

How is professionals' information seeking shaped by workplace procedures?  
A study of healthcare clinicians

Hertzum, Morten; Simonsen, Jesper

*Published in:*  
Information Processing & Management

*DOI:*  
[10.1016/j.ipm.2019.01.001](https://doi.org/10.1016/j.ipm.2019.01.001)

*Publication date:*  
2019

*Document Version*  
Early version, also known as pre-print

*Citation for published version (APA):*  
Hertzum, M., & Simonsen, J. (2019). How is professionals' information seeking shaped by workplace procedures? A study of healthcare clinicians. *Information Processing & Management*, 56(3), 624-636. <https://doi.org/10.1016/j.ipm.2019.01.001>

**General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain.
- You may freely distribute the URL identifying the publication in the public portal.

**Take down policy**

If you believe that this document breaches copyright please contact [rucforsk@kb.dk](mailto:rucforsk@kb.dk) providing details, and we will remove access to the work immediately and investigate your claim.

Pre-print of final submitted manuscript.

Please **Cite this article as:**

Hertzum, M., and J. Simonsen (2019): "How is professionals' information seeking shaped by workplace procedures? A study of healthcare clinicians," *Information Processing & Management*, Vol. 56, Issue 3, May 2019, pp. 624-636.

## How Is Professionals' Information Seeking Shaped by Workplace Procedures? A Study of Healthcare Clinicians

Morten Hertzum, University of Copenhagen, Denmark, [hertzum@hum.ku.dk](mailto:hertzum@hum.ku.dk) (corresponding author)

Jesper Simonsen, Roskilde University, Denmark, [simonsen@ruc.dk](mailto:simonsen@ruc.dk)

**Abstract.** Professional work is often regulated by procedures that shape the information seeking involved in performing a task. Yet, research on professionals' information seeking tends to bypass procedures and depict information seeking as an informal activity. In this study we analyze two healthcare tasks governed by procedures: triage and timeouts. While information seeking is central to both procedures, we find that the coordinating nurses rarely engage in information seeking when they triage patients. Inversely, the physicians value convening for timeouts to seek information. To explain these findings we distinguish between junior and expert professionals and between uncertain and equivocal tasks. The triage procedure specifies which information to retrieve but expert professionals such as the coordinating nurses tend to perform triage, which is an uncertain task, by holistic pattern recognition rather than information seeking. For timeouts, which target an equivocal task, the procedure facilitates information seeking by creating a space for open-ended collaborative reflection. Both junior and expert physicians temporarily suspend patient treatment in favor of this opportunity to reflect on their actions, though partly for different reasons. We discuss implications for models of professionals' information seeking.

**Keywords:** information seeking, information behavior, workplace procedures, expert performance, reflection on action, healthcare

### 1 Introduction

Professionals in business, engineering, government, healthcare, and many other domains rely extensively on information for their competent performance (Allen, 1977; Case & Given, 2016; Leckie et al., 1996). The research on information seeking purports to investigate, model, and explain how they go about acquiring this information. At the same time, the way in which professionals go about their tasks is often regulated by workplace procedures in order to follow best practice, improve safety, obtain certification, or standardize outputs. These procedures stipulate which steps to take and which information to consider. Yet, information-seeking research depicts information seeking as a predominantly informal activity that runs its course in relative isolation from the formal organization of work; workplace procedures are acknowledged but tend to reside in the background. This study

takes healthcare professionals – physicians and nurses – as an example and asks how their information seeking is shaped by clinical procedures.

Case and Given (2016, p. 6) define information seeking as “a conscious effort to acquire information in response to a need or gap in your knowledge”. This definition and others like it (e.g., Wilson, 2000) make information seeking an intentional activity, driven by a recognized need, consisting of the explicit acquisition of information, and accomplished when the gap has been closed. In contrast, pattern recognition is “the perceptual ability to recognise configurations or links between the variables in a situation from previous knowledge or experience, without explicitly stating them beforehand” (Noon, 2014, p. 43). While the above definition of information seeking sets it apart from pattern recognition, we acknowledge that some authors use information seeking in a broader sense that includes pattern recognition (and is near synonymous to information behavior). The relation between information seeking and pattern recognition is important to the present study because workplace procedures favor conscious efforts and, thereby, information seeking. For professionals, the need or gap that gives rise to information seeking relates to their work tasks, which are a common context for the information-seeking process in models of professionals’ information seeking (e.g., Freund, 2015; Hansen & Järvelin, 2005; Leckie et al., 1996). For the healthcare professionals in this study the tasks consist of treating patients; for other professions the tasks consist of producing pharmaceuticals, engineering software, crafting legislation, and so forth. These professionals differ from professional searchers, who have information retrieval as their profession. This difference separates studies of professionals’ information seeking from those of professional search (see, Russell-Rose et al., 2018).

In healthcare settings breakdowns in information seeking may cause harm to patients (Hertzum, 2010). To safeguard against errors, including those caused by information-seeking breakdowns, healthcare organizations invest considerable resources in devising and implementing clinical guidelines – procedures. We will focus on two procedure-governed tasks in the emergency department (ED):

- *Triage*, which is the task of determining the urgency of an ED patient’s condition to prioritize among the patients and determine the order in which they will receive care.
- *Timeouts*, during which the ED physicians suspend patient treatment for 10-15 minutes to meet and collaboratively assess and discuss each patient currently in the ED.

Over an eight-year period we have studied the work at four EDs in Denmark. Each of these EDs sees about 35,000 patients a year, all of whom must be triaged upon arrival and re-triaged when needed. Thus the clinicians in each ED perform triage more than a hundred times a day. Timeouts take place twice a day. Triage and timeouts are genuine examples of tasks that involve information seeking. At the same time the two tasks differ in the important sense that the triage procedure specifies which questions to ask – it is only the answers that are unknown – whereas the timeout procedure aims to create open-ended reflection – neither questions nor answers are known up front. That is, triage is an uncertain task and timeout an equivocal task (Daft & Lengel, 1986). Another difference of importance to our analysis is the clinicians’ level of expertise. We account for this difference by distinguishing between junior and expert clinicians.

## 2 Research question

Whereas previous research on professionals’ information seeking tends to bypass its relation to workplace procedures, the present study addresses this relation for the ED procedures of triage and timeouts. We investigate how triage and timeouts shape the clinicians’ information seeking. More specifically, we ask:

- How is the clinicians’ information seeking shaped differently by a procedure for an uncertain task (triage) and an equivocal task (timeouts)?
- How do these procedures shape information seeking differently for junior and expert clinicians?

As the analysis will show the two questions are interrelated. While the triage procedure shapes information seeking as a rule-following activity that facilitates the junior clinicians, the timeout procedure turns information seeking into an open-ended reflection that is dependent on the clinicians' expertise. Thus, the second question accentuates a central aspect of the first question.

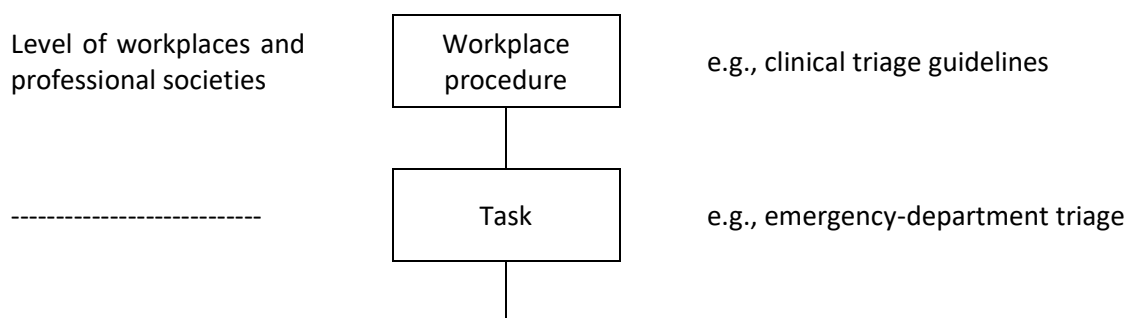
### 3 Related work

Information seeking and workplace procedures are linked through the notion of tasks. However, research on professionals' information seeking emphasizes task characteristics other than procedures.

