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STRUCTURED ANALYSIS OF CRITICAL DECISION METHOD DATA – EMERGENCY MEDICINE CASE STUDY

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Abstract: The critical decision method is a semi-structured retrospective interview used mainly in researching professional decision making within the naturalistic decision making paradigm. There are currently, two main methods of performing analysis: ETA – Emergent Themes Analysis and the structured approach (Wong, 2004). The structured approach consists of five steps: 1. decision chart, 2. incident summary, 3. decision analysis tables, 4. identification of items of interest and 5. collation and comparison of common items of interest across incidents. Naturalistic decision making can be time-consuming, involve high stakes, poorly-structured problems, uncertain dynamic environments and ill-defined or competing goals. For this reason we will demonstrate how to the structured approach to perform an analysis using the example of a decision making situation in emergency medicine.

Key words: critical decision method; structured approach; data analysis; paramedics; decision making.

The aim of the article is to provide a detailed analysis of the critical decision method using the structured approach as an example. The critical decision method (CDM) is a semi-structured retrospective interview which yields rich data on challenging incidents. It is used mainly in expert decision making research in the naturalistic decision making paradigm (NDM) (Klein, 2008; Lipshitz, Klein, Orasanu, & Salas, 2001). NDM research is concerned with real world problems and the study of expert decision making. According to Orasanu and Connolly (1993), in naturalistic decision making environments decision makers deal with ill-structured problems; uncertain dynamic environments; shifting, ill-defined, or competing goals; they use action/feedback loops and work under time pressure and with high stakes. Moreover, there are often multiple players in the situation and decision makers have to consider organizational goals and norms.

The critical decision method (CDM) has proven to be a useful technique in cognitive research. It is used to elicit expert knowledge, decision strategies and cues. As Weitzenfeld, Freeman, Riedl, and Klein (1990) state, CDM is "a particularly useful strategy in complex, novel, or real-life domains, where the researchers are relatively naive." Thus, CDM allows researchers to gain insights into expert cognitive processes from different fields.

CDM provides rich data on selected incidents. There are publications explaining how to conduct a CDM interview (Crandall, Klein, & Hoffman, 2006; Hoffman, Crandall, & Klein, 2008; Hoffman, Crandall, & Shadbolt, 1998; Klein, Calderwood, & MacGregor, 1989), but fewer sources explain how to deal with the data analysis (Wong & Blandford, 2002; Wong, 2004). A two-hour interview often yields 20-30 pages of transcript. As CDM is a cyclical procedure, one part of the incident is discussed several times during the interview making the coding of data more challenging. Therefore, our goal is to provide an example of CDM data analysis using the structured approach. We use an emergency situation involving paramedics to illustrate the analysis. Currently, there exist two main methods of analysis: ETA—emergent themes analysis—and the structured approach (Wong, 2004). By providing an example of the data analysis, which can prove demanding because of the rich data, we would like to encourage researchers to benefit from the advantages offered by the critical decision method.

To understand the data analysis, we need first to understand the process whereby the data is created. Therefore, we will explain CDM and the background to the paramedic research and then go on to look at an example of the data analysis using the structured approach.

Critical decision method

CDM was developed by Klein Associates (Crandall & Calderwood, 1989; Klein et al., 1989) in order to study decision making in real-life situations. This desire to bring the research out of the laboratories and into the real world was the beginning of the naturalistic decision making (NDM) paradigm. In recent decades, CDM has become a well-established method used in a wide variety of fields, for instance emergency ambulance dispatch, mining, intelligence analysis, firefighting and software design (e.g. Blandford & Wong, 2004; Horberry & Cooke, 2010; Hutchins, Pirolli, & Card, 2007, Study 2; Okoli, Weller, Watt, & Wong, 2013; Wong & Blandford, 2002; Wong, O'Hare, & Sallis, 1996; Wong, Sallis, & O'Hare, 1997; Zannier, Chiasson, & Maurer, 2007). This method has been used in only a few studies on decision making in paramedicine, (e.g. Adamovová & Halama, 2013; Harenčárová, 2013).

CDM is a semi-structured interview about a single selected non-routine incident which was professionally challenging. The interview participant is usually an expert and the main decision maker in the incident. During the interview, which lasts approximately from 1.5 to 2 hours, the researchers and expert go through the incident together several times, adding the details, and obtaining a greater understanding of the incident. Probe questions are used to facilitate the retrieval of information.

