed cognition and memory research: History and current directions. *Review of Philosophy and Psychology, 4*(1), 1-24.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis : an expanded sourcebook* (2nd ed. ed.). Thousand Oaks, Calif. ; London: Sage.

Miller, G. A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological Review, 63*(2), 81.

Miller, G. A. (1979, 1 June). *A Very Personal History*. Manuscript:. [Talk to Cognitive Science Workshop, MIT, 1 jun 1979.]. SALTworks at Stanford University Libraries.

Miller, G. A. (2003). The cognitive revolution: a historical perspective. *Trends Cogn Sci, 7*(3), 141-144.

Nalin, K. (2006). *Den ideala kliniska beslutsprocessen. En studie av arbetsprocessen på en kirurgisk akutmottagning (The ideal clinical decison process. A study of the work process in an acute surgical ward).* (Master's thesis), University of Gothenburg.

Nardi, B. A. (1996). Studying context: A comparison of activity theory, situated action models, and distributed cognition. *Context and consciousness: Activity theory and human-computer interaction*, 69-102.

Newell, A. (1980). Physical Symbol Systems*. *Cognitive Science, 4*(2), 135-183.

Newell, A., Shaw, J. C., & Simon, H. A. (1959). *Report on a general problem-solving program.* Paper presented at the IFIP Congress.

Newell, A., & Simon, H. A. (1956). The logic theory machine--A complex information processing system. *Information Theory, IRE Transactions on, 2*(3), 61-79.

Newell, A., & Simon, H. A. (1976). Computer science as empirical inquiry: Symbols and search. *Communications of the ACM, 19*(3), 113-126.

Nilsson, M., Laere, J. v., Susi, T., & Ziemke, T. (2012). Information fusion in practice: A distributed cognition perspective on the active role of users. *Information Fusion, 13*(1), 60-78.

Olovsson, P., & Arvola, M. (2007). *Design Against Fragmentation: Case Study of ICT in Healthcare.* Paper presented at the Work with Computer Systems, Stockholm, May 21-24, 2007.

Osbeck, L. M., & Nersessian, N. J. (2014). Situating distributed cognition. *Philosophical Psychology, 27*(1), 82-97.

Oxford Online Dictionary. (2017). Definition complex, dynamic, network. Retrieved from https://en.oxforddictionaries.com/definition/ Accessed January 24, 2017

Parsons, T. (1956). Suggestions for a Sociological Approach to the Theory of Organizations-I. *Administrative science quarterly, 1*(1), 63-85.

Patel, V. L., & Kannampallil, T. G. (2014). Human factors and health information technology: current challenges and future directions. *Yearbook of medical informatics, 9*(1), 58.

Patel, V. L., Kaufman, D. R., & Arocha, J. F. (2002). Emerging paradigms of cognition in medical decision-making. *J Biomed Inform, 35*(1), 52-75.

Patel, V. L., Kaufman, D. R., & Kannampallil, T. G. (2013). Diagnostic reasoning and decision making in the context of health information technology. *Reviews of Human Factors and Ergonomics, 8*(1), 149-190.

Patton, M. Q. (2002). *Qualitative research & evaluation methods* (3. ed.). London: SAGE.

Peterson, M. (2009). *An Introduction to Decision Theory*: Cambridge University Press.

Putnam, H. (1975). *Philosophical papers. Vol. 2, Mind, language and reality*. Cambridge,.

Pylyshyn, Z. W. (1998). *Constraining Cognitive Theories: Issues and Options* (Vol. 6): Greenwood Publishing Group.

Russell, S., & Norvig, P. (1995). Artificial intelligence: a modern approach.

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search, and attention. *Psychological Review, 84*(1), 1.

Shafir, E., & LeBoeuf, R. A. (2002). Rationality. *Annu Rev Psychol, 53*(1), 491-517.

Shortliffe, E. H., & Buchanan, B. G. (1975). A model of inexact reasoning in medicine. *Mathematical Biosciences, 23*(3–4), 351-379.

Silverman, D. (2010). *Doing qualitative research : a practical handbook* (3rd ed. ed.). London: SAGE.

Simon, H. A. (1944). Decision-making and administrative organization. *Public Administration Review, 4*(1), 16-30.

Simon, H. A. (1952). A Comparison of Organisation Theories. *The Review of Economic Studies, 20*(1), 40-48.

Simon, H. A. (1955). A behavioral model of rational choice. *The quarterly journal of economics*, 99-118.

Socialstyrelsen. (2014). Retrieved from http://www.socialstyrelsen.se/english Accessed January 24, 2017

Spencer, R., Logan, P., & Coiera, E. (2002). *Supporting communication in the emergency department*: Centre for Health Informatics, University of New South Wales.

Sutton, J. (2006). Distributed cognition: domains and dimensions. *Pragmatics & Cognition, 14*(2), 235-247.

Turing, A. M. (1936). On computable numbers, with an application to the Entscheidungsproblem. *J. of Math, 58*, 345-363.

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty - Heuristics and Biases. *Science, 185*(4157), 1124-1131.

Weizenbaum, J. (1966). ELIZA—a computer program for the study of natural language communication between man and machine. *Communications of the ACM, 9*(1), 36-45.

Von Neumann, J. (1993). First Draft of a Report on the EDVAC. *IEEE Annals of the History of Computing, 15*(4), 27-75.

Von Neumann, J., & Morgenstern, O. (1947). *Theory of games and economic behavior*. [S.l.]: Princeton University Press.

Zhang, J., & Patel, V. L. (2006). Distributed cognition, representation, and affordance. *Pragmatics & Cognition, 14*(2), 333-341.

Zsambok, C. E. (1997). Naturalistic decision making: where are we now? In C. E. Zsambok & G. Klein (Eds.), *Naturalistic decision making research and improving team decision making* (pp. 3-16).

Appendix 1 – a transcription model

#1 - 1_1 – triage

(read as Clip nr - Patient nr_study session clip nr – activity)

@ Recorded activity ID: #1 - 1_1 – triage
@ Recorded activity date: YYYY-MM-DD
@ Duration: HH:MM:SS
@ Participants: Participants + researcher
@ Transcription date: YYYY-MM-DD
@ Coded: yes
@ Recorder: Recorder name
@ Transcriber: Transcriber name
# 00:00:00
1 Speaker1: utterance
2 Speaker2: utterance
§ End
# Same as Duration