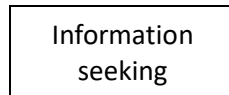
#### 3.1 Tasks and professionals' information seeking

Tasks are central to models of professionals' information seeking. In the model by Leckie et al. (1996) professionals' tasks arise out of their work roles and prompt particular information needs, which in turn give rise to an information-seeking process. This process is influenced by a number of interacting variables that affect the outcome and, through feedback loops, the information need. Relevant changes of the information need will be those that simplify task completion or improve quality. Case and Given (2016) review twelve information-seeking models, two of which are about professionals' information seeking and mention tasks. Both of these models define the relations among work tasks, information needs, and information seeking similarly to Leckie et al. (1996). However, the model by Byström and Järvelin (1995) places a greater emphasis on a rational process that progresses from identifying and ranking alternatives through to choosing among them. Conversely, the model by Freund (2015) includes hands-on experience, which the studied software engineers often preferred over consulting documents or people, but it excludes feedback loops. In the ten other models the task is not explicitly represented but still appears to be central. For example, the model of the information search process (Kuhlthau, 1991) is the result of studies of students "who had been assigned a term paper" (p. 364). It must be assumed that this task shapes the students' search process and their progression through its stages and associated feelings.

Professionals' information seeking is intricately interrelated with their process of performing their tasks. Models of information seeking tend, however, to bypass these interrelations in favor of depicting professionals' information seeking in isolation from their professional work. That is, the models explain information seeking in a manner that is independent of the specifics of the professional tasks. For example, Reddy and Jansen's (2008) insightful model for "understanding collaborative information behavior in context" was developed on the basis of an empirical study of two healthcare teams but is devoid of information specific to the healthcare context. The model describes information seeking at such a distance from the clinicians' medical tasks that their information seeking is dissociated from the clinical knowledge, procedures, and particulars that determine how the two teams go about the treatment of their patients. This dissociation increases the model's scope of application but it also precludes the model from explaining how information-seeking processes interact and align with work-task processes. In the present study we approach tasks as the link between the work context, specifically workplace procedures, and the professionals' information seeking (Figure 1).



Level of individual and collaborating actors



e.g., actual patient assessment (triage)

**Figure 1.** Tasks as the link between workplace procedures and information seeking

The three components in Figure 1 are also discussed by Byström and Hansen (2005) in their conceptual task framework, which distinguishes among three hierarchical levels: work tasks, information-seeking tasks, and an even more fine-grained level of information-search tasks. Procedures are mentioned, along with norms and values, as examples of environmental factors that shape the performance of work tasks. Due to the hierarchical structure of the framework the work tasks, in turn, shape the information-seeking tasks; thereby, procedures may indirectly influence the performance of information-seeking tasks. In the present study the interrelations between procedures and information seeking is of primary interest. Thus, we abandon the hierarchical structure in favor of conceiving the (work) task as the link – or, more figuratively, the meeting ground – between workplace procedures and information-seeking practices. Borrowing terms from practice theory (Feldman & Orlikowski, 2011) we seek to foreground the interrelations between the procedure in principle and the procedure in practice. While the procedure in principle is a formal guideline, plan or established norm, the procedure in practice is the manner in which the work is concretely performed in response to the procedure in principle and the particulars of the situation. For further work with a practice approach to information seeking, see for example Talja and McKenzie (2007).

### 3.2 Workplace procedures

Many tasks are regulated by workplace procedures, which may be developed at the workplace in response to local conditions, instituted by national agencies to obtain standardization, or recommended by international societies as best practice. As an example of procedures clinical guidelines are systematically developed statements to assist practitioner decisions about the appropriate healthcare for specific clinical circumstances. Studies of the use of guidelines mostly find that they improve practice. For example, Grimshaw and Russell (1993) reviewed 59 studies of the use of guidelines and found that guidelines improved the treatment process in 55 of the studies. In spite of the strong evidence in favor of the use of guidelines, studies repeatedly show that it is difficult to change clinician behavior into complying with guidelines (Baatiema et al., 2017; Fischer et al., 2016; Grol & Grimshaw, 2003). This tension emphasizes the distinction between the procedure’s prescription of how a task should be performed (i.e., the procedure in principle) and the professional’s actual information behavior in performing the task (i.e., the procedure in practice).

A procedure is an abstraction devised to be applicable across a class of actual instances, each with its unique characteristics. Consequently, procedures are deliberately underspecified compared to concrete situations (Suchman, 2007). It is by representing classes of instances that procedures become cost-effective; otherwise, each procedure would only apply to a single instance. However, their classness also means that procedures do not represent any instance in all its concrete detail. Professional discretion is necessary to fill the gap between procedure and instance, that is, to apply the procedure. In Suchman’s (2007, p. 72) words procedures are merely “resources for situated action”, that is, they facilitate situated action but “do not in any strong sense determine its course”. To spell out how a procedure facilitates situated action each information-seeking instance may be viewed as a specific configuration of components – such as information need, people, completion criteria, location, and time – that have to be properly integrated to succeed. Hertzum and Reddy (2015) argue that procedures facilitate information seeking by pre-specifying some of these components. Thereby, fewer components require ad hoc specification.

Instances of non-compliance with procedures may be perceived as unwelcome deviations or indicators of skill-based expert behavior. Studies find that thinking oscillates between an “analytic” mode, which

resonates with procedures, and a “holistic” mode, which is governed by an intuitive grasp of the situation and foreign to procedures (Allen, 2011; Berryman, 2008; Kahneman, 2011; Mishra et al., 2015). Analytic thought rests on rules and their meticulous application. Whereas novices tend to behave in an analytic manner – consciously, effortfully, slowly – and to benefit from the presence of procedures, expert behavior tends to be holistic, fast, and best characterized as pattern recognition (e.g., Benner, 1982; Klein, 1998; Miller & Hill, 2018). Expert behavior emerges through the encounter of numerous actual instances, which add nuance to any procedural stipulations and gradually transform them into a skill that can no longer be captured in steps and rules (Benner, 1982; Ericsson, 2008). Novices tend to appreciate and apply procedures (Nordsteien & Byström, 2018); when they resort to holistic thinking they often lack the experience to do it competently. Conversely, insisting that experts comply with procedures and think analytically may degrade their performance but also help avoid occasional oversights (Hammond et al., 1987; Loukopoulos et al., 2009).

### 3.3 Information seeking

Professionals’ information seeking is influenced by the complexity, importance, and urgency of their tasks (e.g., Agarwal et al., 2011; Li, 2008; Vakkari, 2003). For example, Agarwal et al. (2011) find that with increasing task importance, source quality became more important to source selection. Byström (2002) finds that with increasing task complexity professionals increasingly seek information from people rather than documents. More disturbingly, Lee (2002) finds that the social costs of help seeking were perceived as higher for core task than for more peripheral tasks. As a consequence the physicians and nurses at a hospital asked less for help when they had a problem with a core task. The link from core tasks, through social costs, to less help seeking illustrates the potentially severe consequences of task characteristics on information seeking and the resulting task performance. It also resembles the consistent finding that source accessibility has a strong influence on information seeking, in addition to the influence exerted by source quality (Hertzum, 2014). In addition, Liu et al. (2015) find that task difficulty was perceived differently by novice and experienced users. Whereas novice users pointed to complexity and little experience as top reasons for task difficulty, experienced users pointed to uncertainty about the information need, too much unrelated information, and system performance. These differences suggest that the experienced users had a more concrete understanding of the causes for task difficulty, possibly because they knew better how to deal with the tasks.

Several studies refer to media richness theory (Daft & Lengel, 1986; Trevino et al., 1987) in explaining how task characteristics influence information seeking, specifically source selection. Media richness theory distinguishes between uncertain tasks, which are characterized by a lack of information (the question is known but the answer is not), and equivocal tasks, which are characterized by a lack of understanding (the question and answer are both unknown). While uncertain tasks allow collaborating actors to complete tasks while communicating through lean media, equivocal tasks make it necessary for the actors to communicate through rich media (Daft & Lengel, 1986). Studies of professionals’ information seeking equate people with rich media and documentary sources with lean media (e.g., Anderson et al., 2001; Yuan et al., 2011). On this basis, O’Reilly (1982) found that an increase in task uncertainty was associated with an increase in healthcare decision makers’ use of documents, but not people, as sources of information. Christensen and Bailey (1997) found that the use of people as information sources increased with increasing task equivocality. Both these findings are consistent with media richness theory. Christensen and Bailey (1997) also found that when people, but not documents, were made less accessible then participants to a larger extent selected the leaner but more accessible documentary sources. That is, the influence of source accessibility on source selection was stronger than that of task equivocality.