Phases of CDM

The CDM interview consists of four consecutive steps which review the incident in four sweeps (Crandall et al., 2006):

1) *Incident selection and incident recall* – At the beginning of the interview, the researcher and participant have to select a specific non-routine incident. The participant should be the main decision maker in the situation and the situation should be professionally

challenging. Once the incident has been selected, the participant briefly retells the situation from beginning to end.

2) *Timeline verification and decision point identification* – The second step involves identifying the key events and creating the timeline. These key events can be characterized as decisions made, actions taken or information acquired.
3) *Deepening* – During the deepening phase probe questions are used to focus on specific aspects of decision points. The questions mainly concern cues, goals, expectations, alternative courses of action and other information depending on the aim of the study.
4) *"What if?" queries* – At the end of the inquiry, hypothetical questions are asked to ascertain expert/novice differences, potential errors and other possible courses of action.

Hoffman et al. (1998) suggest that the researcher should retell the incident after the first step. The researcher should tell the story by following the participant's version as closely as possible, using the same vocabulary and wording. The participant is asked to intervene at any time to provide further details, correct the story or offer clarifications. During the interview the same part of the situation is discussed several times. This makes CDM challenging to analyse.

Two approaches to CDM interview analysis

Wong (2004) proposed two complementary methods for analysing the CDM data which differ according to the main goal of the research. The first is the *structured approach* which is appropriate when the concepts are clear and when the classification of the data has been set a priori. The second one, the *emergent themes approach*, is more exploratory. It is suitable for cases where the classification of the data is not clear or there are uncovered concepts. As we are focusing on the first approach, we will describe the structured approach in more detail using the example of a non-routine paramedical situation.

Structured approach

In order to organize the data from the CDM interview, Wong (2004) proposes five steps:

1. Create a decision chart showing the decision process on a timeline with progressive deepening to illustrate how the decisions were made.
2. Create an incident summary.
3. Make decision analysis tables based on the a priori decision making framework.
4. Identify items of interest in each incident.
5. Collate and compare common items of interest across the incidents studied.

The first four steps of the analysis are carried out separately for each situation. The fifth step brings together issues of interest from all the selected incidents. Figure 1 provides an overview of the analysis process in five steps. Using the timeline from the interview and the transcript, the decision chart for the situation is created, followed by a narrative-based summary of the incident. The decision chart and the incident summary are then used to guide the next steps. The decision analysis table is constructed using information from the first two steps and additional details are incorporated from the transcript. Next, the items of interest are identified from the decision chart and incident summary. Finally, the items of interest are