In healthcare, studies find that although clinicians are “effective at finding answers to questions they pursue, roughly half of the questions are never pursued” (Del Fiol et al., 2014, p. 710). That is, clinicians often make do with the information at hand or they defer information seeking when immediate action is not deemed necessary. The reasons for not pursuing questions include lack of time and doubt that a useful answer exists (Davies, 2007; Del Fiol et al., 2014).



### 3.4 Triage and timeouts

Triage arose in the military to distribute scarce healthcare resources proficiently among wounded soldiers on the battlefield (Iserson & Moskop, 2007). While EDs fortunately face less extreme situations they still benefit from the effectiveness of triage procedures in creating some order in hectic situations. Several triage procedures exist, including the Canadian Emergency Department Triage and Acuity Scale and the Emergency Severity Index (Farrohknia et al., 2011). Common to the triage procedures are that a selection of the patient's vital signs are measured and assessed against threshold values. On this basis the patient is assigned to one of, usually, five triage levels. In spite of the explicitness of triage procedures clinicians' use of these procedures results in somewhat inconsistent decisions about the patient's triage level (Dong & Bullard, 2009; Göransson & von Rosen, 2011; Wuerz et al., 1998). In addition, Johannessen (2016) finds that triage nurses apply discretion in their triage decisions rather than use triage procedures in a literal and rule-following manner. The triage level regulates how quickly patients receive care and contributes to explaining the variation in their length of stay in the ED (Hertzum, 2016).

The timeout, an intentional pause in patient treatment, aims to prevent errors and oversights by creating an occasion for communication among the clinicians involved in treating a patient (Dillon, 2008). Timeouts were initially introduced on operating wards to prevent wrong-site, wrong-procedure, and wrong-patient surgery but have spread to the ED (Browne, 2014; Kelly et al., 2011). In most cases the timeout is a structured event that consists of walking through a checklist to verify that the treatment procedure about to be initiated is the one intended. However, Sehgal et al. (2011) call for nonprocedural timeouts with a looser format and the goal of addressing questions such as "What do you anticipate happening in the next 24 hours?" The timeouts we investigate in the present study are an instance of such nonprocedural timeouts. In the ED, the timeout is a less established procedure than triage. For example, Kelly et al. (2011) find that 13% of the surveyed physicians were unaware of any formal timeout procedure in their ED and only 35% of them believed that timeouts were warranted in their ED. In contrast, Hertzum and Simonsen (2016) find that timeouts, supported by an electronic whiteboard, were an important coordinative activity in the studied ED.

## 4 Method

In the context of a large research project (2009-2017) we have studied the work in the EDs in Region Zealand, one of five healthcare regions in Denmark. This research involved observation, interviews, surveys, participatory-design workshops, and effects measurements. The present study is based on the observation data from two of the EDs but draws on the entire project for contextual understanding. Prior to the observations the project was approved by the healthcare region and the EDs.

### 4.1 Research sites

In one of the EDs we observed the work at the control desk, which was the information hub of the ED and the location at which the coordinating nurse was stationed. One of the coordinating nurse's tasks was to *triage* the patients upon arrival. In the terms of media richness theory, triage was an uncertain rather than equivocal task. Its execution was specified in detail in the triage procedure. The role of coordinating nurse was demanding and only assigned to highly experienced nurses, who had this role for a full shift or half a shift at a time. Overall, the coordinating nurse was responsible for maintaining the flow of patients through the ED and for assigning physicians and nurses to patients according to patient needs and clinician workload. These responsibilities meant that it, for example, was the coordinating nurse who got informed about the patients about to arrive, received the patients arriving by ambulance, kept an eye on the condition of the walk-in patients in the waiting room, and prioritized and reprioritized the patients.

In another of the EDs our observations addressed how the electronic whiteboard with selected patient information supported the clinicians in coordinating and following up on patient treatment. One of the tasks that involved the whiteboard was the *timeouts* for which the physicians convened every day at

10:45 and 15:00. The rationale for the timeouts was that determining the condition and proper treatment of a patient was an equivocal activity. Considering too little information or interpreting it too narrowly incurred a risk of maltreatment. The timeout procedure provided a collaborative setting for the physicians to reflect and seek information. The timeouts were attended by the ED physicians and by physicians from other departments who were assigned to the ED for part of their shifts. In terms of experience the physicians comprised highly-experienced chief physicians as well as junior physicians, who worked in the ED for six months as part of their medical training.

## 4.2 Data collection and analysis

We collected data by means of general observation supplemented with shadowing. As an integral part of the observation and shadowing we occasionally asked the clinicians clarifying questions about the work they were performing and, thereby, obtained explanations and informed opinions. Ahead of the data collection we presented the research project in the departments' electronic newsletter. We repeated and elaborated this information at the clinicians' morning meetings and, when requested, during the observations.

We made 116 hours of observation in the ED that provided data about triage. For the majority of these observations, we were positioned near the control desk. From this position we could follow the activities and conversations of the coordinating nurse and the other clinicians working or briefly meeting at the control desk. For the remainder of the observations in this ED we moved around in the department to get a sense of the activities performed away from the control desk. In the ED that provided data about the timeouts we made 94 hours of observation. Most of this time was spent observing work at the two locations where the electronic whiteboard was permanently displayed on large, wall-mounted screens. The timeouts took place at one of these locations. The remaining time was spent shadowing individual physicians and nurses by following them around for two-hour periods as they went about their work. The observation sessions were documented in field notes written during the sessions. In addition to documenting the clinicians' activities the field notes included information about the clinicians' role (e.g., "coordinating nurse") or rank (e.g., "chief physician") and, thereby, about their level of experience. Information about the clinicians' role and rank was partly apparent from their activities and partly known to us as a result of our longitudinal involvement with the EDs. We acknowledge that the focus on how procedures shaped information seeking emerged retrospectively and, thus, did not define how the data were collected.

For this study we initially read through the field notes from all the studied EDs to identify procedures that involved information seeking. Triage and timeouts stood out, though a couple of other procedures were also identified (e.g., the procedure defining the coordinating nurse's role). The data about triage and timeouts were mainly from the two EDs that, as a result, became the research sites for this study. In the analysis we looked for instances of information seeking and other components that entered into constituting triage and timeouts. Characteristics of these instances were captured in annotations, which for example indicated the clinicians involved, the information sought, and the conclusion reached. Subsequently, we analyzed the instances for regularities in how the procedures shaped the clinicians' information seeking. This analysis revealed that triage was often accomplished without information seeking. We, then, reread the field notes to understand how triage was accomplished and to verify our understanding of how the timeouts shaped information seeking. The rereading bolstered the validity of the analysis by confronting the results of the analysis with the field notes from which the results were derived. We contend that the results are internally valid but recognize that they cannot be presumed to generalize to other hospitals and procedures. In the two next sections we present the results of our analysis.

## 5 Triage

Triage served to prioritize the patients by quickly and accurately determining how urgently each patient needed care. Such prioritization was pertinent because the ED clinicians had little or no pre-



knowledge of the patients when they arrived. As a consequence the clinicians tended to err on the side of caution by approaching the patients' condition as potentially worse than it initially appeared. Still, it was vital for the few patients with severe complaints to receive immediate treatment, while the high volume of patients with more trivial complaints could easily draw most of the resources and attention. The triage procedure provided a standardized way of assessing a patient by obtaining information about a few core features of the patient's condition. While individual clinicians might obtain this information for different patients, it needed to be collaboratively grounded in a manner that allowed for patient prioritization. The triage procedure provided this grounding.

Figure 2 shows the triage procedure, which was permanently posted in the ED, for example at the control desk. The application of the procedure resulted in characterizing the patient with one of five triage levels: red (life threatening), orange (seriously ill), yellow (ill), green (in need of assessment), or blue (fast track). The triage level was determined by assessing the patient's airways, breathing, circulation, disability, and exposure (the ABCDE approach). For each of these five areas, the procedure specified the information to be obtained and the threshold values against which to interpret it. For example, the breathing category included the respiratory rate (RR) with the threshold values, from most to least severe: (a) above 35 or below 8 breaths per minute, (b) above 30, (c) above 25, (d) between 8 and 25, and (e) no threshold specified. This way, the triage procedure standardized the information seeking involved in determining the urgency of a patient's condition. Otherwise, there would have been one patient with "an unboiled piece of pasta stuck in his airways", another with "a worryingly low blood pressure after a fall in her home", and yet another who had been "kicked by a horse". Prioritization based on such diverse descriptions would lack common ground and invite discussion. For red and orange patients the triage procedure also quantified how quickly the patient must be seen by a physician, thereby extending the information seeking with stipulations about the subsequent care.