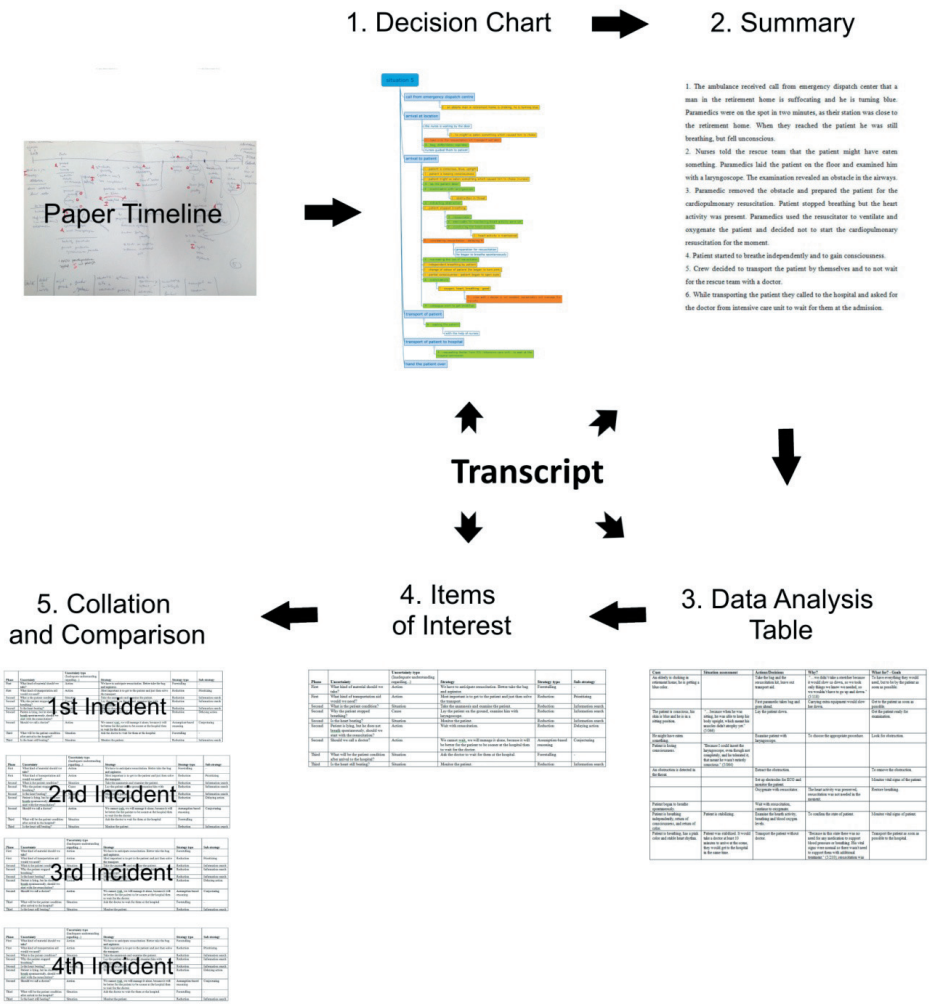

Figure 1. Overview of the analysis process

compared across the incidents and conclusions are drawn. In the next section we go through these steps using a non-routine paramedical situation as our example. First, we briefly discuss the original research from which the example is drawn: research on paramedics' uncertainty and coping strategies (Harenčárová, 2015).

Research on paramedics' uncertainty

The main goal of our study (Harenčárová, 2015) was to identify types of uncertainty and strategies used to manage uncertainty in non-routine situations in paramedics. We conducted

CDM interviews with nine paramedics, all of whom had more than four years of experience. The framework used for analysis is the RAWFS heuristic from Lipshitz and Strauss (1997). RAWFS stands for strategies of reduction, assumption-based reasoning, weighing pros and cons, forestalling, and suppression. The heuristic assumes that different types of uncertainty are managed by particular types of strategies. Strategies of reduction and assumption-based reasoning are further divided into sub-strategies. In their original paper, Lipshitz and Strauss (1997) identified three types of uncertainty: inadequate understanding, incomplete information and undifferentiated alternatives. The research by Lipshitz, Omodei, McClellan, and Wearing (2007) on fire ground commanders yielded three types of inadequate understanding. These were inadequate understanding of the situation, action, and cause of incident. Our analysis yielded one more category previously mentioned in the research by Lipshitz and Strauss (1997) and that was inadequate understanding of the outcome.

Data analysis

Two raters (the author of the article and a student assistant) coded the data according to three main categories: incident phase, uncertainty, and coping strategy and sub-strategy. At the beginning one interview was coded together by both raters. During this session the raters discussed the categories, the coding process and differing opinions while coding the interview jointly. The remaining interviews were coded by the two raters independently. At the end they met to resolve the differences in their results. Consensus was achieved through discussion. The inter-rater reliability was assessed using Krippendorff's (Hayes & Krippendorff, 2007; Krippendorff, 2004). We used package irr (Gamer, Lemon, Fellows, & Singh, 2012) in R (R Core Team, 2013). Krippendorff's was satisfactory for all topics, being higher than 0.617 for all three topics (uncertainty, strategy, sub-strategy) which is the limit of acceptance (Krippendorff, 2004, in Krippendorff, 2004).

In the next section we will outline the structured approach analysis using one selected case of non-routine paramedical decision making. The situation is characterized by high stakes (the patient's life) and time pressure (very short time-frame), shifting goals and multiple players (two paramedics as well as nurses).

As this research had an a priori theoretical concept (uncertainty types and RAWFS heuristic), we followed Wong's (2004) recommendation and opted for the structured approach method to analyze the CDM data.

Emergency in a home for the elderly

We decided to use the structured CDM data analysis approach to identify the uncertainty and coping strategies used in paramedics' decision making. We used the five steps proposed by Wong (2004).