**Triage**

	Acute team Presence 0-5 min.	Acute team Monitoring 15-30 min.	Inspection every 30 min. Monitoring In turn	No inspection In turn Monitoring Max 4 hours	Discharge after treatment In turn
<b>A</b>	Obstructed airways Stridor	Unsafe airways	Clear airways	Clear airways	
<b>B</b>	SpO2 < 80% w/o oxygen RR > 35 or < 8	SpO2 < 90% w/o oxygen RR > 30	SpO2 < 95% w/o oxygen RR > 25	SpO2 ≥ 95% w/o oxygen RR 8-25	
<b>C</b>	ST* > 130 AF** > 180 systolic Systolic BP < 80	HR > 120 or < 40 Systolic BP < 90	HR > 110 or < 50	HR 50-110	
<b>D</b>	Unconscious Status epilepticus	Reacts to pain Strongly agitated Acutely unclear	Reacts when addressed Moderately agitated	Awake and alert	
<b>E</b>	Temp < 34	Tp. > 40 or < 35	Tp. > 38.5	Tp. < 38.5	
	<b>PRIORITY 1</b>	<b>PRIORITY 2</b>	<b>PRIORITY 3</b>	<b>PRIORITY 4</b>	
For severe COPD: 5% lower saturation limits than otherwise:					
	SpO2 < 75% w/o oxygen RR > 35 or < 8	SpO2 < 85% w/o oxygen RR > 30	SpO2 < 90% w/o oxygen RR > 25	SpO2 ≥ 90% w/o oxygen RR 8-25	By default patients are treated in turn, i.e. yellow are not treated before green

\*ST = Sinus tachycardia \*\*AF = Atrial fibrillation/flutter

**Figure 2.** The ED triage procedure (translated from Danish)

Several nurses explained to us how they habitually repeated the five headings of the ABCDE approach to themselves when triaging a patient (airways, breathing, circulation...), thereby applying the top level of the triage procedure. On many occasions the nurses also explicitly applied at least a subset of the triage criteria. They, for example, obtained information about the patients' blood pressure by

measuring it and about their level of consciousness by asking them simple questions, such as “*Do you know which day it is today?*” When less experienced nurses informed a colleague about the triage level of a patient whom they had triaged they also frequently reported one of their triage measurements, presumably to provide evidence for the triage level. However, on other occasions and in spite of the specific triage criteria patients were triaged on the basis of a more holistic impression of their condition. These triage decisions were mostly made by the coordinating nurses, who were highly experienced. The coordinating nurses made their triage decisions from information that was incomplete as regards the prescriptions of the triage procedure, and they often changed a patient’s triage level by merely glancing at the patient, as illustrated by the following field note:

It is announced that the paramedics are en route with a patient who has fallen in her home. The patient’s blood pressure is worryingly low. Before the patient arrives the coordinating nurse selects Room 10 for the patient, sets the triage level to red, and finds a nurse and physician for the patient. [Seven minutes later] the patient arrives and the patient, nurse, and physician immediately enter Room 10. As they go to Room 10, the coordinating nurse records the patient on the whiteboard and triages her as orange.

The change in triage level from red to orange resulted from the additional information that became available to the coordinating nurse upon seeing the patient for herself when the paramedics arrived with the patient. This information added to the information she had been able to obtain from the paramedics prior to their arrival, but it did not include explicit application of any of the criteria in the triage procedure. The paramedics wheeled the stretcher with the patient up to the control desk where the coordinating nurse instructed them to proceed to Room 10; the coordinating nurse looked at the patient but did not measure the oxygen saturation of her blood (SpO<sub>2</sub>) or explicitly assess any of the other ABCDE areas. It appeared that the information needed by the coordinating nurse to change the triage level was available to her at a glance: She recognized the patient as orange rather than established it through examination. In her revised assessment of the patient she rather became more confident than more evidence-based.

In another instance the arrival of a new patient had been announced on the phone. Because the patient had chest pain the coordinating nurse suspected heart problems – a life-threatening condition – and advised the cardiology department. When the paramedics arrived in the ED with the patient they were told to go straight to Room 1. Then:

The coordinating nurse records the new patient on the whiteboard: Room 1, triage level red. A nurse enters Room 1 to attend to the patient. The medical lab technician also enters Room 1 and asks whether to draw blood samples. She comes back out and reports that the patient “is in a poor state and throws up”; they have decided to wait a moment before they draw blood and take an ECG. Because the nurse in Room 1 does not call for a physician within the next few minutes the coordinating nurse re-triages the patient to yellow, after having announced this decision to a nurse who is standing nearby. They now believe that “it probably wasn’t the heart anyway.”

The coordinating nurse initially triaged the patient as red on the basis of the information she received on the phone combined with glancing at the patient when the paramedics wheeled the patient into Room 1. In contrast to the first example, glancing at the patient did not change the coordinating nurse’s assessment of the triage level. When she a few minutes later changed the patient’s triage level to yellow she was acting entirely on indirect evidence. The triage procedure prescribed that a red patient must be seen by a physician within 0-5 minutes of arrival in the ED. Thus, when the nurse in Room 1 did not request a physician for the patient straightaway, the coordinating nurse inferred that the patient was better than initially assumed. The reassessment of the patient involved that the coordinating nurse knew the triage procedure, that she trusted the nurse in Room 1 to act in accordance with its temporal prescriptions, that she had sufficient experience with her colleagues to value the nurse’s inaction over the medical lab technician’s utterance, and that she was confident to

re-triage by reading the situation rather than herself assessing the patient. A few minutes later a physician passed by, looked at the whiteboard, and asked whether she should go see the patient in Room 1. The coordinating nurse informed her to “Take Room 4 first”; the patient in Room 1 was no longer a primary priority.

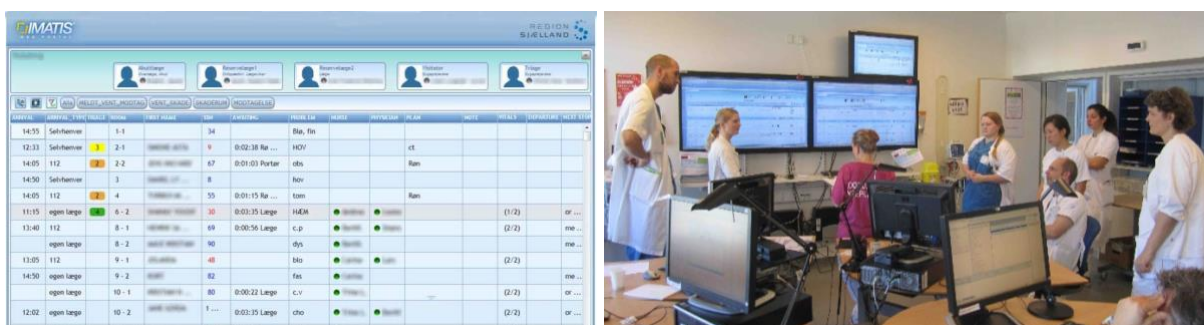
In yet another instance a patient had already been triaged by an ED physician but the coordinating nurse came to a different conclusion, even though both clinicians expressed their assessment of the patient using the levels of the triage procedure. Such differences in the triage level assigned by different clinicians were not perceived as errors in the application of the triage procedure but as variations in professional judgement. It was not uncommon that the physicians assigned lower triage levels than the nurses:

A physician has just triaged the newly arrived patient in Room 8. In passing the control desk the physician says to the coordinating nurse that “Room 8 is yellow/orange”. The coordinating nurse nods and records the patient’s triage level on the whiteboard. The coordinating nurse is now looking for a physician and nurse to examine the patient in Room 8. She enters Room 1 to ask whether the physician or nurse in there can take Room 8. They cannot. The coordinating nurse briefly visits Room 8. As she returns to the control desk, she says that the patient “is red; he is shaking”.

The evidence (“he is shaking”) volunteered by the coordinating nurse as she returned to the control desk was not directed at anyone in particular but it was also not reflecting any of the criteria in the triage procedure. Again, the triage level conveyed the coordinating nurse’s holistic impression of the patient’s condition rather than the application of the triage procedure as such.