First step – Decision chart

A good way to start a decision chart is to consult the timeline created during the interview. As the timeline obtained during the interview was not in digitalized form, our first step was

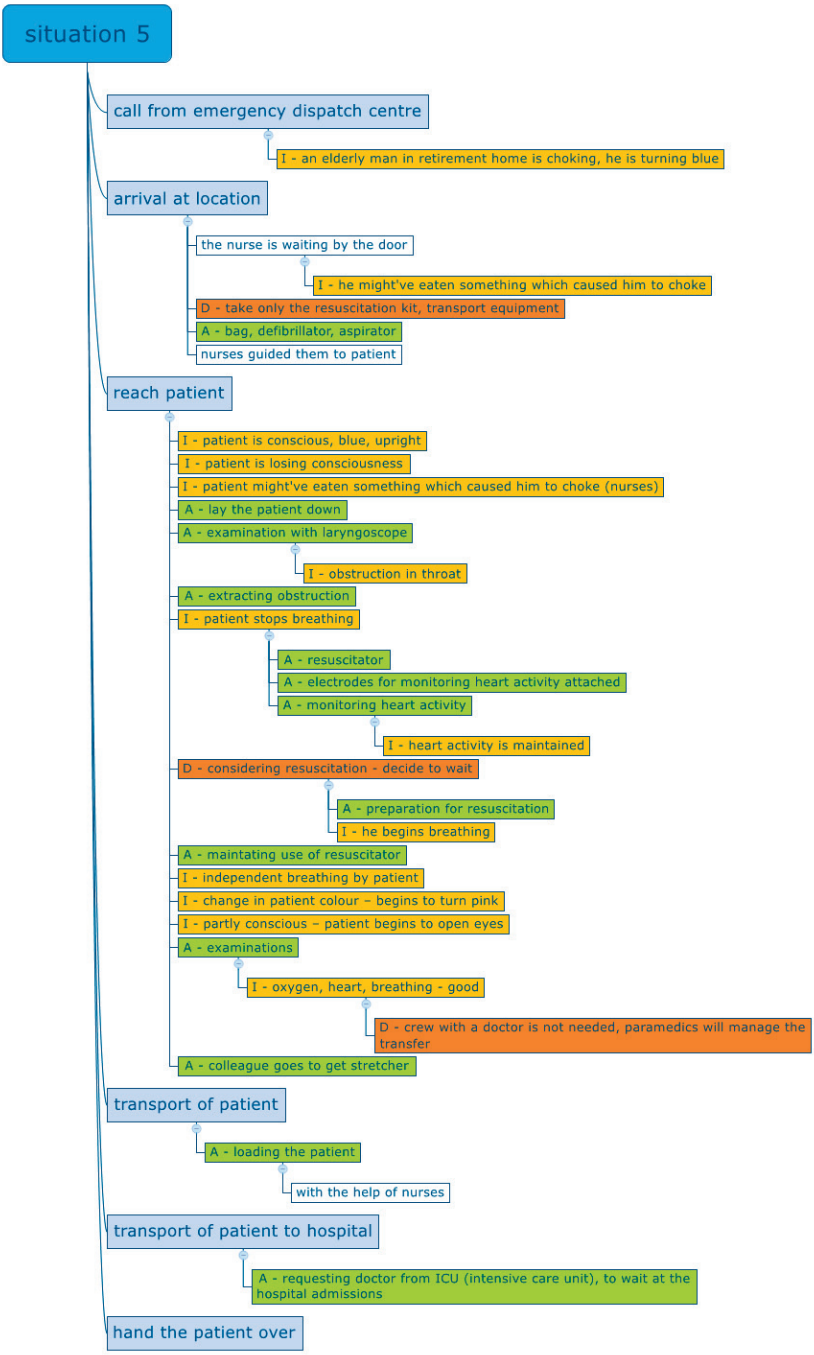

Figure 2. Decision chart of the situation (I – information, A – action, D – decision).

to create a digitalized version from the notes and paper version. To create the timeline we used XMind 6 (2014) mind mapping software, although concept mapping tools could also be used (e.g. CMapTool, 2015). The advantage of mind/concept mapping software is that it is easy to use and flexible. It is very easy for the researcher to create nodes and add additional information while rereading the transcripts. Information can be reorganized, details can be added and a progressive understanding of the situation can be gleaned. The decision chart is the visual representation of the main points of the incident; it is used to help organize the events chronologically. Figure 2 shows the decision chart with the events organized chronologically and summaries of the three types of points of interest – I, A and D. *I* is the information gained either by active search or retrieved from the environment. *A* is an action taken and it emphasizes the active nature of the decision and *D* denotes the decisions made. The first information the paramedic crew received was from the emergency dispatch centre. They were informed that an elderly man in a retirement home was choking and turning blue. The next information was provided by the nurses once the paramedics had arrived at the scene: the patient may have eaten something which caused him to choke. The next point was the decision to take only the resuscitation kit and to get the transport equipment later. This decision was followed by the action: the crew took the medical bag, defibrillator and aspirator and went to the patient.