## 6 Timeouts

To clarify responsibilities in the ED each physician and nurse was assigned to named patients. These assignments were prominently displayed on the whiteboard, which gave one row of information about each patient (Figure 3). In addition to information about the physician and nurse responsible for the patient the whiteboard displayed the patient room, time of arrival, triage level, current treatment activity, status of blood tests, and a few other pieces of information. Further information could be sought by tapping the various cells on the whiteboard and thereby getting access to additional patient information in, for example, the electronic patient record and the laboratory information system.



**Figure 3.** The electronic ED whiteboard (left) and a timeout in front of the whiteboard (right)

In the busy ED environment the physicians were at risk of becoming preoccupied with their own patients or forming premature opinions about them. To counter these risks of insufficient information seeking the physicians met twice a day in front of the whiteboard and walked through the patients currently in the ED. If at all possible, the physicians suspended their treatment of their patients to participate in these timeouts. The chief component of the timeout procedure was the suspension of

patient treatment for 10-15 minutes to make room for reflection. These reflections were prompted by input from colleagues and by the information seeking fueled by this input. The flow of the timeouts evolved around the content of the whiteboard, usually starting with the patient in its top row and proceeding downward. As the following field note illustrates the clinicians, in walking through the patients, made frequent reference to the whiteboard information:

Two physicians are standing in front of the whiteboard. One of them, the chief physician, asks, if everyone is ready. He then starts to talk about the first patient on the whiteboard (the top row); they are waiting for blood-test results. If they come back normal, the patient can be discharged. He then points to the second row and mentions the name of the next patient. Another physician takes over and informs the others of his treatment of the patient. The chief physician offers advice about what can be done.

In contrast to the triage procedure, the timeout procedure did not specify which information to retrieve and which criteria to apply in interpreting it. On the contrary, the timeouts were devised to make the physicians consider which questions that needed to be asked. To stimulate these considerations the physician responsible for a patient briefly summarized the patient's status and current treatment. The other physicians listened to this summary, inspected the row of whiteboard information about the patient, and on that basis started to form their own interpretation of the patient's condition. Often they had little to add, thereby confirming that the responsible physician was reading the patient's symptoms correctly and providing the right treatment. On other occasions they asked questions or made comments to call the responsible physician's attention to other ways of reading the symptoms or other treatment options. The questions and comments tended to be advice and issues to consider, rather than instructions and directives. The physicians, for example, recommended consulting a specialist at the surgical department, asked about a patient's blood pressure to get a better overall sense of the patient, and inquired whether another patient had chest pain, which would suggest cardiac problems and therefore demand extra alertness. It was generally left for the responsible physician to follow up on these issues after the timeout, which was primarily devoted to raising issues for consideration. That said, the timeouts also had a hierarchical element in that they provided an opportunity for junior physicians to seek advice (e.g., on how to interpret the symptoms of a readmitted elderly patient and how to act on a suspicion of domestic violence) and for senior physicians to oversee the work of their less experienced colleagues.

The whiteboard provided ready access to additional information about the patients. Thus, some questions were investigated on the spot. During one of the timeouts, the chief physician on two occasions tapped a blood-test icon on the whiteboard and, thereby, opened a pop-up window displaying the test results. By performing this act of information seeking during the timeout the chief physician invited a collaborative assessment of the blood-test results. Such collaborative assessments bolstered the quality of clinical decisions and provided opportunities for the junior physicians to add nuance to their understanding of how to assess blood tests. Unless such instances of information seeking were believed to be quick to complete they were deferred to after the timeout. Sometimes they were initiated during a timeout but discontinued because they turned out to take longer than expected. This way, the timeouts depended on the ready access to patient information on the whiteboard, whereas the retrieval of information from other systems was considered incompatible with the timeout procedure. The timeouts were the only occasions where we observed physicians who inspected blood-test results on the whiteboard. On all other occasions they used a personal computer to look up such information in the laboratory information system. A junior physician explained to us that apart from during timeouts she would not use the whiteboard to inspect test results because she did not want to block her colleagues' access to the whiteboard and because she saw her inspection of test results as an individual task most suitable for a personal computer. This explanation emphasized the role of the timeouts in stimulating collaborative reflection and information seeking.

The timeout procedure ensured that the information seeking required for gaining an understanding of a patient's condition remained anchored in a collaborative practice even though most of the concrete treatment of the patients was delegated to individual physicians. A supplementary component in the timeouts was to extend the physicians' primary focus on the patients for whom they were individually responsible with an appreciation of how the ED as a whole was coping with the current demand on its resources. While information about the demand was persistently available on the whiteboard (e.g., in terms of the number and triage level of the patients), information about how strained the ED was in coping with this demand was more ephemeral. The chief physician expressed that he gleaned such information from his colleagues' utterances and behavior during the timeouts. Balancing the strain on the different sections of the ED and on the individual physicians was an inherent part of the timeouts:

They walk through the patients who are listed on the whiteboard. Among other things they agree that a patient can be moved to the 24-hour section of the ED (the patient was admitted during the night after drinking two bottles of Jack Daniels), assign a new physician to a patient with dysregulated diabetes, and discuss the results they expect from a pending blood test for a third patient.

Transferring patients among the sections of the ED helped distribute the load on the different sections, but moving a patient to the 24-hour section also implied that the patient was assessed to be fairly stable. Thus, it was a critical clinical decision that warranted collaborative discussion and review of the information about the patient's condition. Redistributing the workload among the physicians by making another physician responsible for treating a patient was one of the possible outcomes of the timeouts because they revealed the amount of work involved in treating the different patients and because the physicians who could possibly take over a patient were present at the timeouts. By gathering the physicians and, thereby, facilitating open-ended information exchange the timeouts were an effective forum for reaching an understanding of issues that concerned the ED as a whole rather than the individual physician. Furthermore, the discussion of the results expected from a pending blood test emphasized the key role of questions in the timeouts. The questions could not be answered until the physician who was responsible for the patient received the test results, but raising the questions served to protect this physician against acting on a single premature opinion and to provide the group of physicians with competing hypotheses about what such a blood test might indicate.

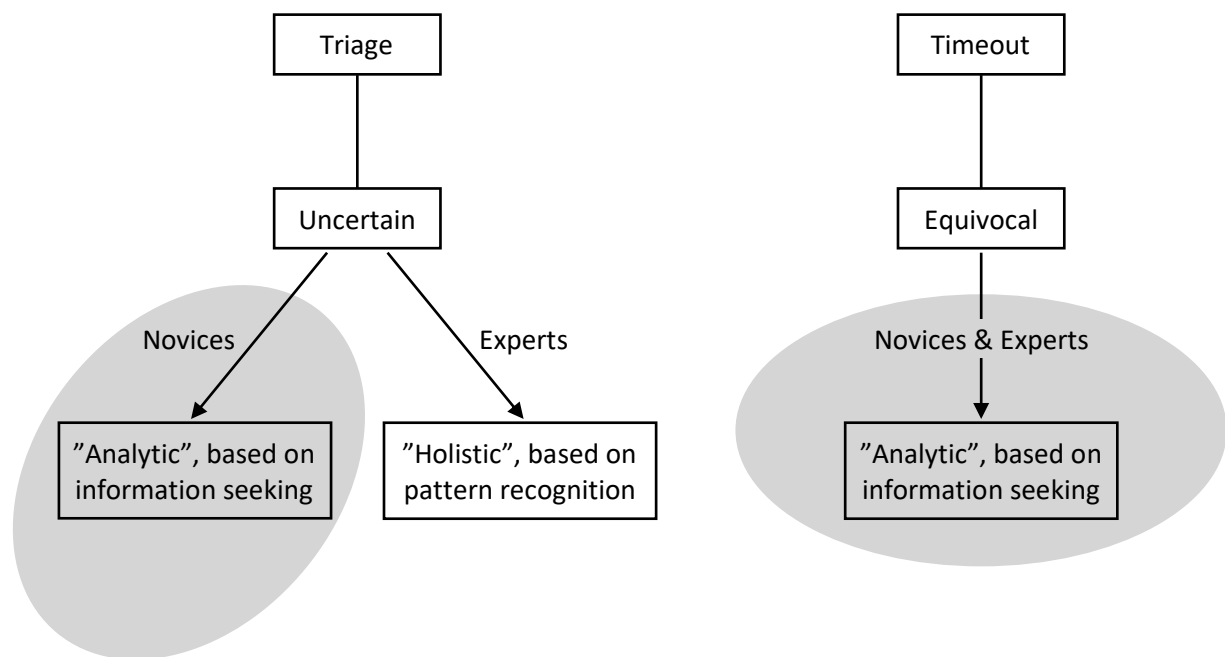
## 7 Discussion

Information seeking is central to the triage and timeout procedures. Yet, the coordinating nurses triaged patients without information seeking, which is defined as a conscious effort driven by a recognized need (Case & Given, 2016). Inversely, the physicians suspended patient treatment to be able to convene for timeouts and seek information consciously and collaboratively. In the following we discuss these interrelations among information seeking, tasks, and workplace procedures.

### 7.1 Information seeking, tasks, and procedures

The analysis of the EDs leads to five findings about how information seeking, tasks, and procedures interrelate. First, the triage and timeout procedures impose an analytic process (Figure 4). The triage procedure formalizes and standardizes information seeking by turning it into a rule-following task. For the clinician who approaches triage analytically, the rules make the knowledge required to triage a patient available in a manner that respects and strengthens this analytic approach. For the clinician who approaches triage holistically, the triage procedure talks a different language and is left unapplied. In a similar vein Johannessen (2016) finds that experienced nurses considered triage guidelines redundant or even obstructive to their practices. The timeout procedure schedules a break from the continual pressure to act during patient treatment. For the clinician who is working holistically, the timeouts create a space for reflection and, thereby, institute a temporary shift to analytic thinking and

information seeking. For the clinician who is already working analytically, the timeouts mainly facilitate reflection by turning it into a collaborative process among the physicians.



**Figure 4.** The triage and timeout procedures impose an analytic process by embodying knowledge in rules (triage) or by temporarily suspending action to make room for reflection (timeouts). The grey areas indicate the practices facilitated by the procedures.

Second, the triage and timeout procedures facilitate information seeking in different ways. For uncertain tasks the questions are known, the problem is lack of information (Daft & Lengel, 1986). By specifying which questions to ask and how to interpret the answers, the triage procedure exploits that triage is an uncertain task. This way triage becomes a structured information-seeking task for the clinicians, who can perform it efficiently, uniformly, and well by applying the triage rules. In contrast, the timeouts target an equivocal task. The equivocality means that the right questions to ask are not known in advance and therefore cannot be specified in the timeout procedure, which instead seeks to establish conditions that are conducive to reflection. By temporarily suspending patient treatment the timeout procedure exploits the difference between reflection in action and reflection on action (Schön, 1983). While the physicians' thinking may be holistic or hurried in the midst of patient treatment, reflection on action provides for taking a step back to think analytically and seek information. That is, for an uncertain task a procedure such as triage can *specify* what to ask, for an equivocal task a procedure such as the timeout can make room for *reflecting on* what to ask.

Third, for the uncertain task of triage information seeking is common among the novice and intermediate-level clinicians but rare among the experts. It is mainly the highly experienced coordinating nurses who triage patients holistically. They recognize a patient as, say, orange and rarely need to resort to explicit examination and information seeking to establish the patients' triage level. The process is somewhat akin to how experienced readers recognize words without explicitly reading the individual letters that make up the words. This finding accords with Mishra et al. (2015, p. 668), who find that "experienced commanders were more likely to use Type 1 [i.e., holistic] approaches to decision making and to make less use of information before a decision was made." Analytic thinking and information seeking are much more common among the less experienced nurses and junior physicians. In this way the present study suggests that models of professionals' information seeking



(e.g., Byström & Järvelin, 1995; Leckie et al., 1996) largely apply to less experienced professionals, including experienced professionals who face situations with which they have little experience. It is the definition of information seeking as a conscious effort to acquire information (Case & Given, 2016) that restricts the models to less experienced professionals. The experts behave differently; they triage by recognizing patterns. For expertise to develop, professionals must be in an environment with a certain amount of regularity and they must face similar tasks repeatedly (Kahneman, 2011). Otherwise they will not be able to build a sufficiently rich repertoire of instances from which to pattern match. In addition, valid feedback on previous performances shortens the path to expertise, and fast-paced tasks help by incentivizing pattern recognition, which is much faster than information seeking (Ericsson, 2008). Triage satisfies these conditions; thus, expertise will develop and information seeking fade away.

Fourth, the timeout procedure concerns an equivocal task and may facilitate expert physicians in periodically engaging in collaborative information seeking to reflect on their treatment of their patients and validate decisions they have arrived at through holistic thinking. Conversely, the timeout procedure is not likely to enable junior physicians to perform equivocal tasks competently, except by creating avenues for consulting more experienced colleagues. In their model of skill acquisition Dreyfus and Dreyfus (1986) distinguish between proficiency and expertise on the basis of professionals' inclination to validate their decisions. The proficient professional (the stage prior to expertise) sees value in validation; the expert proceeds confidently without validation. The timeout procedure insists that periodic reflection and validation are valuable irrespective of the physicians' level of expertise because errors and oversights, though infrequent, may cause death or disability to patients. The physicians appreciated the timeouts. Consistent with previous studies (e.g., Byström, 2002; Reddy & Jansen, 2008; Simonsen & Hertzum, 2010) the physicians found it particularly beneficial and reassuring to reflect on their actions in a collaborative format. Their shared access to information on the whiteboard during the timeouts facilitated this collaborative reflection.

Fifth, procedures underspecify the information seeking that goes into performing a task (Suchman, 2007). While the triage procedure specifies which information the clinicians should retrieve and how they should interpret it, it does not specify how to triage a patient who is yellow according to one criterion but orange according to another. In addition, it does not specify when a patient should be re-triaged and it leaves out factors that are habitually included in actual triage decisions. For example, the clinicians often rounded up when they triaged children to prioritize them over adults with similar injuries. Relatedly, the timeout procedure specifies where and when the physicians meet to walk through the patients but for example leaves unspecified what information to look for, what criteria to apply in interpreting it, and how to divide the limited duration of the timeout among the patients. By pre-specifying (Hertzum & Reddy, 2015) some of the components in triage and timeouts the procedures structure and simplify the clinicians' performance of these tasks. But the clinicians' professional knowledge and experience remain critical to their competent application of the procedures. The timeout procedure is a particularly strong example of a procedure that seeks to amplify professionals' competent use of their collective knowledge and experience rather than to regulate it.

## 7.2 Implications of procedures

To state the obvious, the presence of procedures in no way does away with the need for research into professionals' information seeking. As discussed above there are rich dynamics in the interaction between information seeking and workplace procedures. We see four implications of the study findings.

First, procedures pre-structure tasks and this pre-structuring should be incorporated in studies of information seeking. Byström and Hansen (2005) propose a conceptual framework for such studies and Li and Belkin (2008) mention procedures but merely in the sense of individuals' schemas for task performance, not in the sense of institutional guidelines. Workplace procedures are important to

include because the present study exemplifies that the pre-structuring shapes and, at least for novices, simplifies task performance. In relation to the present study our multi-year involvement with the hospital has been instrumental to acquiring the understanding of ED work necessary to appreciate the interrelations between specific procedures and the clinicians' accomplishment of their information-intensive tasks. The focus on procedures emerged as we, gradually, acquired this understanding. A longitudinal involvement may also enable studies to inform the creation of procedures by pinpointing which task aspects a procedure should pre-specify to achieve the largest reduction in information-seeking difficulty.

Second, procedures may set information seeking as forward-looking or mainly retrospective. It could be argued that these two modes of information seeking simply reflect the purpose of the procedure. That is, it could for example be argued that the triage procedure sets information seeking as forward-looking because the purpose of triage is to make decisions about resource allocation. However, we contend that the mode of information seeking relates to whether the procedure concerns an uncertain or equivocal task. By making known questions explicit, the triage procedure directs the less experienced nurses' gaze as they decide what to look for and how to move forward with triaging a patient. This forward-looking mode of information seeking may be how procedures are typically conceived but it is dependent on triage being an uncertain task. For equivocal tasks a procedure such as the timeout can create a space for looking back on actions to reflect on them in the light of new information or questions, thereby improving the basis for subsequent action. This retrospective mode resembles Weick's (2001) description of sensemaking. He argues that sense is continuously constructed by looking back at how events have unfolded and that the process of making sense subsumes that of making decisions. To disentangle whether the mode of information seeking depends on the purpose of the procedure or the nature of the task future studies could investigate mismatches between purpose and task: Does a decision-oriented procedure for an equivocal task result in forward-looking or mainly retrospective information seeking?