Sometimes it can be difficult to decide what should count as a decision and what as an action. We suppose implicitly that every action is preceded by a decision. By contrast, not every decision is followed by an immediate action. In our analysis we decided to label the points as decisions if the decision was of great importance or if decisions were not followed by action. The paper timeline served as the basis for the decision chart. The researcher read the transcript, reviewed the points and checked if there anything he wished to add which had not been captured by the paper timeline. At this point, the researcher is free to add as much information about the cues, alternatives considered and outcomes as he finds useful. If it is of importance, he can also include information about the time of the decision points or important events of the situation. The decision chart briefly and chronologically presented the main points of the situation and it helped the researcher organize the events and actions of the incident. It gave an outline of the situation from which it was clear which information preceded which actions and decisions. In the next step, these points were connected by the narrative.

Second step – Incident summary

The decision chart provided information on the chronologically ordered events in the situation. The incident summary fills in the relationships between the points. It is a short story of the situation which provides an overview of the incident and the most important events, but unlike the decision chart it also describes the connections. In the summary the narrative is used to clarify the relationships between the pieces of data. Again, the transcript was used to inform the summary. The incident summary of the situation was as follows:

1. The ambulance crew received a call from the emergency dispatch centre informing them that a man in a retirement home was suffocating and turning blue.
2. Paramedics were on the spot in two minutes, as their station was close to the retirement home. When they reached the patient he was still breathing, but had fallen unconscious.

3. Nurses told the rescue team that the patient might have eaten something. The paramedics laid the patient on the floor and examined him with a laryngoscope. The examination revealed an obstacle in the patient's airway.
4. A paramedic removed the obstacle and prepared the patient for cardiopulmonary resuscitation. The patient had stopped breathing but heart activity was present. The paramedics used the resuscitator to ventilate and oxygenate the patient and decided not to start cardiopulmonary resuscitation for the moment.
5. The patient started breathing independently and to gain consciousness.
6. The crew decided to transport the patient themselves and not wait for the rescue team plus doctor, because the patient had been stabilized, they had not had to resuscitate him, and this way he would be in a doctor's care sooner than if they waited for one to arrive at their location.
7. While transporting the patient they called the hospital and asked for a doctor from the intensive care unit to wait for them at admissions.

Both the decision chart and incident summary provide a brief and clear description of the situation. They organize the events, show the connections and are the basis for the next step, the decision analysis table, which provides greater understanding of the situation.

Third step – Decision analysis table

The decision chart and incident summary provide a useful guide of the incident. The next step in the structured approach is creating the decision analysis table. It provides more detailed information about the decisions made. The decision analysis table (DAT) is similar to the decision requirements table (DRT) in Hoffman et al. (2008). There are small differences in the way these two tables are constructed. DRT emphasises the hypotheticals and different options, while DAT focuses more on the link between the cues (information), situation assessment, and goals and rationales for the decision made/actions taken. Thus, we can conclude that DAT is a shorter version of DRT. We presume that they are used to pursue different research goals, as it is often emphasized in CDM that it should be tailored to the particular research.

From the decision chart, we already know the important information, action and decisions relating to the incident. The incident summary added the connections between these points. This served as the basis for the decision analysis table. The information from the decision chart is summarized as cues in the decision analysis table and the actions and decisions are written up in another column. This gives us the basic structure of the table. Next, we searched for additional information to complete the table. By rereading the transcript we looked for the remaining information required for the decision analysis table—the situation assessment, the reasons (Why?) and the goals (What for?). The decision analysis table links the information obtained (cues) with the decisions made and actions taken with their reasons and goals. The cues and decisions are usually easily retrieved from the decision chart. The reasons, goals and situation assessment are obtained from the transcript. Table 1 provides a decision analysis table of the selected incident.