Third, procedures may institute a shift from individual to collaborative information seeking. By creating recurrent situations that have the consultation of colleagues as a pre-specified component the timeout procedure lowers the social costs of help seeking. This is important because clinicians may otherwise abstain from asking for fear of appearing incompetent (Lee, 2002). The timeout procedure also makes it easy for the physicians to predict when and where help will be available and for senior physicians to make themselves available for consultation. Otherwise, physically locating a relevant person to ask may itself be a barrier to information seeking (Bardram & Bossen, 2005). While the immediate objective of a procedure such as the timeout is to facilitate patient treatment, the timeouts should also shape information seeking in a way that facilitates the physicians in, gradually, becoming more skillful. This longer-term objective receives special attention in the research on search as learning (Eickhoff et al., 2017; Rieh et al., 2016). Future research on search as learning should investigate the role of procedures, appraise the prospects of collaboration, and strive to devise approaches that facilitate professionals in developing expertise.

Finally, this study has implications for models of professionals' information seeking in that it contributes to specifying the circumstances under which these models apply. In terms of the forward-looking mode of information seeking this study gives an example of a task for which the models tend to be confined to the less experienced professionals. The retrospective mode of information seeking is under-recognized in the models but the main way in which the expert professionals in the present study engage in information seeking; their forward-looking thinking is instead driven by pattern recognition. By leaving out the interactions between conscious information seeking and holistic pattern recognition, the models evade an important aspect of expert professionals' information behavior. This evasion is especially troubling because many studies of professionals' information seeking involve highly experienced professionals (e.g., Anderson et al., 2001; Bennett et al., 2005; Byström & Järvelin, 1995; Fidel & Green, 2004).

### 7.3 Limitations

Three limitations should be remembered in interpreting the results of this study. First, we acknowledge that the findings of this study are derived from one empirical setting and should not be generalized beyond triage and timeouts. We hope that future studies will test the findings for procedures other than triage and timeouts, professionals other than physicians and nurses, domains other than healthcare, and cultural contexts other than Denmark. Second, in continuation of the distinction between analytic and holistic modes of thinking we distinguish between junior and expert professionals. The analytic/holistic distinction is at the heart of the dual-processing perspective (Allen, 2011) and related accounts of human thinking (e.g., Kahneman, 2011). However, other accounts distinguish among professionals at more than two levels of expertise. For example, Benner (1982) divides the path from novice to expert into five stages of skill acquisition. The additional distinctions may add nuance to how procedures shape information seeking. Third, in the empirical analysis we focus more on the highly experienced coordinating nurses and chief physicians than on their less experienced colleagues. The rationale for this focus is that the highly experienced professionals provide the largest contrast to prevalent definitions of information seeking because they often recognize patterns rather than consciously seek information. We acknowledge the need for more detailed studies of how the triage procedure, for example, shapes the less experienced nurses' information seeking. For a study of the influence of procedures on novice nurses' information behavior, see Nordsteien and Byström (2018).

## 8 Conclusion

The workplace procedures of triage and timeouts shape healthcare professionals' information seeking in ways that depend on whether the professionals are junior or expert and whether the procedure governs an uncertain or equivocal task. While the triage procedure supplies explicit questions and criteria, the timeout procedure employs collaboration and task suspension as its main components. For triage (an uncertain task), the junior professionals benefit from the procedure's specification of which information to retrieve while the expert professionals tend to rely on pattern recognition rather than information seeking. For timeouts (an equivocal task), the procedure creates a space for collaborative reflection and thereby facilitates expert professionals in temporarily shifting to information seeking while junior as well as expert professionals get the opportunity to consult colleagues. We contend that this study has implications for models of professionals' information seeking in that it begins to specify how procedures enter into shaping information seeking and illustrates how conscious information seeking blends with holistic pattern recognition.

## Acknowledgements

This paper is a revised and thoroughly extended version of a paper presented at the ASIS&T2016 SIG-USE workshop. The paper is part of a research and development project conducted by the authors in collaboration with Region Zealand and Imatis. The project has received funding from Vækstforum Sjælland and Innovasjon Norge. The funding sources had no role in the collection, analysis, and interpretation of data; in the writing of the paper; and in the decision to submit it for publication. Arnvør Torkilshøygi collected part of the observation data on which the analysis in this paper is based. Special thanks are due to the ED clinicians.

*Declarations of interest:* none.

## References

- Agarwal, N.K., Xu, Y., & Poo, D.C.C. (2011). A context-based investigation into source use by information seekers. *Journal of the American Society for Information Science and Technology*, 62(6), 1087-1104.
- Allen, D.K. (2011). Information behavior and decision making in time-constrained practice: A dual-processing perspective. *Journal of the American Society for Information Science and Technology*, 62(11), 2165-2181.
- Allen, T.J. (1977). *Managing the flow of technology: Technology transfer and the dissemination of technological information within the R&D organization*. Cambridge, MA: MIT Press.
- Anderson, C.J., Glassman, M., McAfee, R.B., & Pinelli, T. (2001). An investigation of factors affecting how engineers and scientists seek information. *Journal of Engineering and Technology Management*, 18(2), 131-155.
- Bardram, J.E., & Bossen, C. (2005). Mobility work: The spatial dimension of collaboration at a hospital. *Computer Supported Cooperative Work*, 14(2), 131-160.
- Benner, P. (1982). From novice to expert. *American Journal of Nursing*, 82(3), 402-407.
- Bennett, N.L., Casebeer, L.L., Kristofco, R., & Collins, B.C. (2005). Family physicians' information seeking behaviors: A survey comparison with other specialties. *BMC Medical Informatics and Decision Making*, 5, article 9.
- Berryman, J.M. (2008). Judgements during information seeking: A naturalistic approach to understanding the assessment of enough information. *Journal of Information Science*, 34(2), 196-206.
- Browne, M. (2014). What if a pilot was too busy for the checklist? Emergency department safety and the timeout process. *Clinical Pediatric Emergency Medicine*, 15(3), 269-273.
- Byström, K. (2002). Information and information sources in tasks of varying complexity. *Journal of the American Society for Information Science and Technology*, 53(7), 581-591.
- Byström, K., & Hansen, P. (2005). Conceptual framework for tasks in information studies. *Journal of the American Society for Information Science and Technology*, 56(10), 1050-1061.
- Byström, K., & Järvelin, K. (1995). Task complexity affects information seeking and use. *Information Processing & Management*, 31(2), 191-213.
- Baatiema, L., Otim, M.E., Mnatzaganian, G., de-Graft Aikins, A., Coombes, J., & Somerset, S. (2017). Health professionals' views on the barriers and enablers to evidence-based practice for acute stroke care: A systematic review. *Implementation Science*, 12, article 74.
- Case, D.O., & Given, L.M. (2016). *Looking for information: A survey of research on information seeking, needs, and behavior* (4th ed.). Bingley, UK: Emerald.
- Christensen, E.W., & Bailey, J.R. (1997). A source accessibility effect on media selection. *Management Communication Quarterly*, 10(3), 373-387.
- Daft, R.L., & Lengel, R.H. (1986). Organizational information requirements, media richness and structural design. *Management Science*, 32(5), 554-571.
- Davies, K. (2007). The information-seeking behavior of doctors: A review of the evidence. *Health Information & Libraries Journal*, 24(2), 78-94.
- Del Fiol, G., Workman, E., & Gorman, P.N. (2014). Clinical questions raised by clinicians at the point of care: A systematic review. *JAMA Internal Medicine*, 174(5), 710-718.
- Dillon, K.A. (2008). Time out: An analysis. *AORN Journal*, 88(3), 437-442.
- Dong, S.L., & Bullard, M. (2009). Emergency department triage. In B.H. Rowe, E.S. Lang, M. Brown, D. Houry, D.H. Newman, & P.C. Wyer (Eds.), *Evidence-Based Emergency Medicine* (pp. 58-65). Oxford, UK: Wiley-Blackwell.
- Dreyfus, H.L., & Dreyfus, S.E. (1986). *Mind over machine: The power of human intuition and expertise in the era of the computer*. New York: Free Press.
- Eickhoff, C., Gwizdka, J., & Hauff, C. (2017). Introduction to the special issue on search as learning. *Information Retrieval Journal*, 20(5), 399-402.