In this situation the first cue was the same as the first piece of information in the decision chart: the information received from the emergency dispatch centre. There were two important cues: an elderly person was choking and turning blue. The *Actions/Decisions*

Table 1. Decision analysis table – paramedics' incident

Cues	Situation assessment	Actions/Decisions	Why?	What for? – Goals
An elderly person is choking in a retirement home, he is turning blue.		Take the bag and the resuscitation kit, leave out transport equipment.	The transportation equipment would slow them down.	To have everything they will need and be with the patient as soon as possible.
		First paramedic takes bag and goes ahead.	Carrying extra equipment would slow her down.	Get to the patient as soon as possible.
The patient is conscious, his skin is blue and he is in a sitting position.	Patient is sitting, that means his muscles have not atrophied yet.	Lay the patient down.		Get the patient ready for examination.
He might have eaten something.		Examine patient with laryngoscope.	So they can choose the appropriate procedure.	Look for obstruction.
Patient is losing consciousness.	Patient tolerated the insertion of laryngoscope.			
An obstruction is detected in the throat.		Extract the obstruction.		To remove the obstruction.
		Set up electrodes for ECG and monitor the patient.		Monitor vital signs of the patient.
		Oxygenate with resuscitator.	Heart activity was preserved, resuscitation was not needed at that moment.	Restore breathing.
Patient began to breathe spontaneously.		Hold off on resuscitation, continue to oxygenate.		

Table 1. Continued

Cues	Situation assessment	Actions/Decisions	Why?	What for? – Goals
Patient is breathing independently, return of consciousness, and return of colour.	Patient is stabilizing.	Examine heart activity, breathing and blood oxygen levels.	To confirm the state of patient.	Monitor vital signs of patient.
Patient is breathing, pink in colour and has a stable heart rhythm.	Patient was stabilized. It would take a doctor at least 10 minutes to arrive at the scene, they would get to the hospital at the same time.	Transport the patient without doctor.	Patient had been stabilized, resuscitation was not needed.	Transport the patient as soon as possible to the hospital.
		Monitor the patient.	To check for potential changes.	
		Ask the doctor to wait for them at the hospital.	Patient was unconscious during the emergency response.	Secure an immediate doctor supervision for the patient.

column is based on this initial information. The paramedics decided to take the resuscitation kit but leave out the transport equipment. The *Why?* column shows the rationale for this decision ("we didn't take a stretcher because it would slow us down, so we took only things we knew we needed, so we wouldn't have to go up and down." (5/118)). The last column, *What for? – Goals,* provides information on the goal behind this decision/action. In this case the goal was to be with the patient as soon as possible with all the necessary resuscitation and first aid equipment. This decision was followed by the action taken by the first paramedic which was to take the bag and go ahead so as to get to the patient as fast as possible. When they arrived they saw that the patient was sitting up but turning blue. Based on this cue they concluded that he was conscious but deteriorating so they laid him down to prepare him for examination. Some of the information entries also include a situation assessment (e.g. "Because I could insert the laryngoscope, although not completely, and he tolerated it, that meant he wasn't entirely conscious." (5/064)).

The decision analysis table links the information, decisions/actions, improves understanding of the situation by adding the assessment of the situation, goals and reasons. For the paramedics, it reveals how they assessed the situation and what goals lay behind their decisions.

Fourth step – Identification of items of interest

The fourth step is the identification of items of interest. These may differ depending on the research goal. Items of interest are often goals, information and its sources, decisions made, situation awareness, and so forth. As we mentioned before, we were interested in the uncertainty and coping strategies in a non-routine paramedical situation. The previous steps helped us to identify the uncertainty in two ways. Firstly, the decision chart and incident summary guided us through our search for instances of uncertainty. We looked at the decision points and actions, and information preceding them. Secondly, the decision analysis table enabled us to gain an understanding of the reasons for the actions and decisions; it provided the situation assessments and rationales for the choices. This helped us to define the uncertainty and the strategies we were looking for. We looked at the different uncertainty—strategy pairs during the three different stages of the rescue action. The first stage started with the call from the emergency dispatch centre and ended with the paramedics reaching the patient, at which point the second stage started. The second stage involved the patient examination, anamnesis and resolving the situation. The third stage was transporting the patient from the spot to the hospital.

First we identified the uncertainty cases, strategies and sub-strategies and then we classified them according to the predefined categories. The strategies were further divided into sub-strategies. We provide examples of sub-strategies extracted from the interviews. The strategies of reduction and assumption-based reasoning had four coping strategies (Lipshitz et al., 2007). The strategy of reduction had the following sub-strategies:

– *delaying action* was defined as a form of passive information search (e.g. "yes, we considered [resuscitation], but first we wanted to wait for a while to see how his breathing was now that the obstacle had gone, so we waited and helped him breathe" (5/172)[1]).

[1] The first number denotes the interview, while second number denotes the paragraph of the interview.

– *prioritizing* referred to focusing attention on higher priority objectives (e.g. "...but there's a bit of delay, so he told me to run to the patient and he said he would take the things." (8/036)).
– *relying on procedures* was a strategy used when the action was mainly taken because of the procedures (e.g. "We waited until [the helicopter] departed, we always wait until the helicopter is safely away, then we can go." (1/299)).
– *active information search* occurred when the decision maker actively sought out the information (e.g. "...we found out from the relatives that he hadn't taken the medication he was supposed to have taken" (3/032)).

Assumption-based reasoning was divided into the following sub-strategies:

– *planning* was returning to the original plan to resolve uncertainty (e.g. "...we told ourselves we would give the patient some Diazepam and we'd call MRS if we needed to" (8/010)).
– *mental rehearsal* is imagining potential situations and courses of action before selecting an action (e.g. "Since I imagined that we have to go through there, and what if she then collapsed somewhere, so I asked him to help me carry her out." (4/128)).
– *mental simulation* is imagining implementation of a selected course of action before actual implementation (e.g. "I'm working out now that we're going to have to, we'll have to break in, and when we get in we're likely to have to, find a patient and drag her out or do first aid")[2].
– *conjecturing* means using assumptions to create situational awareness (e.g. "...it's better if she stays outside... ...that's why I told her to stay outside..." (4/156) "if I don't come back for a long time (...) she can call the police" (4/158).

The strategies of forestalling, weighing pros and cons and suppression were not divided into further sub-strategies. Table 2 gives the example of incident 5 and shows the identified items of interest – uncertainty, strategies and sub-strategies.

The first uncertainty in the first phase concerned the action—what equipment should be taken from the ambulance to the patient. From the decision chart we know that the paramedics decided to take the resuscitation kit. Using the decision analysis table we identified the strategy of forestalling. The paramedics anticipated the need for resuscitation based on their initial information. There was then also uncertainty over the action: whether they should also take the transportation equipment. The paramedics adopted the strategy of reduction (sub-strategy prioritizing) because they decided that the most important thing was to reach the patient as soon as possible and only then solve the issue of transport, once the patient had been stabilized. The next piece of uncertainty occurred in the second phase of the rescue action. The paramedics did not know what the patient's condition was. This was resolved by taking the anamnesis and examining the patient. This strategy was classified as a reduction strategy and as a sub-strategy of information search.

The table showing uncertainty and strategy indicates the kinds of uncertainty present at each phase of the incident and how the instances of uncertainty were resolved. The table con-

[2] Example is from Lipshitz et al. (2007).

Table 2. Items of interest – uncertainty, strategies and sub-strategies from incident 5.

Phase	**Uncertainty**	**Uncertainty type** (Inadequate understanding of...)	**Strategy**	**Strategy type**	**Sub-strategy**
First	What kind of equipment/supplies should we take?	Action	We have to anticipate resuscitation. Better take the bag and aspirator.	Forestalling	-
First	What kind of transport equipment will we need?	Action	Most important is to get to the patient and only then solve the transport.	Reduction	Prioritizing
Second	What is the patient's condition?	Situation	Take the anamnesis and examine the patient.	Reduction	Information search
Second	Why did the patient stop breathing?	Cause	Lay the patient on the ground, examine him with laryngoscope.	Reduction	Information search
Second	Is the heart beating?	Situation	Monitor the patient.	Reduction	Information search
Second	Patient is lying down, but is not breathing spontaneously, should we start resuscitation?	Action	Hold off on resuscitation.	Reduction	Delaying action
Second	Should we call a doctor?	Action	We cannot wait, we will manage alone, because it will be better for the patient to arrive at the hospital sooner than wait for the doctor.	Assumption-based reasoning	Conjecturing
Third	What condition will the patient be in on arrival at the hospital?	Situation	Ask the doctor to wait for them at the hospital.	Forestalling	-
Third	Is the heart still beating?	Situation	Monitor the patient.	Reduction	Information search

tains not only the classification of the uncertainty, strategies and sub-strategies but also the actions/decisions taken by the paramedics. Through this approach we were able to understand how the uncertainty and strategies manifested in the non-routine decision making situations.