- Ericsson, K.A. (2008). Deliberate practice and acquisition of expert performance: A general overview. *Academic Emergency Medicine*, 15(11), 988-994.
- Farrohknia, N., Castrén, M., Ehrenberg, A., Lind, L., Oredsson, S., Jonsson, H., . . . Göransson, K.E. (2011). Emergency department triage scales and their components: A systematic review of the scientific evidence. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, 19(1), 42:01-42:13.
- Feldman, M.S., & Orlikowski, W.J. (2011). Theorizing practice and practicing theory. *Organization Science*, 22(5), 1240-1253.
- Fidel, R., & Green, M. (2004). The many faces of accessibility: Engineers' perception of information sources. *Information Processing & Management*, 40(3), 563-581.
- Fischer, F., Lange, K., Klose, K., Greiner, W., & Kraemer, A. (2016). Barriers and strategies in guideline implementation - A scoping review. *Healthcare*, 4(3), article 36.
- Freund, L. (2015). Contextualizing the information-seeking behavior of software engineers. *Journal of the Association for Information Science and Technology*, 66(8), 1594-1605.
- Grimshaw, J.M., & Russell, I.T. (1993). Effect of clinical guidelines on medical practice: A systematic review of rigorous evaluations. *Lancet*, 342(8883), 1317-1322.
- Grol, R., & Grimshaw, J. (2003). From best evidence to best practice: Effective implementation of change in patients' care. *Lancet*, 362(9391), 1225-1230.
- Göransson, K.E., & von Rosen, A. (2011). Interrater agreement: A comparison between two emergency department triage scales. *European Journal of Emergency Medicine*, 18(2), 68-72.
- Hammond, K.R., Hamm, R.M., Grassia, J., & Pearson, T. (1987). Direct comparison of the efficacy of intuitive and analytic cognition in expert judgment. *IEEE Transactions on Systems, Man and Cybernetics*, 17(5), 753-770.
- Hansen, P., & Järvelin, K. (2005). Collaborative information retrieval in an information-intensive domain. *Information Processing & Management*, 41(5), 1101-1119.
- Hertzum, M. (2010). Breakdowns in collaborative information seeking: A study of the medication process. *Information Processing & Management*, 46(6), 646-655.
- Hertzum, M. (2014). Expertise seeking: A review. *Information Processing & Management*, 50(5), 775-795.
- Hertzum, M. (2016). Patterns in emergency-department arrivals and length of stay: Input for visualizations of crowding. *Ergonomics Open Journal*, 9, 1-14.
- Hertzum, M., & Reddy, M. (2015). Procedures and collaborative information seeking: A study of emergency departments. In P. Hansen, C. Shah, & C.-P. Klas (Eds.), *Collaborative Information Seeking: Best Practices, New Domains and New Thoughts* (pp. 55-71). Berlin: Springer.
- Hertzum, M., & Simonsen, J. (2016). Effects of electronic emergency-department whiteboards on clinicians' time distribution and mental workload. *Health Informatics Journal*, 22(1), 3-20.
- Iserson, K.V., & Moskop, J.C. (2007). Triage in medicine, Part I: Concept, history, and types. *Annals of Emergency Medicine*, 49(3), 275-281.
- Johannessen, L.E.F. (2016). How triage nurses use discretion: A literature review. *Professions & Professionalism*, 6(1). doi: <http://dx.doi.org/10.7577/pp.1446>
- Kahneman, D. (2011). *Thinking, Fast and slow*. London: Penguin Books.
- Kelly, J.J., Farley, H., O'Cain, C., Broida, R.I., Klauer, K., Fuller, D.C., . . . Pines, J.M. (2011). A survey of the use of time-out protocols in emergency medicine. *Joint Commission Journal on Quality and Patient Safety*, 37(6), 285-288.
- Klein, G. (1998). *Sources of power: How people make decisions*. Cambridge, MA: MIT Press.
- Kuhlthau, C.C. (1991). Inside the search process: Information seeking from the user's perspective. *Journal of the American Society for Information Science*, 42(5), 361-371.
- Leckie, G.J., Pettigrew, K.E., & Sylvain, C. (1996). Modeling the information seeking of professionals: A general model derived from research on engineers, health care professionals, and lawyers. *Library Quarterly*, 66(2), 161-193.
- Lee, F. (2002). The social costs of seeking help. *Journal of Applied Behavioral Science*, 38(1), 17-35.

- Li, Y. (2008). Exploring the relationships between work task and search task in information search. *Journal of the American Society for Information Science and Technology*, 60(2), 275-291.
- Li, Y., & Belkin, N.J. (2008). A faceted approach to conceptualizing tasks in information seeking. *Information Processing & Management*, 44(6), 1822-1837.
- Liu, J., Kim, C.S., & Creel, C. (2015). Exploring search task difficulty reasons in different task types and user knowledge groups. *Information Processing & Management*, 51(3), 273-285.
- Loukopoulos, L.D., Dismukes, R.K., & Barshi, I. (2009). *The multitasking myth: Handling complexity in real-world operations*. Farnham, UK: Ashgate.
- Miller, E.M., & Hill, P.D. (2018). Intuition in clinical decision making: Differences among practicing nurses. *Journal of Holistic Nursing*, 36(4), 318-329.
- Mishra, J., Allen, D., & Pearman, A. (2015). Information seeking, use, and decision making. *Journal of the Association for Information Science and Technology*, 66(4), 662-673.
- Noon, A.J. (2014). The cognitive processes underpinning clinical decision in triage assessment: A theoretical conundrum? *International Emergency Nursing*, 22(1), 40-46.
- Nordsteien, A., & Byström, K. (2018). Transitions in workplace information practices and culture: The influence of newcomers on information use in healthcare. *Journal of Documentation*, 74(4), 827-843.
- O'Reilly, C.A. (1982). Variations in decision makers' use of information sources: The impact of quality and accessibility of information. *Academy of Management Journal*, 25(4), 756-771.
- Reddy, M., & Jansen, B.J. (2008). A model for understanding collaborative information behavior in context: A study of two healthcare teams. *Information Processing & Management*, 44(1), 256-273.
- Rieh, S.Y., Collins-Thompson, K., Hansen, P., & Lee, H.-J. (2016). Towards searching as a learning process: A review of current perspectives and future directions. *Journal of Information Science*, 42(1), 19-34.
- Russell-Rose, T., Chamberlain, J., & Azzopardi, L. (2018). Information retrieval in the workplace: A comparison of professional search practices. *Information Processing & Management*, 54(6), 1042-1057.
- Schön, D.A. (1983). *The reflective practitioner: How professionals think in action*. Aldershot, UK: Ashgate.
- Sehgal, N.L., Fox, M., Sharpe, B.A., Vidyarthi, A.R., Biegen, M., & Wachter, R.M. (2011). Critical conversations: A call for a nonprocedural "time out". *Journal of Hospital Medicine*, 6(4), 225-230.
- Simonsen, J., & Hertzum, M. (2010). Iterative participatory design. In J. Simonsen, J.O. Bærenholdt, M. Büscher, & J.D. Scheuer (Eds.), *Design Research: Synergies from Interdisciplinary Perspectives* (pp. 16-32). London: Routledge.
- Suchman, L.A. (2007). *Human-machine reconfigurations: Plans and situated action, 2nd edition*. Cambridge, UK: Cambridge University Press.
- Talja, S., & McKenzie, P.J. (2007). Editors' introduction: Special issue on discursive approaches to information seeking in context. *Library Quarterly*, 77(2), 97-108.
- Trevino, L.K., Lengel, R.H., & Daft, R.L. (1987). Media symbolism, media richness, and media choice in organizations: A symbolic interactionist perspective. *Communication Research*, 14(5), 553-574.
- Vakkari, P. (2003). Task-based information searching. *Annual Review of Information Science and Technology*, 37, 413-464.
- Weick, K.E. (2001). *Making sense of the organization*. Malden, MA: Blackwell.
- Wilson, T.D. (2000). Human information behavior. *Informing Science*, 3(2), 49-56.
- Wuerz, R., Fernandez, C.M.B., & Alarcon, J. (1998). Inconsistency of emergency department triage. *Annals of Emergency Medicine*, 32(4), 431-435.
- Yuan, Y.C., Rickard, L.N., Xia, L., & Scherer, C. (2011). The interplay between interpersonal and electronic resources in knowledge seeking among co-located and distributed employees. *Journal of the American Society for Information Science and Technology*, 62(3), 535-549.