Fifth step – Collation and comparison of common items of interest across the incidents studied

In the structured approach the final step in the analysis is to compare the common items of interest across all incidents. Generally, this enables the researcher to draw conclusions about the items, to make sense of the data, to generalize, and to link the conclusions with the data which support them. This step, again, varies according to the research aims. In our study the items of interest were different types of uncertainty and coping strategies within the various phases of the incident. For further analysis we used the distribution of the uncertainty cases and the coping strategies within the phases of the incident. The most prevalent uncertainty type was inadequate understanding of the situation and the most frequent strategy used to manage uncertainty was reduction. Most of the uncertainty–strategy pairs were identified in the second phase of the situation—handling the incident. Different types of uncertainty or coping strategies were predicted by the phase of the incident. The RAWFS heuristic has previously been used in studies with firefighters. We were therefore interested to see whether it was valid in the paramedic field. When comparing our results from the paramedic field with those on firefighting, we found a similar pattern of uncertainty–strategy pairs in the first two phases of the incident. Our findings suggest that managing uncertainty is similar across the fields depending on the task structure. However, more research is needed on the RAWFS heuristic before generalizations can be made.

The main aim of our research was to test the theoretical model, the RAWFS heuristic, in paramedicine. The structured approach revealed the important points in the incidents step by step. Having obtained a general understanding of the main decision points as described by the decision chart and incident summary, we moved on to gain a deeper understanding of the situation as provided by the decision analysis table. Finally, we concentrated on the items of interest within each incident and compared them in the fifth step of the structured approach. By using this methodology we obtained a tool for identifying uncertainty and strategy in each case. This is not just useful for testing the theoretical model, but it also gave us an understanding of the uncertainties and strategies that can emerge in paramedics. It links the categories to real problems, actions and decisions. This knowledge can be used to create training scenarios to improve the way in which uncertainty is managed.

Lessons learned

The CDM structured approach to data analysis proved to be beneficial in the study of a priori defined concepts, in our case uncertainty and coping strategies. By creating the decision chart and summary we were able to organize a large amount of data which had not been presented chronologically during the interview. We discovered that the digitalized version of the decision chart, which represents the timeline of the situation, is very flexible and enabled us to organize the data and add details more easily. In some cases distinguishing

between the actions and decisions can be more challenging. This problem was resolved by the decision analysis table which summarizes the actions and decisions together in one column. The decision analysis table helped us to better understand the background behind different actions and the decisions the paramedics made and to link the cues, goal and reasons to these decisions/actions. Finally, by identifying uncertainty and coping strategies in each incident we were able to compare them across the different incidents. We found that the type of uncertainty and the coping strategies differed across the different phases of the paramedic incident. Moreover, the data analysis table described the different individual cases of the uncertainty-strategy pairs and provided actual examples from the paramedic field. One shortcoming of this method is that it is quite time consuming. Depending on the research goals, one could consider choosing just some of the steps that would suit its purposes. Nevertheless, it is a trade-off between depth of the analysis and time.

Conclusion

The critical decision method has found its niche among cognitive task analysis methods. It is mainly used to elicit expert knowledge and also often to identify training requirements. The benefits of CDM are found in its richness and depth, providing insights into expert reasoning. On the other hand, CDM produces long and rich transcripts making analysis demanding. Therefore, as a guide for researchers interested in this method, we have presented a step-by-step example of the data analysis using the structured approach in a non-routine paramedical situation. This example may serve as a guide to researchers new to the critical decision method who are looking for guidance on data analysis. In our example we presented the structured approach, which is beneficial in cases where the researcher knows what s/he is looking for in the data. If the researcher is more interested in exploratory data analysis, the emergent themes approach (ETA) can be used. It is important to note that these two approaches are not mutually exclusive, but complementary, and that each approach provides a different perspective on the data.

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